Report of the Literature Review Committee*

23rd Annual Review of the Literature on Fats, Oils, and Detergents. II.

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Nutrition and Biochemistry

REVIEWS AND GENERAL INFORMATION. Specific review and general information communications pertinent to this subject are: chemistry of lipides (Shorland—*Ann. Rev. Biochem. 25,* 101); metabolism of lipides (Bergström & Bergström—*Ibid.* 177); food science related to food fat (Kaufmann—*Fette-Seifen-Anstrichmittel 57,* 897); nutritive fats (Lembke— *Molkerei- u. Käserei-Ztg. 7,* 586); function of essential fatty acids (Holman—*Svensk. Kem. Tidskr. 68,* 282); fat soluble vitamins (Kodicek—*Ann. Rev. Biochem. 25,* 497); digestion and absorption of fat (Mattson—*Food Res. 21,* 34); distribution of lipase in the alimentary tract and associated glands of laboratory animals (Martin—*J. Anat. 90,* 440); biochemistry of lipides (Debuch—*Acta Histochem. 2,* 135); biological mechanism of β-oxidation (Decker—*Fette-Seifen-Anstrichmittel 58,* 163); nomenclature of the enzymes involved in fatty acid metabolism (Beinert *et al.*—*Mededel. Koninkl. Vlaam. Acad. Wetenschap. Belg. Kl. Wetenschap. 17,* No. 11, 9 pp.; *Biochem. Z. 328,* 75; *Biochem. J. 64,* 782; *Science 124,* 614); enzymes involved in the metabolism of essential fatty acids (Holman—*Ann. Rept. Hormel Inst. 1955–6,* 43); the biological cycle of fatty acids (Bargoni—*Giorn. biochem. 5,* 63); chemistry of milk fat (Jack & Smith—*J. Dairy Sci. 39,* 1); clinical and nutritional aspects of lipotropic agents (Gabuzda—*J. Am. Med. Assoc. 160,* 969); metabolism and mechanism of action of lipotropic factors (Müller—*Deut. med. Wochschr. 81,* 127); lipides of rat liver cell slices (Spiro—*Univ. Microfilms, Ann Arbor, Mich., Publ. No. 15068,* 56 pp.); conference on phospholipides (Anon.—*Chemistry & Industry 1956,* 420); chemistry of animal phosphatides (Hawthorne—*Ibid.* 1171); chemistry of phospholipides (Malkin—*Ibid.* 1186); application of countercurrent distribution of phospholipide chemistry (Olley —*Ibid.* 1120); synthesis of glycerolphosphatides (Baer—*Can. J. Biochem. & Physiol. 34,* 288); chemistry of phosphoinositides (Folch & LeBaron—*Ibid.* 305); chemistry of sphingolipides (Carter *et al.*—*Ibid.* 334); biological synthesis of phospholipides (Kennedy—*Ibid.* 334); metabolism of phospholipides in vitro (Hokin & Hokin—*Ibid.* 349); function of phospholipides (Beveridge—*Ibid.* 361); clinical significance of the determination of serum lipoproteins (Majoor—*Ned. Tijdschr. Geneesk. 98,* 3177); properties of human serum lipoproteins (Hack—*Proc. Soc. Biol. Med. 91,* 92); clinical significance of fatty acids binding by human albumins (Axenfeld—*Wien. klin. Wochschr. 68,* 296); electrophoresis of lipoproteins (Geintz—*Fette-Seifen-Anstrichmittel 97,* 1000; Berger—*Bull. soc. pharm. Marseille 4,* 195; Fasoli—*Il. Progr. Med. 11,* 330); lipoproteins of serum (Hinsberg—*Fette-Seifen-Anstrichmittel 57,* 999); fat nutrition and the course of diseases (Kaufmann & Schmidt—*Ibid. 58,* 879); animal fats and diseases (Shorland—*Food Manuf. 31,* 272); cholesterol metabolism (Friedman *et al.*—*Ann. Rev. Biochem. 25,* 613; Boyd *et al.*—*Proc. Nutr. Soc. 15,* 52); cholesterol content of foods (Okey—*J. Am. Med. Assoc. 161,* 669); methods for investigating cholesterol and associated lipides (Lovern—*Proc. Nutr. Soc. 15,* 46); cholesterol and fat metabolism in relation to nutrition and disease (Cook—*Ibid.* 41); biochemical aspects of atherosclerosis (Anfinsen—*Fed. Proc. 15,* 894); dietary aspects of atherosclerosis (Stare—*Ibid.* 900); biosynthetic path to steroids (Anon.—*Chem. & Eng. News 34,* 6180); research approach to atherosclerosis (Katz *et al.*—*J. Am. Med. Assoc.* 161, 536); research in atherosclerosis (Stare—*J. Am. Diet. Assoc. 32,* 309); experimental cholesterol atherosclerosis (Rannie—*Proc. Nutr. Soc. 15,* 61); is atherosclerosis a continued pyridoxal deficiency (Schroeder—*J. Chronic Dis. 2,* 28); arteriosclerosis in occupational medicine (Paterni—*Folia Med. Naples 39,* 573); relationship of lipaemia to thrombosis and atheroma (Fullerton—*Proc. Nutr. Soc. 15,* 66); cholesterol and arteriosclerosis (Schweigert—*Am. Meat Inst. Foundation Circ. No. 19,* 21 pp.); biochemistry arteriosclerosis (Schettler—*Wien. klin. Wochschr. 67,* 767); comparative susceptibility to experimental atherosclerosis (Pilgeram—*Fed. Proc. 14,* 728); role of some vitamins in phophylaxis and treatment of initial forms of hypertonia and atherosclerosis (Golbers—*Latvijas P.S.R. Zinatnu Akad. Vestis 1956,* No. 4, 73); lipoproteins and atherosclerosis (Bloom—*Arizona Med. 9,* No. 8, 21); liver and atherosclerosis (Aubertin—*J. med. Bordeaux 133,* 105); action of heparin on the disturbed metabolism of lipides (Scheidegger *et al.*—*Helv. Med. Acta 22,* 565); variations in content of proteins and principal lipides in the blood plasma of the rabbit (Hrachovec—*Compt. rend. 243,* 415); influence of fatty materials from tuberculosis organisms on tuberculous infection (Zorn—*Wiss. Z. Friedrich-Schiller-Univ. Jena Math.-naturwiss. Reihe 1954–5,* 559); oxidation of fats by plant lipoxidases and fatty acid dehydrogenases (Frehse & Frank—*Fette-Seifen-Anstrichmittel 58,* 403, 593); fat formation in plants (Prokof'ev—*Uspekhi Sovremennoi Biol. 39,* 129); and biogenesis of long-chain fatty acids in a higher plant (Gibble —*Univ. Microfilms, Ann Arbor, Mich., Publ. No. 13964,* 34 pp.).

Table of Contents

*LITERATURE REVIEW COMMITTEE
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FAT NUTRITION. The value of fats in the nutrition of farm livestock is being investigated because in years of excess supply or when cheap inedible fats are available it may be economical to include them in feed formulation. Grain feed mixtures containing added stabilized fats store well and when fed to dairy cows do not affect milk yield nor alter the characteristics or vitamin A content of the butterfat produced (Horton *et al.—J. Dairy Sci. 39,* 1461). Calves fed rations containing tallow grew 5–6% faster and required less feed per pound of weight gain than controls (Johnson *et al.—Ibid.* 1268). Inedible tallow fed as 7% of the ration of steers significantly reduced digestibility of dry matter and crude fiber but increased the digestibility of the ether extract (Erwin *et al.—J. Animal Sci. 15,* 717). Fevrier (*Rev. franc. corps 3,* 24) discussed the addition of stabilized animal fats to cattle feeds. In tests on utilization of lard by baby pigs the fat digestibility increased from 83.8 to 90.3% between the second and fourth week of a test and the lard had no effect on the digestibility of casein or glucose or on the efficiency of energy utilization (Cunningham & Brisson—*Can. J. Agr. Sci. 35,* 371). Addition of fat to hog rations did not affect the quality of the cured hams produced (Mahon *et al.—Food Tech. 10,* 265, 272, 274). Rabbits fed *ad libitum,* made greater gains on a purified diet containing 10% fat than on a commercial rabbit ration containing 5% fat (Thacker—*J. Nutr. 58,* 243). Many investigators have demonstrated that addition of fats to poultry rations increased the feed efficiency (Reiser *et al.—J. Agr. Food Chem. 4,* 798; Naber & Morgan—*Poultry Sci. 35,* 1161; Curtin & Raper—*Ibid.* 273; Sunde—*Ibid.* 362; Davidson—*J. Sci. Food & Agr. 7,* 240; Rosenberg *et al.—Poultry Sci. 34,* 1308; Arscott—*Ibid. 35,* 1131). The fats investigated included methyl esters of tallow fatty acids, white grease, acidulated cottonseed soapstock, brown grease, and prime tallow. Supplementing turkey poult diets with fat, particularly all vegetable-protein diets, improved the growth rate of the poults (Sizemore *et al.—Ibid.* 1172). The requirements of poultry for choline and folic acid are increased on adding fats to their rations (March & Biely—*Ibid.* 545, 550). The same is true for vitamin B_{12} requirements (Fox *et al.—Ibid.* 501). When the diet of chickens is adequate in vitamin B_{12} and choline the addition of 4% tallow does not affect the hatchability of the eggs produced (Balloun—*Poultry Sci. 35,* 737).

First generation female rats receiving corn oil with 2% sulfathalidine produced young with postnatal mortality of 9–48% within three days; whereas essentially complete survival occurred when the corn oil was replaced with butterfat (Viswanatha & Liener—*J. Nutr. 59,* 197). Rats fed trilaurin plus methyl linoleate as a fat source reproduced and lactated normally (Dryden *et al.—Ibid. 58,* 335). Ingestion of 70 grams of butter by normal fasting subjects was regularly followed by a shortening of the blood coagulation time (Lasch & Schimpf—*Deut. Arch. klin. Med. 203,* 446).

Rats on high-protein and high-fat diets are able to maintain weight with 25% fewer calories than rats on high-carbohydrate diets (Kaunitz *et al.—J. Nutr. 60,* 221). According to Metta & Mitchell (*Ibid. 59,* 501), dietary fat and carbohydrates when fed in isocaloric amounts to rats have essentially the same effect on protein utilization in both protein-depleted and growing animals. Cohn & Joseph (*Proc. Soc. Exptl. Biol. Med. 93,* 462) also found the two equal for sparing nitrogen in phlorohizinized rats. According to Fox *et al.* (*Fed. Proc. 15,* 551) dietary fats reduce the catabolism of tissue protein under stress of limited feeding of a protein-free ration; and during this stress condition there is an increased need for essential fatty acids and tocopherols. High fat rations decrease salivation in the dog; whereas high carbohydrate rations increase it (Sergeeva—*Voprosy Pitaniya 15,* No. 1, 9). The utilization of glucose, as exhibited by an increase of the respiratory quotient, was much more evident in sucrose fed rats than in animals that were maintained on high fat-low protein diets (Ciancimino *et al.—Arch. fisiol. 54,* 396). With purified diets containing a cellulose material (Solka-floc), as bulk, guinea pigs gained 7.9 g. per day when the sole source of carbohydrate or fat was 12% corn oil; gained 4.9 g. per day with 24% corn oil, 2.2 g. per day with lactose and 4.4 g. per day with 1:1 mixture of lactose-sucrose (Heinicke & Elvehjem—*Proc. Soc. Exptl. Biol. Med. 90,* 70). Rats fed high-fat or high-carbohydrate diets had similar blood sugar values, glucose tolerance, and water requirements; but the rats on the high-fat diet had lower liver weights and diminution of the islets of Langerhans (Vartianen & Telkkä—*Ann. Med. Internat'l. Fenniae 44,* 78).

Six workmen doing hard labor in a hot environment were observed for eight days during which 50 g. of soybean oil per day was added to their diet and for 12 days during which 100 g. of the oil was added (Yasui—*Repts. Res. Lab. Asahi Glass Co. 1,* 247, 370). The fat increase in the diet did not lower operational efficiency and acted favorably for control of acid-base balance and water metabolism.

The reduction of thiopental sleeping time in animals by both orally and intravenously administered fat and the reversal of this by administration of heparin has suggested that the fatty meal exerts its effect by virtue of the chylomicronemia resulting from absorption of the fat (Anderson & Magee—*J. Pharm. & Exptl. Therap. 117,* 281).

Some investigations were recorded on the production of essential fatty acid deficiency, and structure and metabolism of the acids involved in the cure. Aaes-Jorgensen *et al.* (*Brit. J. Nutr. 10,* 292, 317) induced fatty acid deficiency in rats with a diet of vitamin test casein and hydrogenated peanut oil and recorded the effects on reproduction, spermatogenesis, growth, skin, kidneys, testes, ovaries, liver and adrenals. Studies on essential fatty acid deficiency by Holman *et al.* (*Proc. Soc. Exptl. Biol. Med. 93,* 175; *Ann. Rept. Hormel Inst. 1955–6,* 35) have indicated that diabetes or feeding of cholesterol, sulfasuxidine or *trans-* isomers of essential fatty acids accelerate the onset of the deficiency; and testicular degeneration induced by the deficiency is only partially corrected by supplementation of diets with linoleates. The metabolic pathway of essential fatty acids was studied using radio-active tracer technique (Mead *et al.—Fed. Proc. 15,* 313; *J. Biol. Chem. 218,* 401; *219,* 705; *220,* 257). The fat-deficient rat metabolized stearate and linoleate at a greater and oleate at a lower rate than the normal rat. Oleate was not converted to linoleate, but linoleate may be converted to arachidonate. An unsaturated fatty acid which accumulates in male fat-deficient rats was shown to be 5,8,11-eicosatrienoic acid and is presumably a reduction product of arachidonic acid. This work also demonstrated that arachidonic is synthesized *in vivo* by condensation of linoleate with acetate. According to Panos *et al.* (*Proc. Soc. Exptl. Biol. Med. 93,* 581) the fat deficiency syndrome is not modified by supplementation of the diet with saturated acids. De Iongh & Thomasson (*Nature 124,* 1051) observed that the C_{20} and C_{22} polyene acids of the brain phospholipides have essential fatty acid activity. This observation and the known fact that hexane lipids of the brain are decreased in fat-deficiency were interpreted to suggest that a relationship exists between the essential fatty acid and the central nervous system. Other observations in this work support the 6, 9-ene structure hypothesis of essential fatty acids.

Essential fatty acid nutrition was studied in infants using di-, tri-, and tetraenoic acid analyses on blood lipides as criteria for response from the diets (Wiese *et al.—Fed. Proc. 15,* 577). Linoleic acid as trilinolein given at 1% calorie level in a skimmilk diet significantly increased polyunsaturated acids in the blood; but as methyl or ethyl linoleate, at least three times more were required to produce the same response. In the feces of breast-fed infants 1.8–7.1% of the fatty acids contain more than one double bond, compared to 0.4–2.0% in feces of infants fed on cow milk (Söderhjem—*Acta Soc. Med. Upsaliensis 57,* 438). The polyunsaturated fatty acids were estimated in the brain, liver, heart, muscle, lung, kidney, and subcutaneous fatty tissues obtained from premature infants to serve as fundamental information in essential fatty acid studies (*Ibid.* 448). A correlation has been made between autoxidation as determined manometrically and total polyunsaturated fatty acid as determined spectrophotometrically of serum lipides (Evans *et al.—J. Applied Physiol. 9,* 301). The empirical curve formulated therefrom served as a basis for a quick and simple oxidative method for estimating polyunsaturated acids.

Essential fatty acid deficiency has been induced in baby chicks and the symptoms and pathology were recorded (Bieri *et al.—Fed. Proc. 15,* 544; *Proc. Soc. Exptl. Biol. Med. 93,* 237). The visible signs are retarded growth, depigmentation of feathers and scaliness of skin. Calves fed milk fat consistently maintained higher plasma arachidonic acid (essential fatty acid) values than groups that received lard, crude soybean oil, or hydrogenated soybean oil (Allen *et al.—J. Dairy Sci. 39,* 1161). The milk fat which calves susceptible to muscular dystrophy receive is less unsaturated beside being grossly deficient in tocopherol than is normal milk fat, but the serum lipides of these calves do not deviate from normal with respect to content of polyethenoid acids (Garton *et al.—Nature 177,* 792).

New emulsions for parenteral alimentation were devised and tested. By the use of glycerol, oil and phosphatide, a substantially anhydrous syrup was prepared which upon manual shaking with 5% aqueous dextrose produced a very finely dispersed fat emulsion suitable for intravenous injection (Zilversmit *et al.—J. Lab. Clin. Med. 48,* 386). An "instant" fat emulsion

prepared by manual mixing of oil, emulsifier, alcohol and water obviated high pressure homogenization and was freshly prepared for each intravenous infusion (Shafiroff & Mulholland—*Proc. Soc. Exptl. Biol. Med. 91,* 111). Among 633 patients 62% tolerated, without untoward effects, a parenteral administration fat emulsion containing sesame oil, dextrose and soybean phosphatides, and it had to be discontinued in only 6% of the individuals because of side effects (Jordan *et al.—Surg. Gynec. & Obst. 102,* 737).

Pure 2-lactyl-1,3-dipalmitin was prepared and its properties were recorded in the interest of its use as an emulsifier in parenteral fat administration (Goldblatt *et al.—J. Am. Chem. Soc. 77,* 2477). The toxicity developing in stored parenteral fat emulsions containing lecithin emulsifier may be due to hydrolysis to give a hemolytic product, presumably lysolecithin (Lambert *et al.—Am. J. Physiol. 186,* 397). However, lack of change in biliribin content of bile in subjects receiving fat intravenously was interpreted as indicating that no hemolysis takes place (Mueller *et al.—J. Lab. Clin. Med. 48,* 379). It was therefore suggested that thermogenic responses are due to other causes. The heat stability in the temperature range of 5-120° has been determined for many common emulsifiers to evaluate their stability after homogenization and sterilization for use in intravenous alimentation (Benerito & Singleton—*J. Am. Oil Chemists' Soc. 33,* 364). Emulsions prepared with emulsifiers whose solubility inversion temperatures were above 85° maintained a low particle size after autoclaving; did not separate into a watery phase and an emulsion; and did not form a layer of oil. Intravenous injection of bile salts accelerates the utilization of intravenously administered fat, the glycocholate having the strongest and taurocholate the weakest activity (Kobayashi—*Hiroshima J. Med. Sci. 4,* 311).

Intravenous administration of a 10% olive oil emulsion into healthy dogs produced marked thrombocytopenia, leucopenia, neutropenia, eosinopenia, lymphopenia, increase in mechanical fragility of erythrocytes and increase in hematocrit (Meng *et al.—Am. J. Physiol. 187,* 107). Some of these effects are correlated with the degree of lipemia produced. Intravenous administration of fat emulsion or certain nonionic emulsifiers alone markedly prolonged blood coagulation time in some animals (Shoulders *et al.—Fed. Proc. 15,* 170). The effect of intravenously administered fat on serum proteins and lipoproteins was also studied. In electrophoresis analyses the β-lipoproteins moved with the speed of α-2-globulins; α-lipoproteins moved ahead of albumin; and small amounts of protein migrated ahead of albumin (Herbst *et al.—Science 123,* 843). The changes are said to be identical with those induced by administration of heparin in normal persons during alimentary hyperlipemia. In similar work, an increase in fat mobility induced by soybean phosphatides was suggested as a possible source of adverse effects encountered in some instances when certain intravenous fat emulsions are administered (Benerito *et al.—Fed. Proc. 15,* 218). Continuous intravenous administration of neutral fat and soya lecithin quickly leads to hypercholesteremia (Friedman & Byers—*Proc. Soc. Biol. & Med. 90,* 496). This association of hypercholesteremia with hyperlipemia has suggested that the derangement may not be in the cholesterol but in some phase of fat metabolism. Because the emulsifier, "Triton WR-1339" inhibited lipoprotein lipase activity it was believed that this action is a mechanism by which injected Triton causes hyperlipemia (Schotz & Scanu —*Fed. Proc. 15,* 349).

The toxicity of autoxidized and heated oils was investigated. Kaunitz *et al.* (*Fed. Proc. 15,* 521; *J. Am. Oil Chemists' Soc. 33,* 630; *J. Nutr. 60,* 237) found that fractions molecularly distilled at 280° from oxidized lard and cottonseed oil were nontoxic, but of slightly reduced net energy value when compared to the fresh fats. The polymer in the undistilled oxidized fat was a more potent growth-depressant when compared to fresh fat, but addition of distillate or preferably fresh fat protected the test animal from the effects of the polymer. Johnsons' *et al.s'* (*J. Am. Oil Chemists' Soc. 33,* 433) feeding tests with thermally oxidized fats and oils indicated that growth depression was related to unsaturation, which suggested that products formed from the unsaturated portion during oxidation were responsible for growth depression. Similar conclusions were drawn from like work by Kaneda *et al.* (*J. Biochem., Japan, 42,* 561). Reduced growth of rats fed fats in which oxidation was initiated by radiation correlated well with the peroxide value of the fats (Andrews *et al.—Fed. Proc. 15,* 918). With heat polymerized linseed, soybean and sunflower oils non-adduct-forming fractions containing nonconjugatable diene *cis*-isomers, possibly of cyclic structure, were of low nutritive value (Crampton *et al.—J. Nutr. 60,* 13).

The alkaloids present in argemone oil have been isolated and their toxicity as well as that of the original oil has been studied in dogs and monkeys (Roy *et al.—Patna J. Med. 28,* 269). The toxic effect to livestock of gossypol, which may be present in cottonseed products can be nullified by increasing the protein intake (Cabell & Earle—*J. Am. Oil Chemists' Soc. 33,* 416).

INTESTINAL ABSORPTION OF FATS AND OILS. The origin of fat in the feces and the factors influencing the amount present have been studied to assist in elucidating fat absorption and excretion. Rats fed 15% olive oil and massive doses of antibiotics lost weight and excreted less lipides than controls not fed antibiotics (Chipault—*Ann. Rept. Hormel Inst. 1955–6,* 29). These excreted lipides were low in saturated acids and contained more of the essential acids than normally. Similar observation on fat excretion after antibiotic feeding were reported by Holasek (*Hoppe, Seylers' Z, physiol. Chem. 298,* 55). This was interpreted to indicate that fecal lipides are not excreted through the intestinal wall but are almost completely of bacterial origin. Confirmation was based on the observation that accelerating the emptying time of the intestines by increase in bulk reduced fecal fat by limiting the time of action of bacteria. Organisms capable of synthesizing significant quantities of fat were isolated from human feces (Sammons *et al.—Nature 177,* 237). These investigators suggested that fat synthesis of this type may make a significant contribution to fecal fat. Lipide excretion was greater with diets containing oleic acid than with diets containing corn or olive oil (Swells *et al.—Proc. Soc. Exptl. Biol. Med. 92,* 613).

Fat absorption studies on Rhesus monkeys showed that fecal fat loss in the individual monkey varied greatly from one collection period to another (De Oliveira *et al.—J. Nutr. 59,* 515). They suggested that a long balance period in such tests is required to obtain reliable data on fat absorption. X-irradiation of monkeys on such tests did not affect fat absorption (Coniglio *et al.—Am. J. Physiol. 184,* 113). The level of fecal fat increases with increasing dosage of X-irradiation, but the fat composition does not change (Morehouse & Searcy—*Science 123,* 1032).

The portion of the intestines participating in fat absorption was investigated on dogs with intestinal loop fistulae. After a meal rich in butter, the veins of the upper portion of the small intestines contained considerable fat, while those of the lower sections showed less lipides (Kadykov & Yazeva—*Doklady Akad. Nauk S.S.S.R. 105,* 856). This was interpreted to indicate that the small intestine participates in some intermediate metabolic process. Another investigation demonstrated that greatest fat absorption occurs from the third quarter of the small intestine (Benson *et al.—Gastroenterology 30,* 53). Intesinal mucosa from the first third of the intestine was more active in incorporating palmitic acid into preëxisting glycerides than mucosa preparations from the more distal portions (Favarger & Gerlach—*Helv. Physiol. et Pharmacol. Acta. 14,* C16). In the cockroach lipase is exclusively excreted in midgut and caeca and is passed forward; thus hydrolysis takes place in the foregut (Eisner—*J. Exptl. Zool. 130,* 159). When radioactive decanoic acid is fed to rats, the major portion is found in the lymph lipides as triglycerides and phospholipides (Blomstrand—*Acta Physiol. Scand. 34,* 67) whereas in the portal blood and *vena cava* it is in the form of free acid (Borgström—*Ibid.* 71).

During fasting or on a fat-free diet the fatty acid output of the intestinal lymph was fairly constant (Kim *et al.—Am. J. Physiol. 184,* 445). The lymph fat decreases considerably in the absence of bile or pancreatic juice. Rats fed rape oil continued to excrete erucic acid after return to normal diet; in the absence of bile this excretion of erucic acid was increased (Bernhard *et al.—Hoppe-Seylers' Z. Physiol. Chem. 304,* 138). These data suggest that under normal dietary conditions endogenous fat is secreted into the lumen of the intestines and then is partially reabsorbed. In absence of bile reabsorption is decreased. Investigation of the methods for measuring rate of absorption of fat showed that those based on disappearance of fat from the intestines were unsatisfactory because endogenous fat is secreted during absorption; and methods based on labeled fatty acid are affected by selective absorption (Tidwell *et al.—J. Biol. Chem. 220,* 733). Good agreement was observed in methods based on labeled carbon dioxide expired, radioactivity of blood, of chylomicrograph, and recovery from tissue. A method of studying intestinal absorption of fat using I^{131} labeled fats was described (Malm *et al.—Proc. Soc. Exptl. Biol. Med. 92,* 471).

The new studies on nutritive value of fats were based on either rate of intestinal absorption or growth of animals. Based on rates of absorption and growth, Thomasson (*J. Nutr. 59,* 343, 455, 469) classified the common edible fats and oils

into five groups. A significant correlation appeared to exist between the rate of absorption and growth action of the oils and fats. Shea butter and palm oil seemed to be exceptions possibly because of presence of a growth inhibiting substance; but these oils were considered harmless on the basis of longevity data. Poor growth also occurred with oils of high erucic acid content. Growth of rats was promoted by addition of butter or corn oil to the diet and the former was superior for growth only at high levels of fat intake (Dryden *et al.—J. Nutr. 58,* 189). Comparative digestibility tests on butter and refined cottonseed oil indicated that they are about equal in this respect (Babakhodzhev—*Voprosy Pitaniya 15,* No. 1, 43). Studies on the nutritive value of whale oils have shown that: the original and hydrogenated oils were better than the methyl esters; sperm whale oil causes a seborrhea in rats similar to that obtained with diets containing oxidized soybean oil; and the nutritive value of nickel catalyzed hydrogenated oil is improved by adding ethyl linoleate (Fujii—*Repts. Japan Marine Products Co. Res. Lab. No. 7,* 18, 23, 28).

Tests on many natural fats, representing variations in saturation and chain length showed that digestibility by rats is high and unrelated to the chemical characteristics (Calloway *et al.—Food Res. 21,* 621; *Fed. Proc. 15,* 545). When these fats were fully hydrogenated, the digestibility varied inversely in linear fashion with melting point and with chain length. Monoglycerides of the hydrogenated fats were more digestible than diglycerides. The findings suggest that digestibility is dependent on chain length of the saturated acids and their arrangement within the glyceride structure. In similar work with young pigs and young guinea pigs, about 30% of the total variability in apparent digestibility of fats and oils was attributed to fatty acid chain length, whereas degree of unsaturation was of minor significance (Lloyd & Crampton—*J. Animal Sci. 15,* 1229). With pups neither chain length nor unsaturation had any significant effect on the apparent digestibility. When 20 mg. of tripalmitin was fed to rats 3.3% was absorbed from the intestines unhydrolyzed. (Reiser & Dieckert —*Fed. Proc. 15,* 336; *Proc. Soc. Exptl. Biol. Med. 92,* 649). Calves fed "filled" milks containing a mixture of tributyrin and tallow as the fat made gains essentially equivalent to those made on whole milk (Ritchey *et al.—J. Dairy Sci. 39,* 1071). Nutritive value experiments have demonstrated that the "acetin fats," made by interesterification of fats with triacetin, are as nutritious as the usual edible triglycerides (Ambrose & Robbins—*J. Nutr. 58,* 113; Mattson *et al.—Ibid. 59,* 277).

Studies on fat absorption showed that feeding pancreatic lipase preparations decreases the time required by human subjects to reach maximum absorption of fats, whereas bile and plant lipase preparations are without effect (Redetzki & Gronow—*Klin. Wochshr. 33,* 701). This observation was also evident in studies in which the labeled fat technique was used (Wells *et al.—Proc. Soc. Exptl. Biol. & Med. 90,* 717). Fat wastage in pancreatic deficient infants was decreased considerably when high potency pancreatin was added to each milk feeding (Kumar & Gibbs—*J. Dis. Children 91,* 606).

Ahrens & Borgström (*J. Biol. Chem. 219,* 665) presented evidence showing that during digestion an exchange of fatty acids (transesterification) occurs through hydrolysis and resynthesis to new esters; that the intestinal hydrolysis of monoglycerides is irreversible; and that hydrolysis proceeds at a faster rate than absorption. When fats are hydrolyzed by lipase there is a specificity of action at the primary positions of the glyceride, which is much greater than any specificity that may be due to unsaturation or chain length (Savory & Desnuelle—*Biochim. et Biophys. Acta 21,* 349; Mattson & Beck—*J. Biol. Chem. 219,* 735). Specificity of pancreatic lipase *in vivo* and *in vitro* was towards liberation of the more saturated acids first (Clement & Clement-Champougny—*Arch. sci. physiol. 10,* 73). Studies on rat pancreas suspensions indicated that at least three esterases are present; each with characteristic activity (Myers *et al.—Biochem. J. 61,* 521).

The synthetic detergent, sodium dodecyl sulfate markedly inhibits pancreatic enzymes *in vitro* and *in vivo,* and it depresses absorption of lipides and other food components (Fuchs *et al.—Gastroenterology 27,* 802). An evaluation of the detergent "Tween 80" for reducing-fecal nitrogen and fat loss following subtotal and total gastrectomy showed that no such reduction occurs (Everson & Hoppe—*Surgery 34,* 33). An observation that monoglycerides of *trans*-octadecenoic acid produce more stable emulsions than those of the *cis*-form was discussed with regard to the biological implications of this difference (Wachs—*Fette-Seifen-Anstrichmittel 58,* 257). Choline, and to lesser extent methionine and ethionine accelerate fat absorption (Tidwell—*J. Nutr. 58,* 569). It was suggested that the improvement with choline is due to increased lecithin production, that methionine acts through production of choline, and ethionine through liberation of methionine. Tests on metabolism of the glycerol of triglycerides have shown that most is absorbed within four hours and up to this time about one quarter has been oxidized (Gidez & Karnovsky—*J. Biol. Chem. 223,* 293). The labeled glycerol in this work was found among the body triglycerides and phosphatides and there was very little synthesis of glycogen from the glyceride glycerol.

INTERMEDIATE METABOLISM OF THE GLYCERIDES. The term intermediate metabolism, for the purposes of this paper, pertains to composition, transport, synthesis, oxidation, storage, and catabolism in the body.

The polyunsaturated fatty acids in the blood of seven normal human males were determined as fundamental physiological data (Evans *et al.—J. Biol. Chem. 218,* 255). In another communication the same measurements on 13 individuals are recorded as the iodine and thiocyanogen values of the fatty acids of blood plasma (Kibrick & Skupp—*Clin. Chem. 1,* 324). Unsaturation of blood increases on passage through the lungs and decreases on passage through the peripheral circulation (Schirosa & Guarini—*Boll. soc. ital. biol. sper. 31,* 938, 939). More neutral fat is in the blood entering lungs than in the efferent blood. In other work on pulmonary circulation it was noted that the fatty acids in arterial blood are more saturated than those of venous blood (Lorenzini & Alfonsi—*Chir. e patol. sper. 3,* 547).

The observation that unesterified fatty acids increase after ingestion of fat, during fasting, and after adrenaline injection was interpreted to indicate that the unesterified fatty acid fraction is primarily concerned with the supply of fats to tissues for oxidative metabolism (Gordon & Cherkes—*J. Clin. Invest. 35,* 206). In similar work it was also noted that carbon tetrachloride poisoning and heparin also increase free fatty acids in the blood and protamine opposes the effect (Spitzer & Miller—*Fed. Proc. 15,* 176; *Proc. Soc. Expt. Biol. Med. 92,* 124). The importance of the unesterified fatty acids in metabolism and transport, particularly palmitic and oleic acids, was studied (Dole—*Ibid. 93,* 532). This work showed that their concentration is decreased by injection of insulin. Several other workers made more comprehensive observations on the effect of heparin. The principal effects observed by Young & Freeman (*Ibid. 90,* 463) were: the normal turbidity of thoracic or intestinal lymph was diminished; glyceride content was decreased and the free acids increased; the change in glyceride content was highest in hepatic lymph and free elaidic acid appears in the lymph when trielaidin is fed before administration of heparin. Administration of heparin in lipema causes a greater rise of free fatty acids in the serum than when used in fasting subjects (Grossman *et al.—Ibid.* 106). This suggested that lipolysis with free fatty acid release plays a role in metabolism and transport.

Both post-heparin plasma and pancreatic lipase exhibit lipolytic activity and cleared the turbidity due to lipides in plasma, but the clearing factors responsible were said to be different (Hollett & Meng—*Am. J. Phys. 184,* 428). It was believed that the clearing factor of post-heparin plasma might be an esterase specific for hydrolyzing long chain acids from esters. Normal rat serum exhibits lipolytic activity following perfusion through isolated liver, but this clearing factor was not considered due to the same one involved in post-heparin serums (Spitzer & Spitzer—*Am. J. Physiol. 185,* 18). A clearing of lipemic dog plasma by partially degraded mucin has suggested that there are two types of clearing, one resulting from lipase action which produces free fatty acids, and the other a physical dispersion of the chylomicra to smaller lipide particles (Baeder *et al.—Fed. Proc. 15,* 396).

Daily injections of parathyroid hormone into guinea pigs increase total blood fat and cholesterol, and decrease phospholipides, ketone bodies and total liver fat (Notario & Larizza—*Arch. sci. med. 101,* 484). Growth hormone increases phospholipides and cholesterol esters in the blood and fatty infiltration of the liver (Sforzini—*Il. Progr. med., Naples, 10,* No. 1, 1).

Some investigations were on the effect of fats on the coagulation of blood. Poole (*Brit. J. Exptl. Pathol. 36,* 248) reported that stearic, palmitic and oleic acids decreased the coagulation time *in vitro,* whereas other common fatty acids had no effect. In this work lauric acid had the opposite effect. In a series of other investigations the reduction in clotting time of blood was attributed to the presence of phosphatidyl ethanolamine. In this work O'Brien (*Lancet 1956,* 232) observed this effect from ingestion of butter, margarine and vegetable fat, Barkhan and coworkers (*Ibid.* 234) from the ingestion of phospholipides of brain tissue, and MacLagan & Billimoria (*Ibid.* 235) from ingestion of butter, cheese,

cream, and milk. These data are discussed with regard to the diets of patients with a history of thrombosis or atherosclerosis.

New work on turnover of the fatty acids in the rat liver using radio-active labeling technique has indicated that the turnover is faster than previously reported (Tove *et al.—J. Biol. Chem. 218,* 275). In this work the metabolism of stearic acid was slower than that of palmitic or oleic acids. Clear lymph coming from the head and neck contains less chylomicrons than lymph from the liver (Morris & Courtice—*Quart. J. Expt. Physiol. 41,* 341).

Much work on fat metabolism pertained to the cause of fatty livers and removal of fat therefrom. Production of fatty liver on high-fat, low-protein diet is more rapid with beef fat (Giacolone & Rubino—*Arch. fisiol 54,* 159) or butter (Benton *et al.—J. Biol. Chem. 218,* 693) than with lard. The C_8 to C_{12} fatty acids have less tendency to produce fatty livers than longer-chain acids, lard or olive oil (Weitzel *et al.—Hoppe-Seylers' Z. physiol. Chem. 303,* 184). Obese strains of rats develop fatty livers on 50% fat diets; with 25% less fat they become obese but do not usually develop fatty livers; whereas non-obese strains did not develop fatty liver (Fenton *et al.—J. Natl. Cancer Inst. 15,* 429). Mindrum & Schiff (*Gastroenterology 29,* 825) reported that patients with fatty livers can absorb large amounts of fat and that high-fat intake reduces excess liver fat and brings about clinical improvement. Rats fed protein-free amino acid rations developed severely fatty livers under stress of lactation (Hallanger & Schultze—*J. Nutr. 60,* 25). A reduction of fatty liver produced by a low protein diet was not due entirely to reduced fatty acid oxidation (Lachaze & Levy—*Arch. sci. physiol. 9,* 63). Rats on diets containing protein solely from vegetable sources develop fatty livers of the portal type which are not prevented by lipotropic substances (Steward—*Bull. N. Y. Acad. Med. 32,* 394). The fatty livers resulting from choline deficiency are characterized by excess of lipides other than phosphatides (Spiro & McKibbin—*J. Biol. Chem. 219,* 643). Ethionine-produced fatty livers can be prevented by administration of methionine, are slightly inhibited with methylthiolactic acid or inositol, whereas choline and thiolactic acid are ineffective (Okuzono—*Kumamoto Med. J. 9,* 1). A comparison of lipotropic agents showed that choline was three times as effective as betaine; and the latter and methionine were equivalent at low levels, but at higher dosages methionine was not as efficient (Young *et al.—Can. J. Biochem & Physiol. 34,* 713). Replacement of choline by methionine in an adequate diet led to fatty infiltration of the livers of rats, particularly very young ones, the degree being influenced by the type of protein in the diet (Harper & Benton—*Biochem. J. 62,* 440). This suggests that the capacity of the rat to synthesize choline increases as it matures.

There have been several studies on the enzyme activity of fatty livers. Inositol and pancreatic lipotropic factor increase the activity of liver tributyrinase, reduce alkaline phosphatase value during restoration of fatty livers to normal (Bergmini *et al.—Boll. soc. ital. sper. 31,* 521). Present and previous observations that the enzymes, chymotrypsin, trypsin, papain and pancreatic factor prevent fatty livers of pancreatic ductlegated rats has suggested that a close relationship exists between the proteolytic enzymes and the antifatty liver factor of the pancreas (Sachdev—*Gastroenterology 27,* 353). A commercial enzyme preparation containing D-amino acid oxidase, lipoxidase citrogenase complex, and tyrosine was very efficient in preventing fatty-livers due to choline deficiency (Krüskemper & Schulze—*Naunyn-Shmiedebergs Arch. exptl. Pathol. Pharmakol. 229,* 34). A study of oxidation in fatty livers caused by threonine-deficiency has indicated that both a defect in diphosphopyridine nucleotide production and improper metabolism of endogenous diphosphopyridine nucleotide in the liver are major factors in liver fat accumulation (Arata *et al.—J. Biol. Chem. 219,* 327). Supplementation of a high-fat, low-protein diet with glucose dimethylmercaptal or methylthioglucoside did not prevent fatty livers nor enhance the ability of the liver tissue to oxidize fatty acid added *in vitro* (Lofland—*Proc. Soc. Exptl. Biol. Med. 92,* 698).

The fatty infiltration of the liver after subtotal hepatectomy can be reduced with methionine, whereas choline and inositol are ineffective (Bergamini *et al.—Boll. soc. ital. sper. 31,* 1469). These observations were correlated with changes produced in the liver enzyme systems by the lipotropic factors. Rats with dietary induced fatty livers respond to partial hepatectomy in much the same way as do animals with normal liver cells (Sutherland—*J. Pathol. Bacteriol. 7,* 403).

Drugs and miscellaneous materials were tested for lipotropic action. One investigation indicated that injections of heparin were effective; whereas aureomycin increased liver fat in choline deficiency (Di Luzio & Zilversmit—*Proc. Soc. Exptl. Biol. Med. 91,* 338). Lactose had a choline-sparing action and had lipotropic activity (Sadu—*Nature 177,* 1236). Bile acids or salts were lipotropic for fatty livers produced by choline deficiency (Monzen—*Hiroshima J. Med. Sci. 4,* 305) or by administration of carbon tetrachloride (Kobayashi—*Ibid. 3,* 307). Cupridihydroporphyrin acted similar to heparin in reducing dietary fatty livers (Martinelli—*Giorn. biochem. 5,* 115). The drugs, *p*-aminosalicylic acid, isonicotinic acid hydrazide, tibione and cyanoacetic acid hydrazide, which are used in the treatment of tuberculosis increase the neutral fat content of the liver (Okuzono—*Kumamato Med. J. 8,* 76). High dosage of folic acid are lipotropic and thyroxine augments this action (Infante & Turchetto—*Boll. soc. ital. biol. sper. 31,* 787). Fatty livers do not develop in baboons after hypophysectomy, thyroidectomy or the combination thereof (Gillman & Gilbert—*Experientia 12,* 65). In this work a simultaneous withdrawal of thyroxine and cortisone from the hypophysectomized baboon was followed by progressive deposition of fat in the liver. Testosterone propionate, 5-androstene-3β,17β-diol, methyltestosterone and hypophyseal growth hormone prevented to a large degree the production of fatty livers by ethionine (Farber & Segaloff—*J. Biol. Chem. 216,* 471). Fatty livers produced by ethanol intoxication are inhibited in adrenalectomized or hypophysectomized rats (Mallov & Bloch—*Am. J. Physiol. 184,* 29). It is suggested that ethanol intoxication may cause the mobilization of fat from the depots to the liver, and that pituitary and adrenal cortical hormones are involved in the mechanism of this mobilization.

In fatty livers resulting from carbon tetrachloride the values for nitrogen and ribo- and deoxyribonucleic acid phosphorus in nuclear and supernatant portions of rat liver homogenate are not changed (Vegni—*Giorn. biochim. 5,* 106). In such fatty livers the level of coenzyme A is decreased (Severi & Fonnesu—*Proc. Soc. Exptl. Biol. Med. 91,* 368). Mucoprotein does not have any effect on the liver steatosis produced by carbon tetrachloride in guinea pigs when it is already induced, but the development of steatosis is reduced if the mucoprotein is given before or during the administration of the carbon tetrachloride (Castellani—*Boll. soc. ital. biol. sper. 31,* 1078). Administration of carbon tetrachloride, cholesterol, a high fat diet, and raw liver diets all cause an increase of simple glycerides in the liver, and cholesterol and high fat diets decrease the choline-phospholipide fraction (Sakagami *et al.—Sapporo Med. J. 4,* 31, 34, 75). This report also included data on the effect of the dietary regimes on lipides of other organs and muscles.

The cellular fractions in liver necrosis produced by the administration of bromobenzene contains more total cholesterol and less lecithin phosphorus than that of normal livers (Cornatzer & Gallo—*Proc. Soc. Exptl. Biol. Med. 93,* 287). The increase of liver lipides caused by poisoning with sodium 5-ethyl-5-(1-methyl-propyl)thiobarbiturate is not caused by influx of depot fat into the liver (Block—*Arzneimittel-Forsch. 5,* 642). The compound 4-aminopyrazolo-(3,4-d)-pyridine produced a fatty change in liver which was associated neither with necrosis nor with inflammation (Scholler *et al.—Proc. Exptl. Biol. Med. 93,* 398).

Rats were fed wheat alone, fasted, or intoxicated with various chlorinated hydrocarbon vapors. The glycerides plus steroids and phospholipides of various fraction of the livers were analyzed (Ceccadi & Biez-Charreton—*Semaine hop. Paris 32,* 577).

Most current work on biological oxidation is done by means of the radio-active technique. Other procedures include use of cyclodextrins to inhibit enzymatic action of phosphorylase and paper chromatography of radio active fatty acids and esters (Schlenk & Mangold—*Ann. Rept. Hormel Inst. 1955-6,* 46). Feeding a low-fat diet to rats reduces the ability of the liver to oxidize fatty acids, but if the rats are fasted several days before sacrifice the oxidative ability is normal (Harel—*Compt. rend. 241,* 1516). These results were considered to be an example of metabolic adaptation. Vitamin B_{12} deficiency like fasting causes a marked decrease in cytochrome oxidase (O'Dell *et al.—J. Biol. Chem. 217,* 625). Liver slices of fat diet-adapted rats oxidized more added palmitic acid than those of carbohydrate fed controls (Tepperman *et al.—Am. J. Physiol. 184,* 80). Studies in which oral administration of glucose reduced the conversion of labeled palmitic acid to carbon dioxide and aceto-acetate, and those in which addition of glucose to the media caused reduction of this oxidation *in vitro* were interpreted to indicate that carbohydrate utilization regulates the catabolism of long chain fatty acids (*Lassow et al.—J. Biol. Chem. 222,* 531). Tests have demonstrated that

presence of acetate and butyrate do not influence the capacity of liver slices to oxidize propionate (Felts *et al.—Fed. Proc. 15,* 61). Experiments with long chain odd carbon fatty acids labeled at various positions with radio active carbons have shown that liver slices cannot convert the terminal three-carbon unit into a two-carbon unit (Chapman *et al.—J. Biol. Chem. 222,* 363). The sparing of long-chain fatty acid by insulin, like its action on lipogenesis, is a manifestation of increased glucose utilization in liver (Lassow *et al.—Ibid. 220,* 839). A single injection of growth hormone produced no inhibition of liver fat acid oxidase in normal or diabetic rats at six hours but produced stimulation of this system at 12 hours after injection (Greenbaum—*Intern. Symp. Hypophyseal Growth Harmone Detroit 1954,* 330; *Biochem. J. 63,* 159). In similar work with the growth hormone in which animals were sacrificed two hours after injection, the liver exhibited less incorporation into fatty acids of radio-active carbon from labeled acetate and an increased incorporation into cholesterol (Allen *et al.—J. Biol. Chem. 221,* 333).

In the metabolism of labeled carboxyl groups in 2, 3, 4, and 8 carbon fatty acids by the isolated dog heart, the labeled carbon dioxide released represented 20, 5, 3, and 3% of the total carbon dioxide from the respective acids (Calvert & Johnson—*Am. J. Physiol. 184,* 582). Formate was not rapidly oxidized in this work. The mechanism of oxidation of β-hydrobutyrate and acetoacetate by heart muscle mitochondria was suggested to include a role for the classical β-hydroxybutyric acid dehydrogenase as proposed about 20 years ago (Von Korff—*Fed. Proc. 15,* 376). The rate of oxidation occurring in normal rabbit marrow fat in acetate buffer was essentially proportional to the total amount of polyunsaturated fatty initially present (Evans & Baker—*Am. J. Physiol. 184,* 461). At low concentrations fatty acids are oxidized by rat-kidney mitochondria but at concentrations of 10^{-3} *M* and higher they inhibit their own oxidation, the oxidation of pyruvate, and those of acids of the tricarboxylic acid cycle (Scholefield—*Can. J. Biochem. & Physiol. 34,* 1211). The longer chain fatty acids are more effective inhibitors and the even-numbered fatty acids show greater inhibitory effects than adjacent odd carbon members. The fumarate stimulated oxidation of pyruvate by rat-brain mitochondria, which is inhibited by decanoate, is considered to be associated with the phosphorylation process which is uncoupled by decanoate (*Ibid.* 1227).

Minute measurable quantities of oxidative products of unsaturated acids are formed in tissues of the hamster *in vivo* (Cole—*Proc. Soc. Exptl. Biol. Med. 93,* 290). The amount of such products formed is related to the development and function of the organ or tissue. The presence of lipide peroxide has been demonstrated in normal blood (Glavind & Hartmann —*Congr. intern. biochem. Resumes Comm. 2d Congr. 1952,* 356). Utilization of fatty acids by liver and the formation of ketone bodies in the liver and elsewhere in the body is increased as the result of adrenaline action (Wataya—*Med. J. Osaka Univ. 6,* 397). Data have been recorded on the aldehyde content of rat tissues and rat particulate fractions (Wittenberg *et al.—J. Biol. Chem. 219,* 39).

Several communications pertained to the role of lipides in some enzyme systems. d-α-Tocopherol functions as a catalyst for the enzymic reduction of cytochrome c whereas other lipides and antioxidants are inactive in this respect (Lehman & Nason—*J. Biol. Chem. 222,* 497, 511). The observation that removal of lipides from liver, kidney, and heart inactivates the succinic acid oxidase and succinic dehydrogenase was interpreted to support the hypothesis of a lipoprotein structure of the enzyme (Polonovski & Gay—*Bull. soc. chim. biol. 38,* 475). Crotonase, an enzyme of the fatty acid cycle, was isolated in crystalline form and has been characterized with regard to molecular weight, activity and action on fatty acids (Stern *et al.—J. Biol. Chem. 18,* 971, 985).

Various phases of fat synthesis in the body were studied. Rats on low-fat diets convert more labeled acetate, administered by injection, into body fat than rats on isocaloric high-fat diets; whereas the conversion of injected acetate to carbon dioxide is greatest in the rats on the high-fat diet (Brice *et al.—J. Biol. Chem. 218,* 107). Fasting of rats markedly depressed the ability of their livers to convert octanoate to fatty acids or utilize it for cholesterol synthesis (Lyon *et al.— J. Biol. Chem. 217,* 757). Both the oxidation of long chain acid and the synthesis of fatty acid from acetate is stimulated in the liver of rats maintained on a diet low in sulfur-containing amines when either cystine or tocopherol is added to the deficient diets (Artom—*Ibid. 223,* 389).

In a study of the endocrine system in regard to labeled acetate metabolism: hypophysectomy reduced incorporation of labeled carbon into liver but had not effect on the carcass acids; no differences in lipogenesis between liver and body was evident from adrenalectomy and thyroidectomy but total body incorporation was depressed; and ovariectomy caused no change in lipogenesis (Bates *et al.—Endocrinology 57,* 505). Although the depressed incorporation of acetate into fatty acid and cholesterol by adrenalectomized liver slices is consistent with depressed synthesis of these lipides, it was also suggested that it could reflect an increased turnover of lipides in the liver of the adrenalectomized animal (Perry & Bowen— *Am. J. Physiol. 184,* 59). Liver slices from hypophysectomized rats previously fed a diet containing 25% glucose as the sole carbohydrate lost the capacity of converting acetate into fatty acids and cholesterol whereas diets of 60% glucose or starch restore this capacity (Hill *et al.—Endocrinology 57,* 316). When insulin is administered, rats readily convert glucose to body fat (Favarger & Bodur—*J. Physiol., Paris, 48,* 534). Insulin injection in diabetic rats for two days increased conversion of glucose to fatty acids via the Emden-Meyerhof pathway 70-fold, and about 375-fold *via* the phosphogluconate oxidation pathway (Felts *et al.—J. Biol. Chem. 219,* 473).

By analysis of the intestines at various periods after feeding, Cahn & Houget (*Compt. rend. 243,* 407; *J. Physiol., Paris, 48,* 427) supported their hypothesis suggesting that the increase in respiratory quotient in rabbits after carbohydrates feeding is due to the conversion of the carbohydrates to lipides in the intestines. They also demonstrated that lipides are synthesized from alimentary glucides in the liver and adipose tissue. In similar work Favarger & Gerlach (*Helv. Physiol. et Pharmacol. Acta 13,* 91, 96) demonstrated that the mouse synthesized fats from acetate or glucose into the mesenteric fat, interscapular fat, lungs, liver, and intestinal wall. Rats exposed to cold convert ingested glucose to fatty acids in about the same degree as control animals (Masoro & Assuncion—*Fed. Proc. 15,* 126). Deprivation of bile flow to the rat intestine did not affect the ability of the intestine to convert labeled acetate to fatty acids (Horn *et al.—Proc. Soc. Exptl. Biol. Med. 91,* 258). Radio-active labeling technique has indicated that only palmitic and stearic acids are formed from injected acetate (Coniglio—*Fed. Proc. 14,* 235). In fed rats greater amounts of palmitic than stearic acid are formed; but during fasting this ratio is considerably reduced. Surviving adipose tissue is capable of synthesizing fatty acids from propionate and does so to an extent 100–200 times greater than does liver (Feller *et al.—Ibid. 15,* 61). Other work on synthesis of fats by adipose tissue has shown that the synthesis occurs with acetate, pyruvate or glucose as a precursor; the synthesis is low in fat-depleted rats; and very high after repletion (Rose & Shapiro—*Biochim. et Biophys. Acta 18,* 504). Vitamin C deficiency did not affect the incorporation of acetate into the lipides of the surviving liver, adrenal, or aorta (Bolker *et al.—J. Exptl. Med. 103,* 199). Over-all synthesis of lipides by aorta perfused with vitamins and hormones was demonstrated (Hahn & Nyan—*Fed. Proc. 15,* 86). Adenosinetriphosphate fortified rat-liver homogenates incorporate palmitic acid into simple glycerides to the same extent in the presence or absence of oxygen in the gas phase (Tietz & Shapiro—*Biochem. et Biophys. Acta 19,* 374).

The fatty acid cycle which governs fat metabolism *in vivo* has been duplicated using simplified model compounds containing the structural elements which are considered important to the activity of coenzyme A (Sheehan & Beck—*J. Am. Chem. Soc. 77,* 4875). Oxidation and synthesis *via* the Krebs cycle from acetate-1-C^{14} was studied in liver slices of fed and fasted rats, measuring the amount of C^{14} incorporated in carbon dioxide, lipides, protein, glucose, glutamate, alanine, lactate, urea, and di- and tricarboxylic acid (Katz & Chaikoff— *Biochim. et Biophys. Acta 18,* 87). About half the acetate was metabolized through the cycle, 40–50% of which was recovered in carbon dioxide and 20% each in glucose and glutamate.

Three enzymes were fractionated from beef and pigeon livers and the fractions were studied for sequential enzymic steps in fatty acid synthesis from acetate (Gibson & Jacob— *Fed. Proc. 15,* 261). In other work on synthesis of fatty acids from these three fractions of pigeon liver, additional elaboration of the various material required for the synthesis was developed (Wakill *et al.—Ibid.* 377). The formation of hydroxamic acids in the presence of potassium salt of fatty acid, hydroxyl amine and adenosine-triphosphate in the liver of pancreatectomized dogs is only about 30% of that found in the liver of normal dogs and the coenzyme A content is only 40% that of the normal dog livers (Ivaldi *et al.—Boll. soc. ital. biol. sper. 31,* 499, 501). Fatty acid synthesis is markedly inhibited by coenzyme A and, by way of contrast, fatty acid oxidation is stimulated by supplemental coenzyme A and

inhibited by the addition of citrate (Brady *et al.—J. Biol. Chem. 222,* 795). Some enzymes of fatty acid metabolism which are involved in the breakdown and synthesis of β-keto fatty acids were isolated from the pig heart and their properties determined (Stern *et al.—Ibid. 221,* 1, 15, 33). The purification and properties of a yellow flavoprotein which catalyzes α,β-dehydrogenation of fatty acid derivatives of coenzyme A was described and some of the mechanisms of the dehydration were discussed (Crane *et al.—Ibid. 218,* 701, 717, 727). A study of the kinetics of three primary dehydrogenases has indicated that they differ markedly in their ability to react (Hauge—*J. Am. Chem. Soc. 78,* 5266). A mechanism was also proposed for the roles of phosphorylase and xanthine oxidase in the dehydrogenation of palmitate in the presence of adenosine coenzyme (Jacob—*Compt. rend. 242,* 2180). The similarity of desaturation of unsaturated and saturated acids by liver enzymes to that of *Gramineae* seed enzyme was pointed out (Franke *et al.—Hoppe-Seylers' Z. physiol. chem. 303,* 58).

The hydrogenation of dietary unsaturated fatty acids in the intestines of the ruminant has been confirmed in investigations on goats (Reiser & Reddy—*J. Am. Oil Chemists' Soc. 33,* 155). In another study the finding of tritium-labeled oleic acid in the milk of goats fed labeled stearic acid was interpreted to indicate dehydrogenation had taken place (Glascock *et al.—Biochem. J. 62,* 529, 535). Analyses of milk and body lipides, glycerol, casein and water suggest that dietary fat contributed 25% of the milk fat and that the short chain acids of milk fats of ruminants do not arise mainly by degradation of long chain acids. Data also have been recorded on the rates of conversion of acetate and feeds to various short chain acids during rumen fermentation (Emery *et al.—J. Animal Sci. 5,* 854).

Fatty acid synthesis from acetate by soluble enzyme preparations from rabbit mammary gland was studied and a mechanism was proposed for the steps in the process (Hele & Popjak—*Biochim. et Biophys. Acta 18,* 294). Another study has elaborated the principal metabolites of the cow which serve as precursors of the milk fat (Rogers & Kleiber—*Ibid. 22,* 284). Glucose promoted the synthesis of fats in rat mammary gland slices (Hirsch *et al.—J. Biol. Chem. 221,* 509). Evidence was observed in this work that suggests long chain fatty acid formation in the rat mammary occurs primarily from condensation of 2-carbon units rather than from elongation of pre-existing short chain fatty acids.

Studies of peripheral fat mobilization as observed in the adrenalectomized rat, before and after fasting, and muscle work in eviscerated rats have suggested that the liver in some way regulates the movement of fat from storage areas in response to changes in the caloric needs of the animal (Tracht *et al.—Am. J. Physiol. 37,* 2). Injection of the surface-active agent, Triton WR-1339, into rabbits increases the mobilization of body lipides; liver lymph becomes milky owing to presence of large numbers of lipide particles; and intestinal lymph lipides increase slightly (Morris & Courtice—*Quart. J. Expt. Physiol. 41,* 349). When rats were exposed to freezing temperatures, groups acclimated to low temperature lost more body weight and water than non-cold acclimated animals (Hart & Heroux—*Can. J. Biochem. & Physiol. 34,* 414). In both groups fat accounted for 85–89% of the body energy utilized and the remainder was supplied by protein. In tests on fasting rats, loss of fat accounted for about 93% of the decrease in adipose tissue (Entenman *et al.—Fed. Proc. 15,* 58). In human subjects, those parts of the body with the thickest fat deposits sustain the greatest loss during caloric restriction; and those individuals with the greater amounts of fat initially sustain greater losses of fat (Garn & Brozek—*Science 124,* 682).

Analysis of carcasses of adult, young, and exercised guinea pigs show that fat depots account for 95% of the body fat and that males have 6–7% less of their total fat in the subcutaneous depot and more in the internal depots than females (Pitts—*Am. J. Physiol. 185,* 41).

Fatty acids of intermediate chain length, C_8–C_{14} are generally too rapidly metabolized to be deposited, but that portion which is deposited in the body appears mainly in the skin (Thomas *et al.—Arch. Tierernähr., Beihefte No. 5,* 103; Weitzel *et al.—Hoppe-Seylers' Z. physiol. Chem. 301,* 118, 132, 143). All normal acids from C_1 to C_8, and, in addition, isobutyric, isovaleric, and α-methylbutyric acid have been detected in bovine muscle and liver phospholipides (Hawke—*Biochem. J. 64,* 311) and in mutton fat (McInnes *et al.—Ibid. 63,* 702). Other reports on uncommon fatty acids in biological material were on isolation of nonadecanoic and isopalmitic acids in ox perinephric fat (Hansen *et al.—Nature 176,* 882; *Biochem. J. 61,* 547); occurrence of trans unsaturated fatty acids in horse feces (Hartman & Shorland—*Nature 178,* 1057) and in ruminants and nonruminants (Hartman *et al.—Biochem. J. 61,* 603); on natural branched chain acids (Shorland—*Australian J. Sci. 19,* 1) and on the branched chain acids of butter (Shorland—*Biochem. J. 61,* 702).

The chick embryo as early as the 14th day deposits subcutaneous fat of the same saponification value as adult chicken fat but the iodine value is similar to that of egg-yolk fat (McGreal—*Poultry Sci. 35,* 1066). In the white-crowned sparrow there is a striking deposition of fat in subcutaneous and visceral depots following prenuptial molt and preceding the beginning of vernal migration (King & Farner—*Proc. Soc. Exptl. Biol. Med. 93,* 354). Human epicardial fat may be as much as one third or more of the total heart weight and the percentage is greater in women than in men (Reiner *et al.—Arch. Pathol. 60,* 369).

LIPOPROTEINS, PHOSPHOLIPIDES AND CHOLESTEROL. Because these constituents of the total lipides may under certain pathological conditions be out of balance, considerable analytic work was done to develop methods for their analysis and many data have been recorded on their normal content in the body. The analytic methods and data also serve in metabolic and pathologic studies.

The relationship between the differences in speed of growth of organs and the development of their cholesterol and lipide phosphorus content has been recorded (Hrachovec—*Compt. rend. 242,* 1071). Papers from a symposium on the biochemistry of the nervous system contain information on: content of various lipides in the brain in relation to maturation (Folch-Pi—*Biochem. Developing Nervous System Symposium Oxford* 1954, 121), lipide and nitrogen metabolism in the brain (Richter—*Ibid.* 225), lipides in the brain during early development of the rat (Sperry—*Ibid.* 261), synthesis of neurophospholipides during growth (Dawson—*Ibid.* 268), and cholinesterase activity of the brain and nervous system (Himwich & Aprison —*Ibid.* 301; Elkes & Todrick—*Ibid.* 309; Gerebstoff—*Ibid.* 315). Kawakita (*J. Biochem., Japan, 43,* 111) recorded the contents of cholesterol, cerebroside, and phospholipide in the various parts of the brain and spinal cord of the ox, rabbit, and hen, as well as in the whole brain of the snake, frog, and mackerel. Bernhard & Lindlar (*Helv. physiol. et Pharmacol. Acta 14,* 113) determined total neutral fat, phosphoglycerides and the constituent fatty acids in the brain and liver of young and old rats. Values were recorded for the phospholipides, free and total cholesterol, neutral fat, and total fat for 30 guinea pigs at 0, 6, and 24 hours after death (Dell'Erba—*Minerva med. legale 75,* 192). These same lipides were determined in the blood of infants, young children and mothers (Poli & Berti—*Pediat. intern. 5,* 151, 267). Another communication on lipides in blood in infancy and childhood contained data on lipoproteins, total and free cholesterol, phospholipides and total lipides (Rafstedt—*Acta Pacdiat. 44,* 588). The various serum lipides of the adult, lactating and infant baboon were compared (van Zyl—*S. African J. Med. Sci. 20,* 119; van Zyl & Kerrich—*Ibid.* 97). Some glycolipides were isolated from hog stroma and characterized as to the fatty acids present (Yamakawa *et al.—J. Biochem., Japan, 43,* 41, 63; Matsumoto—*Ibid.* 53). The sphingolipides were characterized with regard to compounds derived therefrom by reduction and hydrolysis (Carter & Fujino—*J. Biol. Chem. 221,* 879). Microprocedures were devised for determination of phospholipides and sphingolipides in brain and were applied to determine the distribution of these lipides in the brain (Robins *et al.—J. Biol. Chem. 220,* 661, 677).

Oncley (*Harvey Lectures 50,* 71) reviewed the literature on the isolation and structure of α- and β-lipoproteins. Many published analytical methods for the separation of lipoprotein fractions made use of electrophoresis technique and the description of the method, in many cases was supplemented with data derived from its use (Chapin—*J. Lab. Clin. Med. 47,* 389; Jenks *et al.—J. Clin. Invest. 34,* 1437; Lorenzini *et al.—Acta Gerontol., Milan, 5,* 3; Benedetti—*Il. Progr. med. 11,* 439; Antonci—*Med. intern. 64,* 164; Laurell *et al.—Clin. Chem. 2,* 99; Owen—*Analyst 81,* 26; Forbes & Taylor—*Proc. Soc. Exptl. Biol. Med. 90,* 411; Hack—*Ibid. 91,* 92; Eiber *et al.—Ibid. 92,* 700; Bloomberg *et al.—S. African J. Med. Sci. 20,* 140; Paronetto *et al.—Science 124,* 1148).

Data obtained with the ultracentrifuge on α-lipoproteins were correlated with data on the electrophoretic properties (Kunkel & Trautman—*J. Clin. Invest. 35,* 641). The specific refraction increments were recorded for fractions of serum lipoproteins obtained by flotation (Hanig & Shainoff—*J. Biol. Chem. 219,* 479). The action of electrolytes on the sedimentation rate of lipoproteins was recorded as fundamental information for fractionation according to density by sedi-

mentation (Slizewicz *et al.—Ann. inst. Pasteur 89,* 428). Another method of characterizing lipoproteins fractions according to density was based on binding to the anionic dye methyl orange in combination with spectrometric observations (Rosenberg *et al.—J. Am. Chem. Soc. 77,* 6502). Studies on three fractions of low density serum lipoproteins by means of light scattering and ultracentrifuge have indicated that the molecules are ellipsoidal with small axial ratios (Bjorklund & Katz —*J. Am. Chem. Soc. 78,* 2122).

Many procedures were described for the determination of cholesterol and cholesterol esters in biological material (Mosto & Russi—*Rev. asoc. bioquim Argentina 20,* 127; Oeriu & Vladescu—*Comun. Acad. Rep. Romane 4,* 143; Roy *et al.—J. Sci. Res., India, 14C,* 124; Brieskorn *et al.—Fette-Seifen-Anstrichmittel 58,* 161; Hanel & Dam—*Acta Chem. Scand. 9,* 677; Koike *et al.—Nisshin Igaku 43,* 380; Vivano—*Neuropsichiat. 11,* 35; Schön & Gey—*Hoppe-Seylers' Z. Physiol. Chem. 303,* 81; Byers & Friedman—*J. Clin. Invest. 35,* 405; Keyl & Jones—*J. Invest. Dermatol. 23,* 17). A paper electrophoresis method was suitable for quantitative measurement of α- and β-lipoprotein cholesterol (Langan *et al.—J. Clin. Invest. 34,* 1427). Column chromatography was used to separate acid precursors of cholesterol (Adamson & Greenberg—*Biochim. et Biophys. Acta 18,* 516). Most of the above communications contain data derived in demonstrating the methods. The cholesterol contents of muscle and adipose tissue from beef, veal, pork, mutton, lamb, rabbit, chicken, and man were recorded (Del Vecchio *et al.—Proc. Soc. Exptl. Biol. Med. 90,* 449).

Chromatographic technique was applied for the resolution of complex phospholipide mixtures obtained from animal tissues (Marinetti *et al.—Fed. Proc. 15,* 308). A new procedure for estimating serum cholinesterase activity was based on the quantity of physostigmine required for inhibition (Perez—*Rev. clin. espan. 61,* 245).

Besides the data cited above on various lipides, which also included lipoproteins, there were many studies on the lipoproteins alone. In a study of lipides in chyle of nonfasting patients it was suggested that the lipoprotein is a stable protein-cholesterol-phospholipide complex designed to transport a highly labile, rapidly removed component, neutral fat (Albrink *et al.—J. Clin. Invest. 34,* 1467). Ultracentrifuge studies on egg yolk lipides have indicated that all these are bound to protein and that the complexes have densities greater than that of chylomicrons (Weiman—*Fed. Proc. 15,* 381). Comparative data of serum protein and lipoprotein in guinea pigs and rats have been recorded (Garattini & Murelli—*Giorn. biochem. 5,* 98). During pregnancy the blood lipoproteins show no consistant change (Zacutti & Basi—*Boll. soc. ital. biol. sper. 32,* 222). In newborn infants there is a marked increase of serum lipides ascribed especially to an increase in the β-lipoproteins and chylomicrons (Rafstedt & Swahn—*Acta Paediat. 43,* 221). In the serum from umbilical cord blood the α-lipoproteins represent about 43% and β-lipoproteins about 33% of the total lipides compared to 30 and 50%, respectively in normal adults (Rafstedt—*Ibid. 44,* 588). Immediately after birth all lipides increase, the increase in β-lipoproteins is quite marked until the fourth day when α- and β-lipoproteins approach values about that in adults. In similar work on newborn and premature infants, α_1-, α_2-, β_1-, β_2-fractions are reported (Gelli—*Acta Paediat, Parma, 8,* 251). The β_1-fraction is significantly higher in the full-term newborn than in the premature child. New data were recorded on the serum lipoprotein fractions and their relation to protein and lipide fractions of the blood of both sexes at different ages (Böhle *et al.—Deut. Arch. klin. Med. 203,* 29). The lipoprotein patterns as differentiated into α-, β-, and *O*-fractions of the serum were compared in the dog, rabbit, and human before and after administration of cortisone, prednisone, and hydrocortisone (Bossak *et al.—J. Clin. Endocrinol. & Metabolism 16,* 613).

Some studies pertain to the constituents of the lipoproteins. The β-lipides contain 73% total lipides, β-lipoproteins contain an average of 61% phospholipides, and the lipide-phospholipide ratio of β- and α-lipoproteins is 1.2 and 0.7, respectively (Chapin—*J. Lab. & Clin. Med. 47,* 386). Two significant differences were noted in the fatty acid composition of ultra centrifuge fractions of lipoproteins: (a) more than 20% of palmitoleic acid is present in the S_f 20-400, whereas this acid is practically absent in the S_f 0-20 fraction; (b) polyunsaturated are essentially absent in S_f 20-400, whereas S_f 0-20 fraction contains 4% arachidonic acid and 18% linoleic acid (Gilles *et al.—J. Am. Chem. Soc. 78,* 4103). Cold ethanol and paper electrophoretic separation of α- and β-lipoproteins yield fractions containing substantially the same amounts of cholesterol (Anderson *et al.—Clin. Chem. 2,* 145). In ultracentrifugal fractionation of serums at solvent density 1.21 the lower fraction contains 8% phospholipides which are not soluble in petroleum ether (Furman *et al.—J. Lab. Clin. Med. 47,* 730). The supernatant lipide fractions contained 90% or more of the cholesterol. The longissimus dorsi muscle of the rabbit contains 42 mg. of cholesterol per 100 g.; 5% in myosin, 80% in the stroma, and 6% in the ether-extractable lipide; most of which probably exists as lipoprotein (Del Vecchio *et al.—Arch. sci. biol., Italy 39,* 705). The observation that 80–90% of the vitamin A is found in non-floating proteins when plasma is subjected to high-speed centrifugation has suggested that vitamin A is transported in human plasma associated with proteins other than the α- and β-lipoproteins (Krinksy *et al.—Fed. Proc. 15,* 113). Glutamic acid was found to be the nitrogen-terminal in the α_1-lipoproteins and aspartic acid in β_1-lipoproteins (Avigan *et al.—Biochim. et Biophys. Acta 20,* 557). In another study it is reported that the peptide moieties are specific not only for each of the major lipoproteins, α- and β-lipoproteins, but are also specific for each of the density classes of β-lipoproteins (Gitlin *et al. —Fed. Proc. 15,* 262).

α-, β_1-, and β_2-lipoproteins decrease and β_3-lipoproteins increase in rabbits after total body x-ray irradiation; subsequently the values slowly return to normal (Andreoni *et al.—Ricerca sci. 25,* 1393). In another study on the same subject the alterations in lipoproteins classes were independent of dose, dose rate, and type of radiation (Milch *et al.—Radiation Res. 4,* 321). When such studies were applied to different animals, rabbit, dog, rat, and mouse, the time of increase and regression of the abnormality in the various fractions serum differed with the species (Hewitt & Hayes—*Am. J. Physiol. 185,* 257).

Lipoprotein from normal serum inhibits glucose utilization by muscle extracts (Bornstein—*Biochim. et Biophys. Acta 20,* 522). Administration of insulin decreases the amount of inhibitory material *in vivo,* but had no effect *in vitro.* The aqueous extracts of rat adipose tissue were found to contain a lipoprotein lipase (Korn & Quigley—*Biochem. et Biophys. Acta 18,* 143).

On administration of heparin nearly one fifth of the total serum lipides are shifted into association with proteins of the total ultracentrifugal residue (Lindgren *et al.—J. Phys. Chem. 59,* 930). This same process is reflected in the observation that heparin causes the conversion of high to lower molecular weight serum lipoproteins (Hrabane & Reinis—*Vnitrni lekarstvi 2,* 399). This action is considered to result from activation of the lipolytic system. L-Thyroxine and L-triodothyronine inhibit the heparin-catalyzed release of fatty acid from lipoprotein triglycerides (Shore—*Proc. Soc. Exptl. Biol. Med. 90,* 415).

The studies on phospholipide metabolism pertained mainly to their biological synthesis. The following observations were made on incorporation of C^{14}-palmitic and C^{14}-oleic acids into lecithin: 10% of the total radioactivity of the lipide fraction of the lecithin was due to saturated acids and 1% to unsaturated acids; 91–94% of the labeled palmitic acid of liver lecithin was in the α-position while in the intestine 72–82% was in that position; in the lymph there was equal labeling through palmitic acid in the α- and β-position; whereas with labeled oleic nearly equal labeling was found from all three different sources (Hanahan & Blemstrand—*J. Biol. Chem. 222,* 677). Intramuscular administration of adenosinetriphosphate increased serum phospholipides and decreased serum triglycerides (Olivi—*Arch. ital. sci. farmacol. (3) 4,* 59). This was ascribed to phosphorylation of adenosinetriphosphate. Based on incorporation of acetate-1-C^{14}, the synthesis and turnover of phospholipides is much slower than triglycerides (Lipsky *et al.—J. Clin. Invest. 34,* 1760). This has suggested that the latter rather than the former serves as the major vehicle for transport of fatty acids in the plasma. In fasted rabbits administration of insulin causes a rapid mobilization of phospholipides and glycogen to the liver (Agid—*J. Physiol., Paris, 48,* 367).

Several studies were on synthesis of phospholipides by the liver *in vitro.* The optimum pH of incorporation of acetone-soluble lipides into phospholipides is 6.8–7.4 whereas cholesterol has a much sharper optimum at pH 6.6–6.8 (Kline & DeLuca—*Can. J. Biochem. & Physiol. 34,* 429). In this work good labeling of phospholipides occurred with acetate-1-C^{14}, glycine-2-C^{14}, glycerol-1-C^{14}, and fructose-C^{14}, but not with formate-C^{14}, lactate-1-C^{14}, or glucose-C^{14}; whereas cholesterol was not significantly labeled from any of these other than acetate. Labeling of phospholipides in liver slices from acetate and other precursors was greatly decreased if the animal was fasted 24 hours preceding the experiment (Kline *et al.—J. Biol. Chem. 222,* 219). Synthesis of phospholipide *in vitro*

from radio-active inorganic phosphorus was observed in the human skin (Tanaka *et al.—Acta Med. et Biol., Niigata Univ. 3,* 101), in rat skin (Berry—*Nature 177,* 789), kidney and brain (D'Abramo *et al.—Bull. soc. ital. biol. sper. 31,* 414). Studies with radio-active inorganic phosphorus compounds have shown that the rate of synthesis of phospholipides is significantly increased in rabbits when they are fed cholesterol (McCandless & Zilversmit—*Arch. Biochem. & Biophys. 62,* 402). The observation that the specific activity of individual aorta phospholipides exceeded those of corresponding lipides in plasma of cholesterol-fed animals is presented as evidence that the aorta phospholipides are synthesized in the aorta rather than derived by deposition from the plasma.

Previous studies have shown that synthesis of phospholipides in the fasting dog is carried out principally by the liver, whereas in the chicken and in the rabbit synthesis of phospholipides goes on in absence of liver. In the fasting rat, synthesis of plasma phospholipides was significantly reduced by removal of the liver and was further reduced by evisceration (Zilversmit & Bollman—*Arch. Biochem. & Biophys. 63,* 64). The data from this work were discussed with regard to the relative importance of liver and intestines in the rat for supplying plasma phospholipides. In rabbits, plasma phospholipide synthesis continues at a reduced rate in absence of liver, intestine, spleen, and kidney (Zilversmit *et al.—Proc. Soc. Exptl. Biol. Med. 93,* 542). In rabbits the increased synthesis of liver phospholipides obtained by high fat, choline-deficient diets, is further increased by a single dose of choline; whereas chronic choline supplementation depresses liver phospholipide concentration and the synthesis in the whole animal is markedly increased (DiLuzio & Zilzersmit—*Ibid. 92,* 454).

In work on mechanism of enzyme synthesis of phospholipides it was found that cytidine coenzymes mediate the synthesis of lecithin and of phosphatidylethanolamine; and cytidine diphosphate choline and cytidine diphosphate ethanolamine, respectively, are the precursors in the enzyme systems (Kenedy & Weiss—*J. Biol. Chem. 222,* 193; *J. Am. Chem. Soc. 78,* 3550). L-α-Glycerylphosphorylcholine has been prepared in good yields by a simple enzymatic procedure (Uziel & Hanahan—*J. Biol. Chem. 220,* 1).

Recently much data have been recorded on normal cholesterol content of body fluids and its normal metabolism. Also, new data were developed to confirm, check or supplement much that has already been published. Data on the cholesterol content of the serum of normal women in relation to age and diet showed good positive correlation for age and body weight, whereas the percentage of dietary fat and protein calories, as well as total energy intake did not show a significant relation with the variation in total blood cholesterol (Butler *et al.—J. Nutr. 59,* 469). Data recorded during tests on reduction of weight of obese college students, have indicated that undernutrition and low fat diet lower serum cholesterol independently and simultaneously (Anderson *et al.—Fed. Proc. 15,* 542). After a test breakfast it was noted that lower serum cholesterol levels occurred during physical activity than in inactivity (Keys—*Science 123,* 29). Results from comprehensive studies on serum cholesterol levels in man have shown that the levels are essentially independent of the cholesterol intake over the whole range of natural human diets (Keys—*J. Nutr. 59,* 39).

Human subjects absorb about 8 mg./kg. body weight per day of cholesterol administered as crystals and 15 mg./kg./day as egg yolk (Cook *et al.—Biochem. J. 62,* 225). When cholesterol was fed to dogs, those on meat diet excreted cholesterol plus coprosterol; whereas the dogs on rice diet excrete cholesterol (Arnaudi & Canonica—*Boll. soc. biol. sper. 31,* 1334). Serum cholesterol of normal human subjects on rice-fruit diet was not increased by injection of cholesterol (Keys—*J. Nutr. 59,* 39). In young human subject, absorption of cholesterol is increased on increasing the amount in the diet, but the percentage absorption decreases rapidly on elevating the dietary cholesterol levels (Lin *et al.—Fed. Proc. 15,* 120).

Increasing the protein content of diets of rats on a normally hypercholesterolemic regimes caused a progressive drop in serum cholesterol values (Moyer *et al.—Proc. Soc. Biol. Med. 92,* 736). A defect in cholesterol metabolism associated with feeding a diet deficient in cystine was believed to be related to an inability of the cystine-deficient animal to handle exogenous cholesterol (Portman—*Am. J. Phys. 186,* 403). Lack of dietary choline did not influence cholesterol absorption in the rat (Rice *et al.—Proc. Soc. Exptl. Biol. Med. 92,* 754). With dogs, in which cellulose is laxative, adding cellulose flour to the diet increases elimination of endogenous as well as dietary cholesterol; whereas in the rat increasing cellulose content of the diet did not alter cholesterol eliminiation (Lin *et al.—Am. J. Physiol. 187,* 170). The solubility of cholesterol is reduced when β-sitosterol is present due to formation of a mixed crystal complex of lower solubility (Davis—*Trans. N. Y. Acad. Sci. 18,* 123). It is believed that this action also mediates the decrease in intestinal absorption of cholesterol.

Many investigations pertain to metabolism of cholesterol. After intravenous administration of cholesterol-4-C^{14} more than 98% of the labeled carbon was excreted in the bile, 1.3% in acholic feces, and 0.2% in the urine; none appeared as carbon dioxide in expired air (Siperstein & Murray—*J. Clin. Invest.* 34, 1449). Dogs receiving a high-cholesterol diet plus thiouracil have an impaired capacity to convert dietary cholesterol to bile acids (Abell *et al.—J. Biol. Chem. 220,* 527). Administration of cholesterol orally to human subjects increases excretion of 11-hydroxysteroid and decreases 17-keto steroid (Artunkal & Kayahan—*Türk Tip Cemiyeti Mecmuasi 21,* 548). Rabbits fed 3 β-cholestanol showed gall bladder concretions which consisted largely of glycodeoxycholic and glycocholic acids (Mosbach & Bevans—*Arch. Biochem. & Biophys. 63,* 258).

Three hours after oral administration of cholesterol the cholesterol esters fraction of the blood was increased (Schirosa & Guarini—*Bull. soc. ital. biol. sper. 31,* 943). The clearing of chyle by heparinized plasma is followed by a capacity to clear turbidity due to cholesterol, presumably the lipoproteins dissolve the cholesterol (Robinson *et al.—Quart. J. Exptl. Physiol. 41,* 309).

The observations that cholesterol replacement does not occur in drastically hepatectomized rats even when an excess of free cholesterol was administered was interpreted to indicate that the liver serves as the chief organ for the supply and the subsequent withdrawal of plasma ester cholesterol, and in so doing controls the concentration of esterified cholesterol in plasma (Friedman *et al.—J. Clin. Invest. 34,* 1369). Isolated livers remove some cholesterol from perfusates, thus behaving as intact livers (Friedman *et al.—Am. J. Phys. 184,* 412). Chymal and reticulo-endothelial cells of liver were radio-active 24 hours after oral administration of cholesteral-4-C^{14}, thus indicating that they play a role in disposition of dietary-derived cholesterol (*Ibid. 184,* 141). Other workers have demonstrated that the reticulo-endothelial system clears the serum of cholesterol along with other lipides (Neveu *et al.—Am. J. Physiol. 187,* 269).

Injection of the surface-active agent, Triton WR-1339, into the veins of mice increases total body cholesterol (Hirsch & Kellner—*J. Exptl. Med. 104,* 1, 15). Similar injections in rabbits increased cholesterol in serum but not in liver; thus suggesting that passage of cholesterol from plasma to liver was inhibited.

When rats are fed diets containing 2% cholesterol and 5% corn oil a reduction of hepatic synthesis of cholesterol occurs from which there is slow recovery after discontinuing the feeding of cholesterol (Taylor *et al.—Fed. Proc. 15,* 534). Older animals had lower control synthesis rates and their cholesterol synthesis rates recovered slower than those of young animals. With fatty livers due to protein deficiency glycerides accumulate at a higher rate than cholesterol (Okey & Lyman—*J. Nutr. 58,* 471). Protracted cholesterol feeding of rabbits increases total liver fat mainly owing to augmentation of neutral fat and cholesterol (Krüskemper & Schulze—*Naunyn-Schmiedebergs Arch. exptl. Pathol. Pharmakol. 227,* 161). Data from this work indicated that cholesterol feeding caused a disturbance in fat metabolism with a shift to increased synthesis of fatty acids. Daily feeding of cholesterol to rabbits also increases the cholesterol content of the sebum (Lincke—*Dermatologica 105,* 153).

Vanadium pentoxide, added to standard rabbit diets at a level of 100 p.p.m., lowered free cholesterol and phospholipide content of the liver of rabbits, while plasma cholesterol showed no significant changes; and with diets that produce hypercholesterolemia, it restricts elevation of plasma cholesterol levels (Mountain *et al.—Proc. Soc. Exptl. Biol. & Med. 92,* 582). The synthetic estrogen, hexoestrol, causes marked serum hypocholesterolemia, possibly by inhibiting cholesterol synthesis (Boyd & McGuire—*Biochem. J. 62,* No. 2, 19p).

When acetate is administered intravenously in men about 1% is converted to cholesterol in 2–4 hours (LeRoy—*Ann. Internal Med. 44,* 524). *In vitro* biosynthesis of cholesterol from acetate by rat liver fractions requires both microsomes and soluble cell constituents; other cellular structures are not necessary (Bucher & McGarrahan—*J. Biol. Chem. 222,* 1). A symposium on cholesterol metabolism contained several review papers by various authors on the biosynthesis of cholesterol and substances which accompany cholesterol (Various authors—*Fed. Proc. 14,* 752, 757, 762, 765, 767, 775, 783). In the *in*

vitro production of cholesterol by rat liver from acetate, lanosterol and agnosterol are also formed during the incubation; the lanosterol formed is biologically converted to cholesterol (Clayton & Block—*J. Biol. Chem. 218,* 305). Some of the mechanism of this conversion has been elaborated (Olson & Bloch—*Fed. Proc. 15,* 323). When cholestenone is biologically metabolized cholestanol is the predominant neutral sterol formed (Harold *et al.—J. Biol. Chem. 221,* 435). Desmosterol and a cholestadienol were isolated from chick embryos and were considered to be intermediates in the synthesis of cholesterol (Stokes *et al.—Ibid. 220,* 415). Other work on the synthesis of cholesterol pertained to its conversion from squalene (Dituri *et al.—J. Biol. Chem. 221,* 181; Loud & Bucker—*Fed. Proc. 15,* 122; Tchen & Bloch—*J. Am. Chem. Soc. 78,* 1516). X-Ray irradiation of rats increases the synthesis of cholesterol in the liver (Gould *et al.—Fed. Proc. 15,* 264). Phenylethylacetate inhibits the acetate activator enzyme involved in the synthesis of cholesterol (Rossi & Sanguinetti—*Giorn. biochim. 4,* 385).

Blood serum (Tayeau—*Arch. sci. biol. Italy 39,* 545) and bone marrow (Morozova—*Byull. Ekspt. Biol. i Med. 41,* No. 6, 36) contain cholesterol esterases which esterify free cholesterol and change the electrophoretic diagram of blood serum in a manner that suggests that the lipides are shifted to the α-globulin fraction. This esterification is inhibited by bile salts and surface-active agents and is affected by hydrogen ion concentration (Tayeau & Nivet—*Bull. soc. chim. biol. 37,* 634; Shukuya & Shinoda—*J. Biochem., Japan, 43,* 315).

An improved method for preparation of side labeled cholesterol has been developed (Dauben & Payot—*J. Org. Chem. 21,* 1299). Such compounds are used to study biological cleavage of the cholesterol. When cholesterol-3d,4-C^{14} was transformed to coprostanol by incubation with feces, the deutrium present in coprostanol at the sites other than C-3 is located at C-5 and C-6 or exclusicely at the 6-position (Rosenfeld *et al.—J. Biol. Chem. 222,* 321). When cholesterol-4-C^{14} and -26-C^{14} is metabolized in the perfused liver the -26-C^{14} is converted to carbon dioxide and a very little to bile compounds; whereas the -4-C^{14} is excreted in the bile (Harold *et al.—Am. J. Physiol, 183,* 459). The -4-C of cholesterol appears in at least four acids when metabolized by liver mitochondria (Fredrickson—*J. Biol. Chem. 222,* 109). An enzyme system, found predominantly in adrenal glands, is capable of cleaving cholesterol to pregnenolene and isocaproic acid (Staple *et al.—Ibid. 219,* 845).

LIPIDES IN THE DISEASED STATE. On the subject of lipides in the disease state, most interest has focused on the status of dietary fats in atherosclerosis and coronary diseases. Because of high mortality associated with coronary diseases, opportunities of commercial exploitation for selfish interests, and competitiveness among investigators, the subject of fat in relation to atherosclerosis has been aired in the press, popular magazines, and editorials in technical and scientific journals and has been the subject of much research.

In regard to implication of fat in atherosclerosis a conservative trend in editorials and reviews is evident. In this regard May (*J. Am. Med. Assoc. 162,* 1468) points out that this is an acquired disease and besides fats many other factors are involved. He cautioned against manipulating diets of populations lest unanticipated deficiencies or unbalance be created. Blake (*Southern Med. J. 48,* 1080) in a similar review concluded that the current trend recognizes the uselessness of severe dietary restrictions in control of the disease. Eagle & Robinson (*J. Am. Oil Chemists' Soc. 33,* 624) cite the ubiquity of fat and cholesterol in foods of animal origin, the synthesis of cholesterol in the body, and disagreements regarding restricting dietary fat. In a comprehensive review by Kaufman & Schmidt (*Fette-Seifen-Anstrichmittel 58,* 879) it is interesting to note that fatalities from coronary diseases in Germany have risen from 10% to 35% of all causes of death between 1910 and 1915 and during that period there was a gradual change in the principal dietary fat from animal to vegetable fats. Other reviews on the subject were cited by title at the beginning of this division of the review.

Much information is being recorded on geographic patterns in atherosclerosis, the pathology associated therewith, and reason for differences. A survey of coronary heart diseases by states in this country has shown considerable differences which could not be correlated with urbanization (Enterline & Stewart—*Public Health Repts. 71,* 849). Twelve hundred healthy males and females in Staten Island, N. Y., were examined and their serums analyzed for cholesterol and phospholipides in a study on age, sex, and serum lipides in relation to coronary atherosclerosis (Adlersberg *et al.—J. Am. Med. Assoc. 162,* 619). A higher frequency of atherosclerosis among Jews than Italians of similar calorie and fat intake was attributed to the former eating a greater proportion of animal fat (Epstein *et al.—Am. J. Clinical Nutr. 4,* 10). Among workers in Naples, Italy, the serum cholesterol content of steel workers is lower than that of clerks and policemen (Fidanza—*Attualita med. 21,* 7). The serum cholesterol content of new-born African and European infants are identical, although among the mothers it is lower in the African (Bersohn & Wayburne—*Am. J. Clin. Nutr. 4,* 117). Bronte-Stewart *et al.* (*Am. J. Clin. Nutr. 4,* 447) attributed low serum cholesterol and scarcity of coronary heart disease of Bantu natives as compared to Europeans to a lower fat consumption by the former. Similar data by van Oye & Charles (*Ann. soc. belge med. trop. 32,* 85, 297, 305) was attributed to malnutrition in the Africans; the liver though capable of synthesizing cholesterol, fails to do so owing to certain deficiencies in the diet; and chronic malaria, which is known to lower blood cholesterol, may also play a role in the Bantu. A low incidence of coronary disease and low serum cholesterol level among Navajo Indians as compared to population in the Cleveland area was explained on the basis of heredity (Page *et al.—Circulation 8,* 675).

Katz and coworkers (*Fed. Proc. 15,* 885) in a review on nutrition and atherosclerosis attribute the cause to unbalanced diets. Two clinical studies on dietary treatment of atherosclerosis favored low-fat, low-cholesterol diets for such patients (Lyon *et al.—Am. J. Clin. Nutr. 4,* 449; Nelson—*J. Am. Med. Assoc. 161,* 1416).

In a study of history of aortic atherosclerosis first evidence of involvement was at age 5–15 years, thereafter lesions regress slightly, and high per cent of surface involvement does not begin to rise until after age 30 years (Strong—*Fed. Proc. 15,* 533). Hollman (*Sci. News Letter 70,* 279) in studies of involvement of the disease in the 11 to 15 year age group found early signs of the disease in aortas much more often in the Negro race than in whites. He said his findings do not support the current idea that atherosclerosis begins as a passive filtration of fatty substance from blood into the artery walls. The etiology of atherosclerosis suggested by Greig (*Nature 178,* 422) begins with high food fat intake leading to a continued inhibition of fibrinolytic system of the blood and to persistence of mural thrombi and their incorporation into the vessel wall. Guidi *et al.* (*Arch. studio fisiopatol. e clin. ricambio 19,* 225) recorded serum lipoprotein, serum cholesterol and blood-clotting changes in normal, young, presenile, and atheromatous subjects after eating various foods and discussed the data with particular reference to the pathogenesis of atheromatous and thrombotic disease.

The allegation that the behavior of lipoprotein fractionations obtained with the ultracentrifuge predicts atherosclerosis was rigidly investigated (*Circulation 14,* 691). The study shows that the method was no more successful in predicting definite new events than was measurement of cholesterol. Neither serum lipoproteins nor cholesterol elevation was of clinical use in predicting those individuals who would develop coronary heart disease. Serial tests on 800 hospital patients in England also showed that lipide fractions and total serum cholesterol show no significant relation to the degree of atherosclerosis found at autopsy (Paterson *et al.—Ibid. 13,* 224). Analysis of low density lipoproteins obtained by ultracentrifuge fractionation show the molecules contain 40–60% cholesterol esters, 10–30% unesterified cholesterol, 10–20% phospholipide and 3–30% protein depending upon the sedimentation characteristics (Schumaker—*Am. J. Physiol. 184,* 35).

Paper electrophoresis technique was applied to the study of serum lipoproteins in investigation of atherosclerosis with results comparable to applying the ultracentrifuge fractionation (Jencks *et al.—J. Clin. Invest. 35,* 980; Tarasova & Troitskii —*Ukrain. Biokhim. Zhur. 28,* 177; Oliver & Boyd—*Brit. Hearth J. 17,* 299; Hauss & Böhle—*Deut. Arch. klin. Med. 202,* 579). The β-lipoprotein fraction values are higher in Swedes than in Italians where fat is a lesser percentage of the calorie supply, Malmros *et al.—Acta. Med. Scand. 154,* Suppl. 312, 71).

Many observations of interest on atherosclerosis have resulted from animal experiments. The severity of atheromata in cholesterol-fed rabbits was said to vary inversely with the iodine value of the fat used as a vehicle for the sterol (Kritchevsky *et al.—Am. J. Physiol. 185,* 279). Tissue storage of cholesterol or 3,β-cholestanol by rabbits fed these compounds is increased when triolein is also added to the diet (Mosbach *et al.* —*Fed. Proc. 15,* 525). Fibrous intimal thickening in rabbits injected intravenously with a blood preparation was more severe in animals fed large doses of fats than those on diets without added fat (Thomas *et al.—Arch. Pathol. 61,* 380). Rabbits fed cream become hyperlipemic but do not deposit

lipides in the aortas, whereas addition of cholesterol to such diets induces development of atheromas in the aortas (Hirsch & Nailor—*Arch. Pathol. 61,* 469).

Atherosclerosis was induced in rats with purified diets supplemented with cholesterol, sodium cholate and thiouracil; and the vascular lesions produced were described (Fillios *et al.*—*Fed. Proc. 15,* 550). Diets containing cholesterol and free unsaturated acids are toxic to rats (Clement *et al.*—*Compt. rend. 243,* 421; Raulin—*Arch. sci. physiol. 10,* 1). Such a diet causes a decrease in phospholipides in the liver and an increase in the phospholipides in intestines and feces. An all-vegetable diet considerably reduces serum cholesterol in dogs (Tsai *et al.*—*Texas Repts. Biol. Med. 12,* 423). Atherosclerosis lesions induced in a monkey by high-fat diets containing cholesterol were described (Mann & Andrus—*J. Lab. Clin. Med. 48,* 533). Lipide patterns and atherogenesis in cholesterol-fed chickens were also described (Tennent *et al.*—*Fed. Proc. 15,* 574).

The studies on atherosclerosis, hyperlipemia, and hypercholesterolemia, in relation to dietary fats and oils did not produce uniform results. Dietary fats of varying degrees of saturation were no different from each other with respect to their effect on aortic or hepatic cholesterol levels of cholesterol-fed cockerels and only slightly different with respect to serum levels (King *et al.*—*Proc. Soc. Exptl. Biol. Med. 93,* 443). The cholesterol deposition in various organs and aorta, and blood serum content of cholesterol-fed rabbits (Steiner & Dayton—*Circulation Res. 4,* 62; Pihl—*Arch. Physiol. Scand. 34,* 183) and chicks (Dam *et al.*—*Ibid. 34,* 141; *36,* 319) are increased on adding peanut oil to the diet. The cholesterol content of the blood and tissues of rabbits fed cottonseed, coconut, and peanut oil did not vary markedly from control animals on stock feed, but on autopsy those fed peanut oil had occasional lipide infiltration in the lungs and heart with mild intimal fibrosis (Chakravarti *et al.*—*Indian J. Med. 44,* 49). In balanced experiments on rats oleic acid increased absorption of cholesterol whereas stearic acid and bile acids did not (Pihl—*Acta Physiol. Scand. 34, 197,* 206). Higher serum cholesterol levels are induced in female rats fed cholesterol when 15% cottonseed oil is added to the diet, than when 15% lard is added (Okey & Stone—*J. Am. Diet. Assoc. 32,* 807). In another comparable test more cholesterolemia and higher cholesterol levels occurred with lard than when cottonseed was the sole source of fat (Aftergood *et al.*—*Fed. Proc. 15,* 541). Corn oil, which has already been shown to be a depressant of plasma cholesterol levels, was further investigated. In monkeys, diets containing hydrogenated vegetable oils elevated whereas corn oil depressed cholesterol levels (Portman *et al.*—*Fed. Proc. 15,* 570). Similar observations were evident when corn oil was compared with animal fats on human subjects (Beveridge *et al.*—*Can. J. Biochem. & Physiol. 34,* 441). These investigators believe corn oil contains a factor or factors that lead to depression of plasma cholesterol. Whole corn germ is more potent for limiting hypercholesterolemia than the oil extracted therefrom (Jones *et al.*—*Proc. Soc. Exptl. Biol. Med. 93,* 88). In this work distilled acids reconstituted to glycerides of the same composition as of corn oil did not behave as the natural corn oil. Peifer & Holman (*Fed. Proc. 15,* 326), attributed the curative effect of corn oil or essential fatty acids on the toxicity induced in rabbits through cholesterol feeding to the assumption that cholesterol transport is related to mobilization of essential fatty acids. Bronte-Stewart *et al.* (*Lancet 1956,* 521) recorded experimental data showing that unsaturated fats depress whereas animal fats and hydrogenated oil increase serum cholesterol in human subjects.

Rats on a cholesterol-free diet eliminate three times more cholesterol when two grams of palmitic or stearic acid is fed every second day than the controls not fed the fatty acids (Lin *et al.*—*Am. J. Physiol. 173,* 4). Oleic and linoleic acids do not induce this elimination of endogenous cholesterol. Similar more comprehensive work has shown that: erucic and nervonic (C_{24} monoethenoid) acids increase cholesterol elimination two- to four-fold and increase adrenal cortex cholesterol without depletion of total body cholesterol; eicosenic acid also increased fecal cholesterol concentration although it had little effect on adrenal cholesterol; and oleic acid and various even numbered saturated acids from C_4 to C_{22} failed to increase cholesterol in the feces (Carroll & Noble—*Fed. Proc. 15,* 31; *Can. J. Biochem. & Physiol. 34,* 981). In tests with rat-liver homogenates both saturated and unsaturated free fatty acids inhibited cholesterol synthesis whereas fatty acid synthesis from acetate was accelerated (Wood & Migicovsky—*Can. J. Biochem. & Physiol. 34,* 861).

Regression of atherosclerosis symptoms in human subjects (Galeone & Boero—*Acta gerontol. 1,* No. 6, 3) and in rabbits (Baguena *et al.*—*Arch, med. exptl., Madrid, 18,* No. 1, 13) was observed on administration of α-tocopherol. Similar effects occurred in chickens on administration of vitamin K_1 and vitamin A (Weitzel *et al.*—*Klin. Wochschr. 33,* 772). Atherosclerosis lesions develop in pyridoxine-deficient monkeys (Rinehart & Greenberg—*Am. J. Clin. Nutr. 4,* 318; Mushett & Emerson—*Fed. Proc. 15,* 526). Young rats fed a high-fat, choline-deficient diet develop lipomatous infiltration of the coronary type and aortic sclerosis (Wilgram *et al.*—*Circulation Res. 3,* 549). Administration of pantothenic asid to diabetic rats increases the cholesterol levels in the tissues of the animals (Mookerjea & Sadhu—*Biochem. J. 64,* 6). Treatment of cholesterol-fed rabbits with adenosinephosphate resulted in higher level of serum lipides, especially phospholipides, without significant relation between atherogenic proteins and lipide fractions (Gambassi & Maggi—*Acta Gerontol. Milan 5,* 206). Reduction or elevation of dietary protein beyond a modest range leads to ultimate elevation of serum cholesterol in the rat (Jones & Huffman—*Proc. Soc. Exptl. Biol. Med. 93,* 519).

β-Sitosterol administration to atherosclerotic and hypercholesterolemic subject reduced serum cholesterol and produced other favorable effects (Sachs *et al.*—*Arch. Internal. Med. 97,* 738; Farquhar *et al.*—*Circulation 14,* 77; Joyner & Kuo—*Am. J. Clin. Nutr. 4,* 448; Shipley—*Trans. N. Y. Acad. Sci. 18,* 111; Peterson *et al.*—*Fed. Proc. 15,* 569). One group of investigators considered the results suggestive rather than significant (Barber & Grant—*Brit. Heart J. 17,* 296; *Am. J. Clin. Nutr. 4,* 449). One patient, in this study, who showed a reduction in serum cholesterol died of a further infarction. In experiments on mice fed cholic acid and cholesterol, administration of β-sitosterol decreased total liver cholesterol (Beher & Anthony—*Proc. Soc. Exptl. Biol. Med. 90,* 223); in similar tests on rabbit liver cholesterol was reduced but there was no change in aorta lipide or cholesterol, and plaque regression was not apparent (Beher *et al.*—*Circulation Res. 4,* 485). Soybean sterols slightly inhibit the rise in cholesterol in cholesterol-fed cockerels, but given in combination with diethanolamine salt of monocamphoric acid ester of α-4-dimethylbenzyl alcohol the inhibition is greatly increased (Clarkson *et al.*—*Circulation Res. 4,* 54). The reduction of body cholesterol through administration of plant sterols was attributed to a reduction of intestinal absorption through competitively inhibiting the cholesterol esterification in the gut (Bisset & Cook—*Biochem. J. 63,* No. 2, 13P) and through formation of mixed crystals of lower solubility (Davis—*Trans. N. Y. Acad. Sci. 18,* 123). However, Curran & Castello (*Proc. Soc. Exptl. Biol. & Med. 91,* 52) found that plant sterols were absorbed by rabbits and produce atherosclerosis in these animals; whereas rats do not absorb significant amounts of these sterols. Data by Sewell *et al.* (*J. Nutr. 58,* 385) suggest that plant sterols are absorbed through the same mechanism as cholesterol and the plant sterols may be converted to bile acids, cholesterol, or a cholesterol intermediate in the intestine or liver. Oral administration of a cerebroside concentrate from brains reduced serum cholesterol in hypercholesterolemic patients (Jones—*J. Lab. Clin. Med. 27,* 261).

Incubation of hyperlipemic serums with soybean phospholipides increased the migration velocity of β-lipoproteins as determined by electrophoresis (Sachs & Danielson—*Proc. Soc. Exptl. Biol. Med. 93,* 22). Infusions of an emulsion of soybean phosphatides in rats led to a rise in the plasma cholesterol of the animals (Friedman *et al.*—*Am. J. Physiol. 186,* 13).

The daily intraperitoneal injection of 2 mg. heparin into cholesterol-fed rabbits suppresses the accumulation of fat in the livers and the development of aortic atherosclerosis (Meng & Davis—*Arch. Pathol. 60,* 276). Administration of insulin inhibits the ability of estrogens to protect the coronary vessels of cockerels against cholesterol-induced atherosclerosis (Stamler *et al.*—*Fed. Proc. 15,* 178). The effect is like that of hypothyroidism.

The effect of hormones under conditions that induce atherosclerosis has been studied. Injection of stilbestrol in birds for six months produced atherosclerosis as does feeding cholesterol for two months; but there are some differences in centrifuged lipoprotein fractions and their cholesterol content induced by the two processes (Hillyard *et al.*—*J. Biol. Chem. 223,* 359). Ovariectomy lowers the average cholesterolemic response of cholesterol-fed rabbits, while orchidectomy increases the response in males (Fillios & Mann—*Circulation Res. 4,* 406). Estrodiol treatment of both males and females increased their cholesterol response, while testosterone decreased it. Serum cholesterol was high and adrenal cholesterol increased in estrogen-dosed rats on a high-protein (30%) diets, but liver cholesterol was within the ranges of intact controls fed 15% protein (Okey & Lyman—*J. Nutr. 60,* 65). Administration of progesterone reduces the incidence of atherosclerosis in rab-

bits maintained under conditions that induce it (Oester *et al.*—*Fed. Proc. 15,* 464). Dogs receiving a high cholesterol diet plus thiouracil have an impaired capacity to convert excess dietary cholesterol into bile acids (Abell *et al.*—*J. Biol. Chem. 220,* 527). In absence of parathyroid glands, mineralocorticoids in excessive dosage failed to produce cardiovascular necrosis in rats, whereas parathyroid hormone assured emergence of lesions in complete absence of mineralocorticoids (Lehr & Martin—*Proc. Soc. Exptl. Biol. Med. 93,* 596). This suggested that subtotal parathyroidectomy be tried in preference to adrenalectomy in attempts to arrest sequellae of malignant hypertension. During cortisone-induced regression of cholesterol-atherosclerosis in the rabbit: there is a large increase of neutral fat in plasma and liver, and decrease of aortic neutral fat; aortic and plasma esterified cholesterol are significantly decreased, but plasma cholesterol remains at eight times normal; and plasma phospholipide amount and turnover rate are elevated, but liver and aortic phospholipide turnover rates are less than of untreated cholesterol-fed animals (Dury—*Fed. Proc. 15,* 52; *Am. J. Physiol. 187,* 66; *Am. J. Med. Sci. 230,* 427).

The regression of atherosclerosis by certain chemical compounds was studied. In lowering serum cholesterol of rabbits by administration of sodium 2-phenylbutyrate some hemorrhages occur in the kidneys (Kritchevsky *et al.*—*Angiology 7,* 156). The hypocholesterolemic action of this compound appears to be through inhibiting cholesterol synthesis, presumably through blocking coenzyme A (Mininni & Le Brun—*Minerva med. 1955,* Pt. II, 1864). The effect of sodium 3-phenylvalerate in cholesterol synthesis is the reverse of the known effect of 2-phenylbutyric acid (Roth & Favarger—*Helv. Physiol. et Pharmacol. Acta 13,* C61). Feeding vanadium sulfate to rabbits inhibits experimental atherosclerosis, possibly through inhibiting endogenous cholesterol synthesis (Currani & Costello—*J. Exptl. Med. 103,* 49). Potassium iodide, which protects animals against induced atherosclerosis, has been restudied on human patients (Avendano *et al.*—*Rev. med. Chili 80,* 195) and on cholesterol fed rabbits (Moyer *et al.*—*Proc. Soc. Exptl. Biol. Med. 92,* 416) so as to record its effect on body lipides. Feeding of caffeine, chloral hydrate, and barbamil significantly reduces experimental atherosclerosis; the effect of barbamil being the most marked (Shkhvatsabaya *et al.*—*Byull. Eksptl. Biol. i Med. 41,* No. 4, 39). Intramuscular injections of chlorpromazine reduces experimental atherosclerosis in rabbits; and in animals on stock diet may cause transient periods of mild hypercholesterolemia (Wilens *et al.*—*Proc. Soc. Exptl. Med. Biol. 93,* 121). Some ionic and nonionic detergents when dissolved in plasma, bring about the withdrawal of lipide from the aorta of cholesterol-fed chicks (Goldberg—*Congr. intern. biochem., Resumes communs., 3rd, 1955,* 123). Ingestion of alcohol with cholesterol had little or no effect on elevated tissue lipide concentrations or on induced atherosclerosis in birds (Nichols *et al.*—*J. Exptl. Med. 103,* 465) or in rabbits (Feller & Huff—*Am. J. Physiol. 182,* 237).

In oral administration of elastase to retard induced atheromatosis in chickens, the lipide patterns were not influenced in a direction that would be considered beneficial in treatment of atherosclerosis in man (Tennent *et al.*—*Science 124,* 588).

Many analytical data on serum lipides, proteins, and sugars were recorded in work on elaboration of diabetic vascular diseases (Antonini—*Arch. studio fisiopatol. e clin. ricambio 19,* 281). The lesser degree of atherosclerosis observed at autopsies in myeloma cases was associated with low serum cholesterol levels and rapid lipide clearance in the disease (Spain *et al.*—*Am. J. Med. Sci. 231,* 165).

Body lipides were investigated in relation to many other diseases and abnormal conditions. In mild malnutrition all serum lipides are decreased except α-lipoproteins (Laurell—*Scand. J. Clin. & Lab. Invest 7,* 257). Both α- and β-lipoproteins decrease in inflammatory chronic rheumatism (Jacqueline *et al.*—*Rev. rhum, 21,* 566). Serum cholesterol is increased in lead poisoning (Saitta—*Folia Med. 36,* 718) and is at subnormal values in inevitable abortion (Ciaramella & Martella—*Arch. ostet. e ginecol. 60,* 338). After electric shock cholesterol decreases for 0.5 hours and increases after one hour (Dogliani—*Nevrasse 5,* 162). Fat and cholesterol contents of patients with lambliasis are not abnormal (Mastrandrea—*Arch. ital. sci. med. trop. e parassitol. 36,* 457). No considerable differences were observed in the various lipides of naturally as compared to artificially fed infants (Cipolloni & Paci—*Riv. clin. pediat. 56,* 366). Anemias induce subnormal levels of various lipoproteins; this effect depended upon the type of anemia involved (Miettinen—*Ann. Med. Internae Feniae 45,* Suppl. 22, 78 pp.). In demyelinating diseases various deviations are evident in the amount of the individual components in brain phospholipides (Cumings—*Brian 78,* 554; Edgar—*Monatschr. Psychiat. Neurol. 131,* 274).

Radio-active-labeled protein and fat were used in the evaluation of pancreatic disorders and fat digestion under such disorders (Shingleton *et al.*—*Surgery 38,* 134; Blomstrand *et al.*—*Helv. Paediat. Acta 10,* 640). Fat absorption in pancreatic fibrosis was improved by administering various pancreatic extracts (Ross—*Arch. Disease Childhood 30,* 316; Jensen & Schneidelbach—*Acta Paediat. 45,* 70). Fat absorption in idiopathic steatorrhea is improved during the adrenocorpticotropin and cortisone therapy (Mackay & Volwiler—*Gastroenterology 28,* 972). Respiratory virus infections cause measurable disturbance in fat metabolism (Droese & Stolley—*Klin. Wochschr. 33,* 726). Intestinal excretion of fats is increased in liver cirrhosis (Ciauri *et al.*—*Arch. ital. sci. med. trop. e parassitol. 36,* 564).

Absence or low incidence of gall bladder diseases in certain Asiatic countries was attributed to their low-fat diets (Morrison—*Am. J. Gastroenterol. 25,* 158). The abnormally high serum lipide values in patients with cholelithiasis regress to normal after cholecystectomy (Giorgi—*Minerva chir. 11,* 285).

Chronic nephritis increased serum β-lipoproteins (Heijdemann—*Ned. Tijlschr. Geneesk. 98,* 3174). No direct relationship was evident between blood cholesterol and severity of kidney diseases (Corsini—*Boll. soc. med. chir. Pisa 23,* 72; *Rass. fisiopatol. clin. e terap. 27,* 910). In another study it was reported that the cholesterol content of blood and kidneys increases in nephrosis (Sadhu & Mookerjea—*Metabolism, Clin. & Exptl. 4,* 531). In proteinuria the lipides are removed from the serum proteins during their renal excretion (Schrade *et al.*—*Klin. Wochschr. 33,* 771).

In hyperthyroid patients a significantly shorter turnover time of serum phospholipides was evident (Florsheim *et al.*—*J. Lab. Clin. Med. 48,* 902). Total lipides, cholesterol, and phospholipide contents of serums of patients with myxedema and atherosclerosis are higher than in hypothyroidism (Jones *et al.*—*Am. J. Clin. Nutr. 4,* 449). The ratio of β-α-lipoprotein is elevated in diabetes and the elevation is quite marked in the presence of atheroma (Baker *et al.*—*Quart. J. Med. 24,* 295). The increase in free fatty acids during diabetic acidosis is not sufficient to affect the electrophoretic mobility of the lipoproteins (Laurell—*Scand. J. Clin. & Lab. Invest. 8,* 81).

X-Ray irradiation reduced the rate of intestinal absorption of fats (Morehouse & Searcy—*Radiation Res. 4,* 175) and increased linoleic acid, linolenic acid, and total fat in bone marrow (Bernheim *et al.*—*Ibid. 4,* 132).

Mammary fibroadenoma development in female rats is enhanced by a high-fat diet (Benson *et al.*—*Cancer Res. 16,* 135). Low melting point fractions of hydrogenated oils give rise to a higher proportion of hepatomas than high melting fractions, when fed to mice predisposed to hepatomas (Jardetzky *et al.*—*Proc. Soc. Exptl. Biol. Med. 90,* 648). Conversion of acetate to carbon dioxide and cholesterol is similar in normal livers and preneoplastic livers arising from treatment by *p*-dimethylaminoazobenzene (Medes *et al.*—*Cancer Res. 16,* 57). The fatty acid oxidation of normal liver mitochondria is inhibited after addition of mitochondria from any of many transplanted and spontaneous mouse tumors (Emmelot *et al.*—*Rev. trav. chim. 74,* 1343; *Brit. J. Cancer 10,* 188). It is suggested that the inhibitory effect is due to high adenosinetriphosphate splitting activity. In case of malignant tumors of the liver the blood level of total cholesterol and its ester is normal (Torban—*Terap. Arkh. 28,* No. 3, 12). The kidneys of tumor bearing rats as compared to kidneys of nontumor rats are higher in moisture, total cholesterol, free cholesterol and phospholipides (Boyd & Tikkala—*Can. J. Biochem. & Physiol. 34,* 259). Oxidized degradation products of cholesterol are carcinogenic to mice (Bischoff *et al.*—*Fed. Proc. 14,* 183).

Serum protein-bound lipides are not altered in experimental tuberculosis (Sher *et al.*—*Proc. Soc. Exptl. Biol. Med. 93,* 578). The resistance of mice to tuberculous infection is increased by dietary administration of fatty acid esters derived from coconut oil (Hedgecock *et al.*—*J. Bacteriol. 70,* 415). The hair of balding and nonbalding male individuals show no striking differences in fat content nor in characteristics or composition of the fat (Bloom *et al.*—*J. Invest. Dermatol. 24,* 97).

Pigs with an inherited tendency to obesity have higher serum cholesterols, and phospholipides and a greater concentration of lower density serum lipoproteins than those that tend to leanness (Lewis & Page—*Circulation 14,* 55). Curves relating growth and fat deposition were recorded for mice and

used as a basis to develop a definition of obesity for these animals (Fenton—*Am. J. Physiol. 184,* 52).

LIPIDES IN MICROBIOLOGY AND PLANTS. The rate of formation of fat in surface cultures of *Aspergillus nidulans* is initially slow, rapid during the 8th and the 9th days, and thereafter fat content decreases (Singh & Walker—*Biochem. J. 62,* 286). A survey of lipide synthesis in various particulate fractions of yeast has shown that the lighter material is most active (Klein & Booher—*Biochim. et Biophys. Acta 20,* 387). The role of fat and results from use of various fats in the production of penicillin were studied in developing conditions for optimum yields of the antibiotic (Peterson *et al.—Congr. intern. biochem. Resumes. communs. 3rd Congr. 1955,* 150). Numerous soil actinomycetes grow well on complex phosphotides, cerebroside, fatty acids and esters; whereas cholesterol, phrenosin and ethylamine do not permit good growth (Schatz *et al.—J. Applied Microbiol. 4,* 223). The improvement in growth of *Lactobacillus plantarum* occurring in the presence of oleic acid was said to be due to more efficient entry of biotin into the bacterial cell (Traub & Lichstein—*Arch. Biochem. & Biophys. 62,* 222).

Pyrodoxine was isolated from lipoprotein extracts of bovine tubercule bacteria (Yamamura *et al.—J. Biochem. Japan, 43,* 409). Strain H37Rv tubercle bacilli grow in culture medium containing Tween 80 as a sole source of carbon (Yasui *et al. —Fukushima J. Med. Sci. 1,* 95, 105, 113). *Mycobacterium avium* contains enzymes capable of synthesizing hydroxamic acid from fatty acids (Kimura & Sasakawa—*J. Biochem., Japan, 43,* 175). An enzyme has been prepared from yeast which catalyzes the formation of glyceryl and phosphoglyceryl methylthiol esters (Black & Wright—*J. Biol. Chem. 221,* 171).

Methods for determining lipase in biological fluids in clinic work have been published (Desnuelle *et al.—Bull. soc. chim. biol. 37,* 285; Bunch & Emerson—*Clin. Chem. 2,* 75). Investigations of serum lipases of various mammals has shown a wide range of activity, and some had no lipase activity (Tauber— *Proc. Soc. Exptl. Biol. Med. 90,* 375). Much data have been recorded on selectivity and characteristics of the milk lipase systems (Harper *et al.—J. Dairy Sci. 38,* 1391; *39,* 1364, 1375; Frankel & Tarassuk—*Ibid.* 1506, 1517, 1523; Forster *et al.—Ibid.* 1120). Selectivity or nonselectivity of lipase was discussed with relation to the biological formation of fats in nature (Vander Wal—*J. Am. Oil Chemists' Soc. 33,* 371; Reiser & Dieckert—*Ibid.* 372). An enzyme extract obtained from *Mucor delemar* split various oils to about 80%, independent of the acidity of the oils, and conversely, in a system of oil-fatty acid-alcohol (ethyl or butyl alcohol) esterification occurred up to 90% completion (Taussig—*Acad. Rep. Populare Romine, Studii Cercetari Stiint 5,* 157). An enzyme which releases ethanolamine and choline from phospholipides was obtained from cottonseed (Tookey & Balls—*J. Biol. Chem. 218,* 213).

In the synthesis of oil from acetate -1-C^{14} by slices of cotyledons of castor oil seed the C^{14} is converted to carbon dioxide, unsaponifiable material, and C_{18} fatty acids, but the ricinoleic acid fraction (70% of the total fatty acids) contained no radio-activity (Coppens—*Nature 177,* 279). With glucose present in the substrate radio-activity developed most in C_{16} acids; and C_{14} and C_{16} acid synthesis was favored. Direct evidence was presented to show that in the maturing cotton boll, D-glucose (as D-glucose 6-C^{14}) is partially converted to the seed oil (Shafizadeh & Wolfrom—*J. Am. Chem. Soc. 78,* 2498). With similar techniques it was shown that developing flax fruits utilize acetate to synthesize long-chain fatty acids (Gibble & Kurtz—*Arch. Biochem. & Biophys. 64,* 1).

Extracts of cotyledons of germinating peanut seedlings contain a fatty acid peroxidase which peroxidizes stearic, palmitic, or myristic acids with a loss of carboxyl carbon as carbon dioxide and the accumulation of a long chain fatty aldehyde (Stumpf—*J. Biol. Chem. 223,* 643; Stumpf & Barber— *Plant Physiol. 31,* 304). Red clover, sunflower, sugar beet, and bean chloroplasts were isolated and were characterized for synthesis of fatty acids from various media and for the oxidation of linoleic, linolenic, oleic, and palmitic acids (Sisakyan & Smirnov—*Biokhimiya 21,* 273). The oxidases of coriander and peppermint grass were characterized for the effect of various compounds on their oxidation and synthesis of fatty acid esters (Pshenova—*Biokhimiya 21,* 279). Coumarin blocks the hydrolysis of lipides in germinating lettuce seeds (Poljakoff-Mayber & Mayer—*J. Exptl. Botany, London 6,* 287). When lipolysis is permitted to proceed, volatile free fatty acids develop, although none were detected before hydrolysis. Frehse & Franke (*Fette-Seifen-Anstrichmittel 58,* 403) reviewed current knowledge of the primary fatty acid degradation by enzymes from higher plants.

Mayne (*J. Applied Microbiol. 4,* 263, 270) isolated many microorganisms associated with the deterioration of cottonseed in storage, and classified and characterized these with respect to ability to hydrolyze the oil.

Characteristics and Composition

COMPREHENSIVE AND GENERAL. Those communications dealing merely with analytical methods, composition and properties are briefly cited in this section. Where analytical methods are more pertinent to spoilage of fat, detergents, biochemistry of fats, etc. they are cited in other sections accordingly.

Many comprehensive analytical reports pertained to progress of collaborative testing of methods, standard methods, discussions on modifications and official actions on series of modifications which had been recommended. The text of these reports were on: changes in about 18 American Oil Chemists' Society official methods (Andrews—*J. Am. Oil Chemists' Soc. 33,* 422), revised methods of the Society of Leather Trades' Chemists for the analysis of fats (Burton & Robertshaw— *J. Soc. Leather Trades' Chemists 40,* 170), conversion of the standard American Oil Chemists' Society Methods to analyses of samples of less than 20 mg. weight (Sims & Stone—*J. Am. Oil Chemists' Soc. 33,* 287), methods for determining composition of oils and fats (Filajdic—*Kemija u. Ind., Zagreb, 4,* 41, 235), analytical methods in fat chemistry (Franzke— *Seifen-Öle-Fette-Wachse 82,* 79, 103), analyses and trade classifications of the vegetable oils from the Belgian Congo (Patzsch—*Ibid. 81,* 532, 582), methods of analyzing sperm-whale oil (Moldavskaya & Dmitrieva—*Masloboino-Zhirovaya Prom. 21,* No. 7, 30), standards for ghee (Dastur—*Indian Dairyman 7,* 267), physical properties of stearic acid (Tillotson—*J. Soc. Cosmetic Chemists 6,* 40), increasing the scope of spectroscopy methods to the determination of pentaenoic acids (O'Connor *et al.—J. Am. Oil Chemists' Soc. 33,* 289), a tabulation of 100 absorption bands employed in fatty acid chemistry with the vibrating groups responsible for their origin (O'Connor—*Ibid.* 1), ultraviolet spectrophotometry in the analysis of oils (Vazquez-Roncero—*Grasas y aceites, Spain 6,* 233), spectrophotometry in analysis of oils and fats (Ahlers— *Paint Technol. 20,* 237), influence of various molecular structures on the elimination maximum of fatty acids (Demakis— *Univ. Microfilms, Ann Arbor, Mich. Publ. No. 15616,* 208 pp.), and polarography in the field of fats and oils (Asahara & Hayano—*J. Japan Oil Chemists' Soc. 5,* 202).

Environmental and variety influences on fats were investigated. Regional differences do not cause marked changes in the composition of tobacco seed oils, and the varietal factor is subordinate to environmental influence (Chakrabarty & Chakrabarty—*Science & Culture, India, 20,* 555). Investigations on eight varieties of soybeans show: no increase in yield with any possible combination of fertilizers; yields dependent on the variety; and there is no definite relation between yield and the amount of oil produced (Gutierrez-Rojas—*Acta Agron, Colombia 5,* 211). Seeds from the lower half of soybean plants were 0.5% higher in oil and 1% lower in protein than those from the upper half; beans near the tip of long terminal racemes had less oil than those further down; and seed in the tip of the pod had highest oil and lowest protein content (Collins & Cartter—*Agron. J. 48,* 218). Investigations with eight varieties of cottonseed grown at 13 locations during three crop years showed that grams of oil and gossypol per 100 kernels tended to increase with increasing rainfall and decrease with increasing mean temperature; and that the relationship of nitrogen to gossypol ratio is negatively correlated with the oil content of the kernels (Stansbury *et al.—J. Am. Oil Chemists' Soc. 33,* 282). The composition of 54 samples of Greek cotton seeds has been tabulated (Katsoulis—*Chimika Chronika 20,* 150). Data on the steady increase of protein and fat occurring in the course of ripening of sunflower seeds (Franzke —*Fette-Seifen-Anstrichmittel 58,* 340) and of rapeseed (Maruta & Iwama—*J. Chem. Soc. Japan Ind. Sect. 58,* 605) have been recorded. The work on rapeseed also included changes in oil content and characteristics of the oil during germination.

In perch there is a high correlation between fat and water content of the edible part, which can be used for analytical purposes (Brandes & Dietrick—*Fette-Seifen-Anstrichmittel 63,* 433). The vitamins of fish oils have been reviewed with regard to origin and biological variations (Creac'h—*Oleagineaux 10,* 801).

ANALYSIS OF FAT SOURCES. A modified conductivity method for determination of moisture in cooked cottonseed meats gives results that agreed well with those by the oven drying method (Hancock & Burdick—*J. Am. Oil Chemists' Soc. 33,* 175).

A Soxhlet apparatus, which was supplied with a stopcock on its siphon to permit reuse of solvent, permitted accuracy of fat determinations equal to that of the conventional apparatus (Schwarz—*Z. Lebensum.-Untersuch. u. -Forsch. 104,* 275). Crushing cottonseed with sand containing a small amount of petroleum ether-washed cotton permitted reduction of the analytical oil extraction period from four hours to 10 minutes (Bhatty & Ullah—*Pakistan J. Sci. Res. 7,* 54). An investigation on petroleum ether versus ethyl ether for rapid determination of oil content of oilseeds has indicated that the latter solvent is preferable when the extract is to be used to determine iodine value and free tocopherol content of the oil (Kartha & Sethi—*J. Sci. Ind. Res., India, 15B,* 102). Data and technique have been developed for applying refractrometric methods to fat determinations in cocoa products (Kleinert—*Rev. intern. chocolat. 10,* 440; *Zucker- u. Süsswarenwirtsh 8,* 880) and linseed (Hermida—*Arch. fitotec., Uruguay 5,* 149). Rapid methods developed for safflower and sunflower seeds were based on using a forced drafted oven at 130° for moisture and determining oil by a rapid dielectric method (Johnson *et al.—J. Am. Oil Chemists' Soc. 33,* 314). A method of calculating the original oil content of palm pulp that may have been partly dehydrated in harvesting and storage before arriving at the mill is based on assuming that the sum of oil and moisture of the pulp of the fruit is 84% at harvesting (Desassis—*Oleagineux 10,* 739).

The influence of acid concentration, temperature, time in water bath, addition of amyl alcohol, presence of carbohydrates, etc. has been determined as basic information for applying the Gerber method for determination of fat in meat products (Ponja *et al.—Z. Lebensm-Untersuch. u. -Forsch 103,* 333). A procedure for determining oil in fish meal is based on extracting with acetone containing 8% water (Stansby & Clegg—*Com. Fisheries Rev. 17,* 16). In a comparison of preparing food for analytical fat extraction by drying with the air oven, vacuum oven, infrared rays and lyophilizer, the latter was preferred but the drying procedures were less time consuming (Watts *et al.—Food Res. 21,* 528). In an emulsion method for fat in foods the sample is dissolved in a mixture of trichloroacetic acid, precipitated by addition of water, and the turbidity is compared with standard fat emulsions (Fedotov —*Voprosy Pitaniya 15,* No. 4, 51).

With hogs, means have been devised to determine the fat layer or the total fat in the animal as a basis of selecting breeding stock that have a large ratio of primal cuts. A patented method for measuring the thickness of the fat layer in live hog bodies involved pushing electrodes through the tissues and noting current flow (Whatley & Andrews—*U. S. 2,763,935*). This method of measurement of backfat thickness at a live weight of about 210 lbs. was more highly correlated with primal cuts, carcass index, and ham specific gravity than was backfat thickness measured on the carcass (DePape & Whatley —*J. Animal Sci. 15,* 1029). The amount of fat in an animal was correlated with the length of their sleep after administering an anesthetic (Feinstein & Fulmine—*Agr. Res. 5,* No. 4, 11). The shorter the sleep, the more fat present in the body.

Because grease cannot be extracted from cured or soaked hides with a solvent it was recommended that the sample be hydrolyzed with 6 *N* hydrochloric acid and the extraction made with chloroform (Hauch & Lollar—*Leather Mfg. 73,* No. 1, 5). Because castor oil is insoluble in petroleum ether, the oil in castor oil fat liquors used in the leather industry should be treated with a mixture of equal parts of petroleum ether, ethyl ether, alcohol and water; the nonaqueous portion separated should be washed with aqueous 50% alcohol; and oil determined in this solution (Dietsche & Lübbe—*Das Leder 7,* 119).

According to a patented method for butterfat in milk, the sample is homogenized and light transmission is measured under control conditions as a measure of the fat content (Batchelor—*U. S. 2,752,815*). A new method for analysis of microquantities of milk involves reacting the sample with alkaline hydroxylamine in isopropanol, diluting with acidic methanol containing ferric chloride, and calculating concentration from the red color intensity by referring to a standard curve (Bassette & Keeney—*J. Dairy Sci. 39,* 910). Low fat tests by the Babcock method on mercuric chloride preserved milk samples were attributed to an increase of lipolytic hydrolysis of the fat catalyzed by the preservative (Manus & Bendixen—*Ibid.* 508). Comparative data on determining butterfat by the detergent, Mojonnier, Babcock, Gerber, and Schain methods have been recorded (Freeman *et al.—Food Technol. 19,* 12). A new digestion solution has been designed for the Gerber butterfat determination (Jannucci—*Acta med. vet., Naples, 1,* 263). British standards have been issued for the Gerber apparatus and method (*Brit. Standard 696,* 61 pp.). To eliminate the long soaking required with the British standard procedure when applied to casein, the sample was soaked in 3% borax solution containing a little amyl alcohol and then treated with sulfuric acid before the Gerber digestion (Falkenhahn—*Australian J. Dairy Technol. 11,* 66). Dawson (*Ibid. 10,* 108) recommends the Babcock method for butterfat in casein and has developed details for applying the method to this material.

Total fatty acid and cholesterol were determined in blood by refluxing with 10% caustic, evaporating to dryness, adding dilute phosphoric acid, extracting with ether, and titrating aliquots of the extract (Nakamura *et al.—Nisshin Igaku 43,* 147). New modifications have been proposed for determining fatty acids in blood by the Bloor-Pelkan-Allen method (Polosukhina & Kaipova—*Nauch. Isvest. Kasakh. Med. Inst. 1953,* No. 11, 49) and for the Bauer-Hirsch method for estimating the esterified fatty acids (Jarrier & Polonvski—*Bull. soc. chim. biol. 37,* 495). The methods and solvents used for extracting lipides from human feces were critically reviewed (Planche—*Compt. rend. soc. biol. 150,* 545).

To estimate the amount of oleic acid and potassium oleate in white spirits as total oleic acid the sample was titrated with perchloric acid using thymol indicator and calculations were made by comparison with titrations made on known solutions (Mitchell & Davies—*Analyst 81,* 121). Approximation of small amounts of fatty acids in test solution was made by dipping cleaned and flamed aluminum foil in the sample, drying, spraying with a methyl blue solution and comparing the droplet size with photographic standards (Krämer & Heiss—*Fette-Seifen-Anstrichmittel 58,* 87).

GRADING AND VITAMIN TESTS. Damage to sesame seed by mechanical equipment resulted in a loss of seed viability which correlates well with the increase in free fatty acids occurring during storage (Kinman—*J. Am. Oil Chemists' Soc. 33,* 637). Accordingly, tests for viability of seeds at harvest were recommended for approximating the free fatty acid of the oil that may develop for various storage periods. Tests have indicated that the phosphorus level of deodorized soybean oil is closely associated with its color and oxidative stability but that of the refined or bleached oil is not a good criterion for predicting the quality of the finished oil (Beal *et al.*—*J. Am. Oil Chemists' Soc. 33,* 619). An instrument for graphically recording weight changes of thin films of oil was demonstrated (Kaufmann—*Fette-Seifen-Anstrichmittel 58,* 844). It may be used for moisture determinations in butter, margarine, and detergents and for studying the weight changes of drying oil films.

The optical density of oils as determined with a spectrophotometer over the 20 mμ increments between 400 and 700 mμ were converted to readings equivalent to those obtained by the Lovibond tintometer by use of a special formula (Jacini & Carola—*Olii minerali, grassi e saponi, colori e vernici 32,* 215). Naudet *et al.* (*Rev. franc. corps gras 3,* 425) also evaluated the color of oils between the wavelengths 400–700 mμ; correlated his results with other common methods; indicated how different stages of refining are recognized; and pointed out that purity and brilliancy may also be evaluated by the technique. In similar work Sterlin and Mironova (*Masloboino-Zhirovaya Prom. 22,* No. 4, 10) have shown how the color obtained by the spectral-transmittance could be used in selection of refining methods that improve the stability of the refined oils during subsequent storage.

A gain in the rapidity of methods for estimation of vitamin A in powdered formulas for infants and in animal feed supplements was based on solubilizing the vitamin A in the test material with surfactants so as to accelerate the extraction, which was performed with mixed solvents (Gade & Kadlec—*J. Agr. Food Chem. 4,* 426). The vitamin A activity of rendered beef and mutton fats has been shown to be due entirely to vitamin A, together with a minor amount of β-carotene (Gillman *et al.—Biochem. J. 63,* 458). In this work reverse-phase partition chromatography of the unsaponifiable portion was used in the determination of the vitamin. An investigation of the carotene and vitamin A content of butterfat throughout lactation has shown higher than normal values during 10–12 days after parturition and also some seasonal changes that correlated with the carotene content of the feed (McDowell—*J. Dairy Res. 23,* 111). The vitamin A content per gram of butterfat of cows and Indian buffaloes is practically alike but on the milk basis buffalo milk contains about one-third more because of the higher fat content (Narayanan *et al.—Indian J. Dairy Sci. 9,* 44). The tocopherol content of the buffalo milk is higher than that of the cow milk, but was

lower on a fat basis. The validity of the correction procedure of the British pharmacopolia spectrophotometric method for determination of vitamin A in fish oils was confirmed by chromatographic separation tests (Balasundaram *et al.—J. Sci. Ind. Res. 15C*, 23). The fish liver oil vitamin A contained an average of about 25% neo-vitamin A_1 and 10% vitamin A_2. The vitamin A_2 present in the liver oils of some Indian freshwater fish is quite high (Balasundaram—*Biochem. J. 64*, 150). Analyses of the liver oils of 10 deep-sea sharks have shown vitamin A contents of 13,600–1,931,000 U.S.P. units (Higashi *et al.—Bull. Japan Soc. Sci. Fisheries 21*, 448). The highest values, 938,000–1,931,000, were found in the liver oils of *Heteroscymus longus*. The tocopherol and vitamin A content of many marine blubber oils have been recorded (Heller—*Univ. Microfilms, Ann Arbor. Mich. Publ. No. 15601*, 28 pp.).

Methods for isolation and identification of the antirachitic compound formed by action of floridin on cholesterol have been devised (Raoul *et al.—Bull soc. chim. biol. 38*, 495). This compound has been identified as 5-cholestene-7-one-3β,10-diol.

A method for qualitatively detecting α-, γ-, and δ-tocopherols in oils and pharmaceutical preparations was based on chromatography on paper impregnated with petroleum oil and use of silver nitrate as the detecting agent (Kopecky—*Prumysl Potravin 7*, 267). Interference by oxidizing fatty ester in the bipyridine colorimetric method for tocopherol is eliminated by treating the sample with 80% sulfuric acid, but the spectrophtometric determination is applicable only when the oxidized components of the fats are completely removed (Lips—*J. Am. Oil Chemists' Soc. 33*, 426). Surveys of Swedish (Hellström & Anderson—*Var föda 7*, 33) and Dutch (Kruisheer—*Neth. Milk Dairy J. 9*, 275) butters indicate tocopherol contents of 12.5–27 and 8–24 γ per gram, respectively.

CHEMICAL CHARACTERISTICS. Iodine values determined with a simple reagent, iodine in carbon tetrachloride plus mercuric acetate, agreed with those by conventional methods on 15 vegetable oils, but required adjustment of reaction time for good results from castor and linseed oils (Ubaldini & Capizzi-Maitan—*Chim. e ind., Milan 37*, 943). A standard procedure for iodine value was shortened by adjustment of the reagent concentration (Ryzhova—*Masloboino-Zhirovaya Prom. 20*, No. 5, 26). Best results with a coulometric determination of iodine value were obtained with a solution containing 80–93% acetic acid plus 0.2–1.2 *N* hydrochloric acid (Kucera—*Sbornik J. Celostatui Pracovni Konf. Anal. Chem. Prague, 1952*, 231). A method for detecting and locating double bonds in fatty acids is based on periodic acid oxidization splitting at the double bond position, and characterizing and estimating the carbonyl derivatives as their 2,4-dinitrophenylhydrones or dimethones (Chatterjee & Majumdar—*Anal. Chem. 28*, 878).

The solubilities of tetra- and hexabromostearic acid in various solvents have been recorded as basic information for quantitative determination of linoleic and linolenic acids (Franzke & Ittrich—*Fette-Seifen-Anstrichmittel 58*, 834). The hexabromo acid is best separated for analytical purposes from petroleum-benzene at a temperature of 50°; whereas separation of the tetrabromo acid appears only possible at low temperatures and by repeated recrystallization. A new method of determining hexabromide value or linolenic acid in linseed oil acids was based on controlled urea complex precipitation (Pathak & Aggarwal—*J. Sci. Ind. Res., India, 15B*, 247).

Means for eliminating errors in the determination of the carbonyl values caused by the presence of acid anhydride and peroxides have been reviewed and discussed (Weber—*Fette-Seifen-Anstrichmittel 58*, 232).

The saponification value of tall oil is affected by oxidation of the samples, hence drying should be in vacuum or inert atmosphere (Kirjakka & Tammela—*Paperi ja Puu 36*, 497). A colorless solution of potassium hydroxide in ethanol was prepared for use in saponification value determinations by treating the ethanol with aluminum butylate to precipitate the aldehyde impurities before adding the potassium hydroxide (Bertam—*Chem. Weekblad. 51*, 677).

In the semi-microdetermination of the butyric acid value of fats the saponification of the fat should be done under a reflux condenser otherwise low values will result (Fincke—*Zucker- u. Süsswarenwirtsch 9*, 158). The butyric acid values along with other characteristics have been determined on many fats and oils in a search for substitutes for cocoa butter and chocolate fats (Kleinert—*Rev. intern. chocolat. 10*, 449).

A scheme of analysis has been developed for determining lead, magnesium, zinc, barium, cobalt and other metals in mixtures of metallic soaps (Marwedel—*Farbe u. Luck 62*, 92).

PHYSICAL PROPERTIES. Methods used in the study of the modes of crystallization of a number of mono-, di-, and triglycerides were reviewed by Lutton (*J. Soc. Cosmetic Chemists 6*, 26). Sydow (*Acta Chem. Scand. 10*, 1; *Arkiv Kemi 9*, 231) has indicated how fatty acids crystallize in different polymorphic forms depending on the temperature, purity, solvent and rate of crystallization; and has discussed the structure of the crystals as determined by single crystal x-ray methods. With the short chain acids the stable form have triclinic chain packing, whereas with longer chains (23 or more carbon atoms) the stable form have orthorhombic chain packing. Unit-cell dimensions of γ-lauric and γ-myristic acid crystals as determined by x-ray diffraction patterns have suggested that there are 12 molecules per unit cell (Lomer—*Nature 176*, 653). X-ray data on various mixtures of C_{14} to C_{18} even carbon chain fatty acid mixtures do not support a complete intersolubility of fatty acids, but are consistent with some degree of compound formation that could explain the inflection in the solidification point curves (Fieldes & Hartman—*Proc. Roy. Soc., London, A233*, 195).

An adiabatic calorimeter was designed for studying the thermal characteristic and phase composition of fats over a wide temperature range and was applied to cocoa butter, butter fat, palm kernel stearins and mixtures of these to gain practical data for use in selection of alternates for part of the cocoa butter in chocolate (Steiner—*J. Sci. Food & Agr. 6*, 777, *7*, 425). The heat capacities of methyl palmitate and palmitic acid was determined in the temperature range of 14 to 300°K. (Wirth *et al.—J. Phys. Chem. 60*, 917). Composition-melting point curves were recorded for various mixtures of methyl- and ethyl-stearate, hydrogenated fat, lanolin, and paraffin (Gluzman & Dashevakaya—*Zhur. Priklad. Khim. 29*, 1066). The lanolin systems show a maximum slightly above the melting point of lanolin. A ternary system has a triple eutectic with 60% methyl stearate, 30% hydrogenated fat and 10% paraffin. The melting behavior and the structure of cocoa butter has been investigated for the effect of one-year storage, heating, stirring and presence of seed crystals during solidification (Vaeck—*Zucker- u. Süsswarenwirtsch. 8*, 718). On slow cooling palmitodistearin and stearodipalmitin crystallize out into separate crystals.

A modified dilatometer was designed for the rapid evaluation of the solid glyceride contents in fats (Teasdale & Svardal—*J. Am. Oil Chemists' Soc. 33*, 78). The dilatometric properties and x-ray diffractions were recorded for some butyropalmitins, butyrostearins, and acetopalmitins (Feuge & Lovegren—*Ibid.* 367). The long spacing indicates a triple chain length structure for some compounds and as yet nondetermined structure for the others.

The resistance to cutting of butter and margarine was correlated with spreadability, iodine value, melting point, and flow point (Lagoni & Samhamn—*Molkerei- u. Käserei-Ztg. 6*, 1350) and to the methods of warming and recooling (Mohr & von Drachenfels—*Fette-Seifen-Anstrichmittel 58*, 609). The latter report also contained photomicrographs of the samples whose details were related to the physical data. Herb *et al.* (*J. Am. Oil Chemists' Soc. 33*, 189) recorded photomicrographs to show the difference in appearance of the crystals from normal and rearranged lard when both polarized light and phase contrast are employed.

The boiling points of acids, esters, and saturated alcohols of the C_8 to C_{22} fatty series were determined for pressures between 10^{-4} and 1 mm. of mercury (Spizzichino—*J. recherches centre natl. recherches sci. Labs. Bellevue No. 34*, 1). The measurements were used to determine the Dupre-Rankine equation constants and the heats of vaporization were then calculated.

A new modification of the capillary rise method and apparatus for determining surface tension like that of Ferguson has been designed and applied for measurements on methyl laurate and other compounds (Nevin—*J. Am. Oil Chemists' Soc. 33*, 95).

X-ray diffraction patterns of films of fatty acids from C_{12} to C_{22} adsorbed on glass indicated increasing average tilt of molecules relative to the surface normal with decreasing length of molecules, but no apparent change in tilt with variations in surface density (Bigelow & Brockway—*J. Colloid Sci. 11*, 60). Investigations on adsorption of fatty acid films on solids have shown that on quartz glass and basal planes of mica the acids are weakly adsorbed; on platinum a unimolecular film is stable but further layers desorb readily; and on copper and nonbasal planes of mica all adsorbed layers are stable (Young—*Australian J. Chem. 8*, 173). Layers of copper or calcium stearate are much more stable on all surfaces.

The surface potentials of very dilute films of fatty acids spread on distilled water are negative and tend to negligible value when the pH decreases (Minassian-Saraga—*J. Colloid Sci. 11*, 398). The surface pressure-area relation of myristic

acid films at air-aqueous interfaces for very low surface pressures showed a molecular cohesion six times that of gaseous butane under comparable conditions (Semeluk *et al.—Can. J. Chem. 34,* 609). The characteristics of myristic acid and mixed myristic acid-trimyristin films on water were discussed (de Bernard & Dervichian—*Bull. soc. chim. biol. 37,* 943).

Spreading coefficient measurements of lenses of white oil containing octadecanol indicated that at equilibrium the lens of oil rests on the closed-packed hydrocarbon tails; whereas for tetradecanoic acid this was only approximately correct (Sawyer & Fowkes—*J. Am. Chem. Soc. 60,* 1235). Absorption of the enzyme trypsin at lipide-water interfaces reduces the activity of the enzyme (Fraser & Schulman—*J. Colloid Sci. 11,* 451). This loss in activity of the enzyme at the interface is thought to be due to a structural unfolding of the molecule.

Molecular areas of films of stearic, palmitic and lauric acids in distilled water are 19.9–20.5 sq. Å per molecule and oleic acid 48.5 sq. Å per molecule (Aenlle & Cadorniga-Carro—*Anales real soc. espan. fis. y quim. 51B,* 515). Similar data for β-hydroxypalmitic, β-hydroxystearic, and β-hydroxyarachidic acids are, respectively, 85, 72 and 41 sq. Å per molecule (von Hahn & Grün—*Helv. chim. acta 38,* 1803). Area measurements of mixed monolayers of isodextropimaric acid and the normal C_{14} to C_{24} fatty acids have indicated greater average area per molecule than would be expected for an ideal mixture except for the mixtures involving myristic acid (Brunn —*Acta. Chem. Scand. 9,* 712). This was explained by suggesting that two layers are formed, the upper is formed by parts of the fatty acid chains projecting above packed molecules of isodextropimaric acid and the lower layer by densely packed molecules of the latter and the lower parts of the fatty acids.

A side chain in a fatty acid reduces the influence of the acid on the interfacial tension in a water-liquid paraffin system (Kromphardt—*Biochem Z. 327,* 20). The effect of the substituent was greatest at position 2 in the chain and the effect diminished with removal of substituent further from the carboxyl group. The diffusion coefficients of a series of fatty acids and fatty phosphates in decane at 30° were measured; and the magnitude and variations were shown to be predictable with the unmodified Stokes-Einstein equation (White—*J. Chem. Phys. 23,* 2247).

A film on water composed of 80 moles of arachidic acid and 20 moles of ethyl palmitate reduces the evaporation of the water (Rosano & LaMer—*J. Phys. Chem. 60,* 348).

The measurements of the dielectric permeability at various frequencies of castor oil at pressures up to 9,000 atmospheres show a maximum which could be linked to the change in the viscosity under high pressures (Vereshchagin *et al.—Zhur. Eksptls i Teoret. Fiz. 30,* 661). The dielectric constants of animal fats plotted with respect to temperature show a maximum within the crystallization zone, the other relationships are linear (Lapshin—*Myasnaya Ind. S.S.S.R. 27,* No. 1, 13). The dielectric measurements were used to study the dipole orientational freedom of solid triglyceride and the hydrogen bonding in fatty alcohols and fatty mercaptans (Giacomo & Smyth—*J. Am. Chem. Soc. 78,* 2027, 2032).

The solubilities of tristearin in hexane, benzene, carbon tetrachloride, chloroform, ethyl acetate, acetone, and ordinary cottonseed oil have been recorded (Hoerr & Harwood—*J. Am. Chem. Soc. 60,* 1265). The solubility of this triglyceride is decreased markedly by increased polarity of solvents, and it exhibits three distinct solubility curves corresponding to the three crystalline forms. A re-examination of the solubility of linseed oil and linoleic acid in water has shown that a high solubility may develop by hydroxylation probably from a peroxidized system (Schauenstein *et al.—Monatsh. 87,* 144).

DETECTION OF ADULTERATION. Wagle (*Bombay Technologist 6,* 76) reviewed methods for the detection of adulteration of fats and oils. Mitra (*J. Proc. Inst. Chemists, India, 28,* 44) discussed the use of saponification, iodine, and refractometric value for determining the purity of oils and fats. Ibarra (*Rev. fac. cienc. quim. Univ. Peron 26,* 27) suggests that analytical relations between titer, refraction, and iodine values suffice to detect mixtures of olive, grapeseed, rapeseed, cottonseed and peanut oils; but substitution of sunflower seed oil for grape seed oil or *vice versa* was not possible with these characteristics.

The methods described for detection of refined lard were based on ultraviolet spectroscopic absorption at 232 and 268 mμ (Kaufmann *et al.—Fette-Seifen-Anstrichmittel 58,* 505), the aniline point (Kaufmann & Thieme—*Ibid.* 585), and electrical conductance (Bertram—*Rev. fermentations et ind. 10,* 165). Treating lard with Neutral-red dye solution induces a bluish fluorescence in fresh samples; high temperature rendering tends to change this to yellowish; later reheating after oxidative rancidity reduces the fluorescence; and adulteration with mineral oil is evident from blue-violet to white-bluish natural fluorescence (Wuringer & Lindemann—*Die Fleischwirtschaft 8,* 675). The use of this test, the aniline point, and iodine value gave doubtful results for detecting presence of white grease in lard, while determination of cholesterol content was a much better indication (Roos—*Fette-Seifen-Anstrichmittel 58,* 118). In a general communication on investigating imported lard, the neutral-red test, fluorescence test, the relation between aniline point and iodine value, and the presence of antioxidants were discussed (Wurziger—*Ibid.* 260).

The Association of Official Agricultural Chemists (U. S.) has reported collaborative investigations on the most promising methods for detection of adulterations of butterfat. The apparatus and methods for the Reichert-Meissl and Polenske values have been modified to yield results on butter, palm kernel oil, and coconut oil that serve best for the purpose of detecting presence of the latter two in butterfat (Klayder & Fine —*J. Assoc. Off. Agr. Chemists 39,* 355). The test based on the melting point of the sterol acetates gave a figure of 114.6 ± 1.8° for butter and 118.7 ± 2.5° for butter containing 10% cottonseed oil (Cannon—*Ibid.* 359). A modified Keeney chromatographic method which depends on the percent butyric acid when tested on samples of butter containing margarine fat gave results which were within ± 0.2 mole % of butyric acid among 92 tests and within ± 0.3 mole % among 98% of the tests (Anglin & Mahon—*Ibid.* 365). Hydroxamate methods were designed in an empirical manner so that they correlate with the butyric acid method cited above (Basssette & Keeney —*Ibid.* 469; Nelson—*Food Tech. 8,* 385). The test depends on the milk fats forming red water soluble hydroxamic acid-iron complexes from the short-chain fatty esters. Bhalerao & Kummerow (*J. Dairy Sci. 39,* 947) worked out a method to detect adulteration of butterfat by a foreign fat at a 10% level based on the glyceride structure. A lowering of the index of refraction of that portion of butter soluble in alcohol at 20° indicates the presence of coconut oil, whereas an increase in the refraction of this fraction indicates the presence of other vegetable oil or animal fat. Normal index of refraction of this fraction of butter varies only from 1.4538 to 1.4541. These investigators (*Ibid.* 956) also reviewed methods based on butyric acid, phytosterol acetate, tocopherol, isovaleric acid, hydroxamic acid derivative color, isoöleic acid, etc. for the same purpose. A method based on the melting point of isolated sterols designed by den Herder (*Neth. Milk Dairy J. 9,* 261) was said to be sensitive to adulteration of butter with 1% rapeseed oil.

The methods for detection of hydrogenated dolphin oil in butter were based on detection of acetic acid and/or isovaleric acid in the mixed fatty acids. The Bezzi & Sacconi method for this purpose based on a Reichert-Meissel distillation into four standard fractions and titrating these has been standardized to a higher sensitivity (Ongaro—*Bull. lab. chim. provinciali 6,* 4). Other methods were based on the conductivity of the Reichert-Meissl fraction (Chioffi—*Ibid.* 37) and on chromatographic detection of the acids (Priori—*Ibid. 45;* Parrozzani—*Latte 28,* 397). The Tortelli-Jaffe reaction has been challenged with regard to its detection of hydrogenated marine animal or fish oils in butter (Olivari—*Boll. lab. chim. provinciale 6,* 116; Ono & Toyama—*Res. Rept. Nagoya Ind. Sci. Res. Inst. No. 8,* 50; Bigoni—*Olii minerali, grassi e saponi colori e vernici 32,* 193). In general, false positives may occur with olive oil or oxidized vegetable oils and consequently other criteria should be used with the test. Cerutti (*Latte 29,* 855) believes this test combined with paper chromatographic adsorption of the fat and the solutions successfully detects dolphin and fish oils in butter or coconut oil.

The butter oils of southeastern Turkey which are made from sheep, goat and cow milk have each been described with regard to chemical and physical characteristics as a basis for identification and for detection of adulteration (Adam—*Univ. Ankara Fac. Agr. Pub. 67,* 99 pp.). The characteristics and a chromatograph of the acids have been recorded for sheep butter and discussed with regard to detecting it in cow butter (Cerutti—*Latte 29,* 695). Best criteria were Polenske value and the Tortelli reaction. The determination of isoöleic acid was recommended for detecting hydrogenated oil in ghee (Narayanan & Kartha—*J. Sci. Ind. Res., India 14B,* 544) and in vanaspatti (Subbaran & Mahadevan—*Ibid. 15B,* 198).

Cruciferae oils when fractionated on an alumina column, the oil fraction chromatographed on paper moistened with paraffin oil, developed with 1:9 mixture of benzene:methanol and exposed to iodine vapors exhibits five spots, whereas with other

plant oils two spots are formed (Priori—*Olii minerali, grassi e saponi, colori e vernici 33,* 23). With this method 5% rapeseed oil can be detected in other vegetable oils. A similar method comprised saponifying the oil, removing the unsaponifiable matter, placing a drop of 1–4% solution of the fatty acids in benzene on paper, chromatographing with 90% acetic acid as a mobile phase; and detecting the erucic acid of rapeseed oil by a specific reddish brown to violet spots (Hadorn & Biefer—*Mitt. Lebensm. Hyg. 47,* 75). A similar test was used to detect argemone oil in rapeseed oil (Chakravarti and Chaudhuri—*Bull., Calcutta School Trop. Med. 3,* 164). Urea complex precipitation technique was used to detect adulteration of mustard oil with linseed or peanut oil (Mehta —*J. Indian Chem. Soc. Ind. & News 19,* 39).

To distinguish pure and refined olive oils, Carola (*Olii minerali, grassi e saponi, colori e vernici 32,* 219) determined optical density at every 20 mμ between 600 and 700 mμ, and used the data to calculate a "variable index" which is quite high (about 7) for the pure and low (about 1) for the refined oil. Other investigators (Uzzan—*Oleagineux 11,* 27; *Rev. franc. corps gras 3,* 9; Wolff—*Ibid. 17*) have pointed out that ultraviolet spectrophotometric adsorptions of olive oil can be correlated with acidity, degree of oxidation, geographical source and presence of olive-residue oil.

A method for analysis of mixtures was based on fractional crystallization of the unsaponifiable into three fractions, separating the sterols by chromatography on a column and determining their rotatory value (Aunon—*Bol. inst. nacl. invest. agron., Madrid, 15,* 187). Mixtures of soybean and cottonseed oil are successfully analyzed by the method. Semimicro methods were considered unsuccessful for detecting substitute fats in chocolates, particularly in American chocolates where butter is used as the substitute (Kleinert—*Rev. intern. chocol. 10,* 478). The foreign fat determination in cacao products based on crystallization from acetone was simplified by using a crystallization period of one hour at −14° (Purr—*Fette-Seifen-Anstrichmittel 58,* 898).

Addition of 15 drops or 0.2 grams of an oil or fat containing linolenic acid to 2 ml. of acetic acid saturated with picric acid induces the appearance of a red color (Pkheidze & Goguadze—*Zhur. Anal. Khim. 11,* 91). This reaction may be used to indicate the presence of soybean, linseed, mustard, prune or fish oil in a sample.

COMPOSITION. A molecular distillation method was applied for fractionation and analysis of mono- and diglycerides (Privett—*Ann. Rept. Hormel Inst. 1955–6,* 13). Chromatographic examination of this distillation analysis indicated that no free acid is produced during the distillation and if disproportionation of acids among the glycerides takes place it is very slight. Details of two new procedures for estimation of 1-monoglycerides in commercial samples by oxidation with periodic acid were published (Dowse & Saunders—*Biochem. J. 62,* 455; Hartman—*Analyst 81,* 67). The periodic method gives abnormally high values with monoglycerides made from fish liver oils, possibly due to oxidation of vitamins A and E, and of double bonds of the highly unsaturated fatty acids (Perez & Molero—*Grasas y aceites, Spain, 6,* 135).

Optimum conditions were worked out to permit quantitative determination of unsaturated acids by the periodate-permanganate oxidation (von Rudloff—*Can J. Chem. 34,* 1413). Among many solvents tested, the oxidation proceeded most favorably in butanol and pyridine. This procedure in combination with chromatographic methods was applied to the determination of the position of the double bonds in oleic, elaidic, eiosenoic, 10-undecenoic, and linoleic acids (von Rudolff—*J. Am. Oil Chemists' Soc. 33,* 126). A new modification of the Hilditch acetone-permanganate oxidation procedure for determination of the glyceride structure of fats was proposed (Yakubov—*Masloboino-Zhirovaya Prom. 21,* No. 1, 14). A like procedure was applied for the estimation of saturated acids in small amounts of fats or fatty acid mixtures (Sethi & Kartha—*J. Sci. Ind. Res., India, 15B,* 103). A method of degradation of fatty acids intended for studies of the biochemistry of fatty acids in which C^{14} is used is based on removal of carboxyl carbon of the acid as the carboxyl carbon of benzoic acid by a combination of the methods of Mikeska and of Dauben (Gipple *et al.—J. Am. Oil Chemists' Soc. 33,* 66).

Whalley (*Soap, Perfumery & Cosmetic 29,* 783) reviewed methods and techniques for column, paper, and gas-liquid chromatographic separation of fatty acids. Another review was on the column methods only (Vioque—*Grasas y aceites, Spain, 6,* 88). The adsorption isotherms of solutions of oleic, linoleic and linolenic acids in methanol on silica, activated carbon and magnesium oxide have been determined as data useful in column chromatographic separation (Di Modica & Tira—*Ann. chim., Rome, 46,* 21).

The paper chromatography method for fatty acid mixtures of Kaufman-Nitsch has been investigated and discussed with regard to systematic analysis of the fatty acids of various oils and fats (Kaufmann—*Fette-Seifen-Anstrichmittel 58,* 492); for distinguishing between individual fatty acid, as for instance, identification of isolinoleic and palmitic acids in linseed oil (Jaky—*Ibid.* 721); and for separation of hydroxylated and brominated acids (Kaufmann & Nitsch—*Ibid.* 234). Long chain acids separated chromatographically on paper were quantitatively determined by means of a photometric method (Seher—*Ibid.* 498). Abish and Bernhard (*Helv. Chim. Acta 38,* 1536) described the separation of mixtures of erucic, stearic, palmitic, oleic, and linoleic; and of mixtures of oleic, linoleic and linolenic acid on paper and their identification. Three paper chromatographic methods were on separation and identification of steam volatile fatty acids (Coppens *et al.*—*Chem. Ver. 17,* 199; Perilä—*Acta Chem. Scand. 9,* 1231, *10,* 143; Hashmi & Cullis—*Anal. chim. acta 14,* 336). A procedure described earlier for separation of glycerides, cholesterol, and cholesterol palmitate was applied to separating mono-, di-, and triglycerides (Dieckert & Reiser—*J. Am. Oil Chemists' Soc. 33,* 123). Pustovalov (*Biokhimiya 20,* 730) demonstrated the use of chromatographic paper treated with caoutchoric and with naphthalene, and methanol as the solvent for determination of fatty acids and recorded the R_f values of many acids. Franks (*Analyst 81,* 384, 390) described paper chromatography with continuous change in solvent composition for separation of fatty acids and surface-active agents. Paper chromatographic separation and identification was also done with the fatty acids as their 2,4-dinitrophenylhydrazides (Inouya *et al.—Bull. Agr. Chem. Soc. Japan 19,* 214), as their acetal ester derivatives (Inouya *et al.—J. Japan Oil Chemists' Soc. 5,* 16), as their *N*-acyl-N,N^1-bis(*p*-dimethylaminophenyl derivatives (Tulus & Osman—*Arch. Pharm. 289,* 127), and as their anilides (de Jonge—*Chem. Weekblad 52,* 37).

Column chromatograph methods have been described for the separation of oxo-, hydroxy- and trans-hydroxy fatty acids (Desnuelle & Burnet—*Bull. soc. chim. France 1956,* 268), C_8–C_{22} fatty acids (Kapitel—*Fette-Seifen-Anstrichmittel 58,* 91), C_{12}–C_{24} fatty acids (Vandenheuvel & Vatcher—*Anal. Chem. 28,* 838), C_1–C_{10} monocarboxylic acids and C_{11}–C_{18} dicarboxylic acids (Corcoran—*Ibid.* 168). Gas-liquid chromatography equipment and method were designed and demonstrated for separation and identification of the methyl esters of saturated and unsaturated C_1–C_{18} fatty acids (Martin & James—*Biochem. J. 63,* 138, 144).

The component fatty acids of coconut oil were determined by combination of urea adduct technique and distillation of the fractions (Mehta & Kokatnur—*J. Indian Chem. Soc. Ind. & News Ed. 18,* 158). Urea adduct fractionation in combination with determination of several characteristics of the fractions was utilized for analyses of the composition of Indian shark liver oils, and mixtures of oleic, elaidic, linoleic, and saturated acids (Mehta *et al.—Ibid. 19,* 1). Deoxycholic acid has been demonstrated to conform with urea and thiourea in its properties for fractional precipitation of fatty acids from mixtures and was utilized for the analysis of menhaden oil Schlenk—*Ann. Rept. Hormel Inst. 1955–6,* 66).

Several communications pertained to spectroscopic methods for the analysis of oils and fats. A modification in the American Oil Chemists' Society method for polyunsaturated acid pertains to a newly designed isomerization tube (Sakuragi & Kummerow—*J. Am. Oil Chemists' Soc. 33,* 305). A method for determining linoleic and linolenic components of soybean oil involved isomerization at 180° with 11% potassium hydroxide in glycerol and determining optical densities at 268 and 233 mμ (Collins & Sedgwick—*Ibid.* 149). Calculations were by means of a nomograph. A method of isomerization with potassium *tert.*-butoxide, containing five grams of potassium per 100 ml. *tert.*-butanol, at 90° was not complicated by side reactions such as polymerization and deisomerization (Sreenivasan & Brown—*Ibid.* 521). This type of isomerization for four hours with determination of the spectral densities at 233 and 268 mμ was designed for estimation of linoleic and linolenic acids in olive, cottonseed, soybean, and linseed oil. While the above communication was in preparation for press, the same observation regarding that isomerization reaction was published by a separate group of investigators (Davenport *et al.—Chemistry & Industry 1956,* 136). In tests on isomerization of cuttle fish oil with potassium hydroxide-glycol solutions the absorption coefficients greater than 2900 Å were increased and those lower than 2900 Å were decreased with

increasing concentration of potassium hydroxide (Oikawa—*Sci. & Crime Detection, Japan, 8,* No. 3, 58). A procedure for estimating arachidonic, linoleic and linolenic acids in milk and blood fatty acids is based on isomerization, dilution with alcohol and photometric measurements at 234, 268, and 316 mμ (Corsini—*Acta Vitaminol. 10,* 64). Infrared spectra determinations of the C_{20}–C_{26} fatty acids has been shown to be a linear function of the number of carbon atoms in the acid chains; each carbon atom contributes a decrease of 0.0045 μ to the mean frequency distance (Fuchs—*Fette-Seifen-Anstrichmittel 58,* 3). The data were developed for application to montanic acid and to the question of odd- or even-numbered carbon chain. The infrared absorptions of branched-chain fatty acids and derivatives have been investigated as a basis for characterizing and differentiating a number of structural isomers (Guertin *et al.*—*J. Am. Oil Chemists' Soc. 33,* 172).

The spectral absorption of a number of fatty and other lipides has been measured between 0.9 and 3.0 microns and the characteristics for distinguishing *cis* double bonds, terminal double bonds, hydroxyl groups, amine groups, acyloin, hydroperoxide, CH_2- and CH_3-groups indicated (Holman & Edmondson—*Anal. Chem. 28,* 1533). Similar data were recorded for the absorption bands between 2 and 15 μ for use in analysis of oxidized or polymerized linseed, tung, and castor oils (Berton—*Compt. rend. 241,* 1291). A survey was made of the applications of infrared spectroscopy in connection with a study of isomerization, oxidation, and copolymerization of drying oils; the curing of epoxy resins, and the identification of synthetic resins (O'Neill & Cole—*J. Applied Chem. 6,* 399).

Infrared spectra was also applied for the study of polymorphism of fatty materials. The technique easily permits distinguishing between sub-α- and β′-forms of 1-monoglycerides, but it was difficult to distinguish between β′- and β-forms (Chapman—*J. Chem. Soc. 1956,* 55). The 2-monoglycerides upon cooling gave a stable β-form and no evidence of an α-form. The infrared absorption spectra between 5 and 13 μ of crystalline fatty acids with 12, 13, 14, 15, 16, 18, 20, 22, 24, and 26 carbon atoms has been recorded (von Sydow—*Acta Chem. Scand 9,* 1119, 1685).

Details for semimicro method for analysis of normal fatty acid mixtures by distillation of their methyl esters were published (Okukhova—*Zhur. Anal. Khim. 11,* 193). In a polemic on accuracy of a procedure for fractional distillation of group esters segregated by crystallization from acetone the report of Kyte was discussed (Hilditch—*J. Am. Oil Chemists' Soc. 33,* 372).

Characteristics and analytical data that permitted convenient tabulation are so presented in tables appended to this section of the review. Data in some others were very comprehensive, and were determined for merely noting the variations that occur. Other analyses were limited to one or a limited group of constituents. These were not tabulated and are reviewed in the paragraphs that follow.

The composition of Dutch butter varies in a manner such that content of myristic and palmitic acids are at their highest in winter, conjugated dienoic acids are highest in summer, and in spring caproic, caprylic and capric acids are at their highest content (Stadhouders & Mulder—*Neth. Milk Dairy J. 9,* 182; *10,* 53). The range of the butyric acid content of American butters is 9.6 to 11.3 mole per cent, with an average of 10.41 mole per cent (Keeney—*J. Assoc. Off. Agr. Chemists 39,* 213). A survey of United States butterfat constants showed some significant variations in Reichert-Meissl and Polenske values among geographical areas for different months (Zehren & Jackson—*Ibid.* 194). The butterfat from cows fed different rations show reciprocal relations between the proportions of oleic and palmitic acids present (Garton & Duncan—*J. Sci. Food & Agr. 7,* 734). Thus cows fed mainly on roots produce milk fat of a relatively high content of palmitic acid accompanied by a corresponding low content of oleic acid. Fatigue in cows has a tendency to increase the Reichert-Meissl and Polenske value of the milk fat produced. (Beninati—*Atti soc. ital. sci. vet. 9,* 443).

There is no considerable difference in characteristics of white and yellow ox fats (Barresi—*Ibid.* 451). Feeding fish meal to pigs induces an unusual high content of the unsaturated fatty acids in the lard (Diller—*Fette-Seifen-Anstrichmittel 58,* 263).

Six samples of commercial margarines and five shortenings examined by infrared absorption have indicated presence of *trans*-components calculated as trielaidin to the extent of 22.7–41.7%; except for one sample which was a vegetable and animal fat blend and had been subjected to minor hydrogenation (Mabrouk & Brown—*J. Am. Oil Chemists' Soc. 33,* 98). These hydrogenated fats contain 25–40% *trans*-monoethenoic acid and 2–8% linoleic acids; the latter containing considerable proportions of both 9,12 *cis-trans* or *trans-cis* and isolated *cis-trans* isomers of linoleic acid (Sreenivasan & Brown—*Ibid.* 341).

A lack of variation in the composition of peanut oil through five crop years was assumed to be due to the seeds developing two inches under soil shaded by the plant where variable air temperatures do not play a role in formation of unsaturated oil as in other commercial oilseed (Pickett & Holley—*Ibid.* 650). Turkish rapeseed and mustard seed oils were about six percent higher in linoleic acid content than such oils from five other geographical sources (Craig—*Can. J. Tech. 34,* 335). The fatty acid composition of 300 samples of linseed oil have been tabulated according to the iodine value (Pouchon & Massoni—*Peintures, pigments vernis 32,* 217). The glyceride structure of linseed oil as determined by counter-current distribution with a Craig apparatus indicated essentially the random pattern (Dutton & Cannon—*J. Am. Oil Chemists' Soc. 33,* 46). The glyceride structure of *Calophyllum wightianum* seed oil was determined by the acetone-permanganate technique and by a combination of this technique and chromatography on an alumina column (Nair & Varier—*Bull. Central Res. Inst. Univ. Travancore Ser. A, 4,* 19, 23). A crystalline deposit from stored hexane-extracted soybean oil consisted of small amounts of wax esters containing fatty acids higher than C_{22} and some triglycerides (Toyama & Takai—*Res. Rept. Nogoya Ind. Sci. Res. Inst. No. 8,* 44).

The blubber fat of suinsh resembles dolphin and porpoise fat in composition but it does not contain isovaleric acid which is characteristic of the latter two (Pathak *et al.*—*Biochem. J. 62,* 634). In the Indian Waghbeer shark liver oil, C_{20} and C_{22} acids predominate over C_{18} and C_{16} acids; whereas in the Khada muski shark liver oil C_{18} acids constitute the major portion (Kamath & Magar—*J. Indian Chem. Soc. 32,* 455). The constituent acids of pink salmon eggs contain 45% C_{20} and C_{22} acids with average unsaturation equivalent of 7.3 hydrogens for the C_{20} and 11.8 hydrogens for the C_{22} acids (Kyte—*J. Am. Oil Chemists Soc. 33,* 146).

Human hair fat was obtained by ether extraction and the free acids, neutral fat, saturated hydrocarbons, squalene, branched chain matter, straight chain waxes, and sterols were determined (Nicolaides & Foster—*Ibid.* 404). Both odd- and even-numbered straight chain fatty acids as well as odd-num bered branched chain acids were isolated from human forearm sebum by gas-liquid chromatography (James & Wheatley—*Biochem. J. 63,* 269). Saponified merino wool wax contains a mixture of monohydroxy acids with empirical formula $C_{31}H_{62}O_3$ (Horn & Pretorius—*Chemistry & Industry 1956,* R27). The wax alcohols of sea anemones predominate in C_{18}, C_{20} and C_{22} alcohols (Bergman *et al.*—*J. Org. Chem. 21,* 720). Two new alcohols, eiconcenol and 11-docosenol, were identified in this wax. The fusel oil from cane molasses contains a mixture of unsaturated C_3–C_{18} fatty acids (Cattaneo *et al.*—*Anales asoc. quim. Argentina 43,* 190).

Two iso acids, isobutyric and isovaleric and an anteiso acid, x-methylbutyric, as well as formic acid, have for the first time been shown to be components of mutton fat (McInnes *et al.*—*Biochem. J. 63,* 702). 9-Heptadecenoic acid was isolated from lamb caul fat (Shorland & Jessop—*Nature 176,* 737). *n*-Pentadecanoic and *n*-heptadecanoic acids were isolated from shark liver oil (Morice & Shorland—*Biochem. J. 61,* 453; *64,* 461). Petroselenic and petroselaidic acid are present in the seed oil of *Panax schinseng* (Kurono *et al.*—*Ann. Rept. Fac. Pharm. Kanazawa Univ. No. 5,* 1). Ximenynic acid is present in relatively large amounts in the seed fats of the *Santalacae* family (Hatt & Schoenfeld—*J. Sci. Food Agr. 7,* 130). Marigold seed oil contains some 8,10,12-octadecatrienoic acid (McLean & Clark—*J. Chem. Soc. 1956,* 777). *Cis*-11-octadecenoic acid was isolated from the baleen of blue whale (Abe—*J. Chem. Soc. Japan, Ind. Sect. 58,* 714). *Cis*-5,8,11,14,17-eicosapentaenoic acid was isolated from South African pilchard oil (Whitcutt & Sutton—*Biochem. J. 63,* 469). Bombacic acid, isolated from kapok seed oil appears to be a cyclo-C_{18} acid with a structure similar to that of sterculic acid (Dijkstra & Duin—*Nature 176,* 71). This acid gives a positive Halphen reaction. The material in *Malvacae* oils that gives the Halphen reaction and causes "pink white" of eggs has been shown to be one of the fatty acids and the name halphen acid has been suggested for it (Shenstone & Vickery—*Nature 177,* 94). Means of characterizing 9,10-dehydroxystearic acid as the erythro- or threo-form were worked out (Gensler & Schlein—*J. Am. Chem. Soc. 78,* 169).

According to Cason *et al.* (*J. Biol. Chem. 220,* 391, 407, 893) the lipides of tubercle bacteria contain more than 13 acids of more than 20 carbon atoms, at least nine of which are unsaturated. C_{25}- C_{26}-, C_{27}- and C_{29}-phthienoic acids were present.

NEWLY RECORDED CHARACTERISTICS OF FATS AND OILS

Oil or Fat Source	% Oil or Fat	Specific Gravity	Index of Refraction	Acid No. (or % Free Fatty Acids)	Saponification No.	Iodine No.	Thiocyanogen No.	Acetyl No. or [(OH) No.]	Reichert-Meissl No.	Polenske No.	% Unsaponifiable	Miscellaneous
Achyranthes bidentata seed[1]	0.89		1.4770^{20}	6.0	212.3	115.0					6.7	
Bacaba palm fruit[3] *Oenocarpus bacaba*		0.9102^{25}	1.4677^{25}	(5.7)	196.4	81.4		21.4			1.2	
Bazna seed[4] *Zanthoxylum badrunga*		0.919– $0.920^{15.5}$	1.4609– 1.4621^{40}	4.1–4.6	191.2– 192.2	77.9–80.3			0.6–0.7	0.34–0.40	1.4–1.7	*a*
Buxus microphylla seed[1]	14.1	0.9213^{15}	1.4726^{20}	5.1	207.9	116.6					2.06	
Calanus cristatus[6] (obtained from whale stomach)				11.4	103.2	159.7					43.1	
Calophyllum inophyllum[7]		0.9174^{28}	1.4659^{28}		212.0	86.0			0.18			*b*
Cassia fistula seed[8]	3.0	0.9112^{20}	1.4672^{40}	2.9	184.2	109.3	66.6	9.2			5.7	
Cassia occidentalis seed[8]	2.8	0.9166^{32}	1.4714^{32}	5.4	176.1	110.3	72.6				8.3	
Cassia tora seed[8]	5.0	0.9012^{32}	1.4672^{32}	4.2	163.4	91.3	58.2	11.2			5.7	
Cucurbitacae seeds[10]												
Momordica charantia–muricata	29.9		1.4962^{25}	(1.2)	185.0	126.9					1.4	
Momordica charantia–proper	32.8		1.4899^{25}	(0.9)	186.0	123.5					1.4	
Trichosanthas anguina	29.9		1.4854^{25}	(0.6)	186.0	108.7					1.2	
Cucumis sativus	31.3		1.4702^{25}	(1.2)	187.0	118.5					1.1	
Luffa acutangula	19.9		1.4681^{25}	(1.1)	187.0	95.7					1.0	
Luffa aegyptica	20.3		1.4672^{25}	(0.9)	188.0	112.4					0.9	
Cuttle fish[11]		0.9277– 0.9299^{15}	1.4823– 1.4843^{20}		175–184	190–201					2.5–4.0	
Erythrina rubinerria seed[14]	15.5			3.4	200–205	75–78		25.4	2.04	0.62	1.9	*c*
Fish oil[15] *Cololabis saira*		0.9358^{15}	1.4736^{20}	24.6	183.6	126.4					4.14	
Gokhru seed kernel[16] *Xanthium strumarium*	33.1	0.9110^{25}	1.4713^{25}		199.8	119.9					0.66	*d*
Hippophae rhamnoides seed[17]	8.0	0.914^{20}	1.4770^{20}	6.0	186.8		96.0	(11.9)			2.1	*e*
Iris pesudacorus seed[1]	4.2				172.8	136.1					32.0	
Kamala seed of Australia[19] Kamala seed of India[19]				3–26 19.0	194–198 193.0	124–151 160.0						
Macauba palm kernel[20]		0.9212^{15}	1.4631^{15}	3.4	239.7	23.6						*f*
Melon (of Sudan) seed[21] *Citrullus vulgaris*				4.2	189.3	116.8						
Nageswar nut kernel[22] *Mesua ferrea*	70.0	0.9202^{34}	$1.4721^{32.5}$	8.8	203.2	81.1						
Nagpur orange seed[23]	54.7	0.9149^{33}	1.4650^{31}	3.1	190.0	101.0					0.70	
Photinia glabra seed[1]	18.5			8.6	183.5	114.7					5.8	
Phytolacca americana seed[1]	10.8	0.9178^{15}	1.4737^{20}	2.1	187.5	106.7					2.8	
Sophora secundiflora seed[14]	15.7			3.0	188–193	95–100		32.4	2.39	0.72	1.99	*g*
Stephania cepharantha seed[27]	19.4	0.9219^{14}				133.4					0.44	
Turtle, Mexican giant sea[28]		0.911– 0.919^{25}	1.4599– 1.4715^{20}		197–210	89–97		3.5	0.20		0.6	
Sperm whale meat[29]	1.6–8.5			1.2–4	123–148	68–97					27–39	
Sperm whale milk[30]	30.0			0.27	185.8	161.5					0.74	
Zakatal'sk tea seed[31]	25.3	0.9200^{20}	1.4711^{20}	0.18	219.0	89.5			0.66	0.07		*h*

Solidification points for *a*, *b*, *f*, and *h*, resp., = 3–9, 4, 18, and 10–13. Melting point for *b*, *c*, and *g*, resp. = 8, 13–14, and 14–15. Diene No. for *d* and *e*, resp. = 9.3 and 0.0.

COMPOSITION OF THE FATTY ACIDS

Oil or Fat Source	Common Saturated Acids			Common Unsaturated Acids			Other Fatty Acids
	C_{14} Myristic	C_{16} Palmitic	C_{18} Stearic	$C_{18}(-2H)$ Oleic	$C_{18}(-4H)$ Linoleic	$C_{18}(-6H)$ Linolenic	
Albizzia amara tree seed[2]	1.5	7.6	4.3	31.3	45.6		C_{20} 2.2, C_{22} 0.6, C_{24} 0.4
Bacaba palm fruit[3] *Oenocarpus bacaba* *Jessenia bataua*		11.8 7.6	9.6 9.4	64.8 77.5	13.8 5.5		
Brazilnut kernels[5]	0.3	15.0	6.0	48.0	30.0		
Calanus cristatus[6] (obtained from whale stomach)	9.0	7.0	Trace	——— 14(−4.7H) ———			$C_{14}(-2H)$ 3, $C_{16}(-2.2H)$ 10, $C_{20}(-4.2H)$ 29, $C_{22}(-4.2H)$ 28
Cassia fistula seed[8]		16.0		30.7	48.1		C_{24} 5.2
Cassia occidential seed[18]		19.7		31.6	38.1		C_{24} 4.3
Cassia tora seed[8]		23.5		28.1	45.0		C_{24} 3.4
Castor seed (of India)[9]	——— 3.0–3.5 ———			5.1–5.8	3.4–3.5		Ricinoleic 85.5–86.0, dihydroxystearic 1.6–2.4
Cuttle fish[11]	3.6	13.6	4.8	14.3		6.2	C_{10} 0.1, C_{12} 0.5, $C_{14}(-2H)$ 1.2, $C_{16}(-2H)$ 5.8, $C_{16}(-6H)$ 0.1 $C_{18}(-8H)$ 0.4, C_{20}(Satd. & unsatd.) 31, C_{22}(Satd. & unsatd.) 16, $C_{24}(-10H)$ 2.0.
Delphinium seed[12]		4.0	1.0	53.0	16.0	2.5	$C_{20}(-2H)$ 18, $C_{20}(-4H)$ 1, $C_{16}(-2H)$ 1
Erythrina indica seed[13]		8.2	8.0	45.6	7.1		C_{20} 4.3, behenic 13.3, $C_{16}(-2H)$ 3.1, $C_{20}(-2H)$ 9.8, C_{24} 0.6
Impatiens balsamina seed[18]		4.7	5.8	18.3	9.2	30.2	C_{20} 2.8, $C_{18}(-8H)$ 29.1
Penicillium lilacinum[24]	1.1	32.3	9.4	38.6	13.4		C_{20} 1.4, $C_{10}(-2H)$ 3.4, C_{20}(Unsatd.) 1.4
Rapeseed of Poland[25]	——— 7.0–21.7 ———			15–23	13–19	4.5–9.8	$C_{22}(-2H)$ 44–49
Ricinodendron viticoide nut kernel[26]	——— 13.7 ———			15.1	40.1	31.1	

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23. Mehta *et al. Ibid 21*, 87.
24. Singh *et al. Biochem. J. 62*, 222.
25. Budzynska. *Roczniki Panstwowego Zakladu Hig. 6*, 229.
26. Fairchild *et al. Colonial Plant & Animal Products, London, 5*, 158.
27. Akasu *et al. J. Pharm. Soc. Japan 76*, 462.
28. Avalle. *Inds. Parfum 10*, 463.
29. Pedersen. *Norsk Hvalfangst-Tidende 41*, 296.
30. Pedersen. *Ibid.* 300.
31. Guseinov. *Doklady Akad. Nauk Azerbaidzhan 10*, No. 5, 347.

One levorotatory acid named C_{31}-mycosanic was isolated in pure form. The C_{27}-phthienoic acid found in virulent strains of tubercle bacillus was not found in nonvirulent strains and there were also other differences in the fatty acids from the two types of strains. Various derivatives were made from the mycoceranic acid of *tubercle bacilli* and their characteristics recorded (Marks & Polgar—*J. Chem. Soc. 1955,* 3851).

Rhodes (*Chemistry & Industry 1956,* 1010) reviewed and indicated the practical advantages of chromatographic methods for studying phospholipides. Many investigators described novel chromatographic techniques for separation and identification of their components (Rouser *et al.*—*J. Biol. Chem. 223,* 485; Weise—*Ibid.* 523; Marinetti & Stotz—*Biochem. et Biophys. Acta 21,* 168; *J. Am. Chem. Soc. 77,* 6668; Polonovski & Valdiguie—*Bull. soc. chim. biol. 38,* 19, 27; Dieckert & Reiser —*J. Am. Oil Chemists' Soc. 33,* 535; Miani—*Boll. soc. ital. biol. sper. 31,* 1008). Chromatographic methods were used for estimating the lecithin, cephalin, and sphingomyelin in butterfat (Baliga & Basu—*Indian J. Dairy Sci. 9,* 95) and brain (Robbins *et al.*—*J. Biol. Chem. 220,* 661); and for the determination of inositol containing phospholipides in vegetable oils (Hawthorne—*Biochem. et Biophys. Acta 18,* 389). One attempt at separating lysolecithin from the lecithin of egg yolk chromatographically was unsuccessful (Rikimari *et al.*—Fuku*shima J. Med. Sci. 2,* 131).

The complex mixture of fish phospholipides contains 50–60% lecithin and at least three other types of phospholipides (Lovern—*J. Sci. Food & Agr. 7,* 729). The nonhydratable soybean phosphatides contain inositolmonophosphoric acid 2, glycerophosphoric acid 15, lysophosphatidic acid 25, and phosphoric acid 55% (Nielson—*Acta Chem. Scand. 9,* 173). Phosphatidyl choline was identified as the major constituent of beef heart phospholipides (Rapport & Alonzo—*J. Biol. Chem. 217,* 199). Phospholipides from beef muscle contained 0.17% volatile acids (Hawke *et al.*—*Nature 176,* 882). A method for determination of the amount of fatty acids in phospholipides is based on hydroxylaminolysis and measurement of the color produced by reaction of the liberated hydroxamic acid with ferric perchlorate (Rapport & Alonzo—*J. Biol. Chem. 217,* 193).

Monolayer studies with proteins and phospholipides indicated that first sublayer of protein combines with cephalin through the peptide bonds, probably by means of hydrogen bonding; whereas with lecithin the interaction appeared to be ionic (Eley & Hedge—*J. Colloid Sci 11,* 445).

The lipides of cod and haddock flesh are very similar, containing lecithin 35, wax and alcohols 13, free cholesterol 8, phosphatidyl ethanolamine 7, free fatty acids 6, cholesterol esters 5, triglycerides 3, inositol lipides 2, and unidentified lipides (Garcia *et al.*—*Biochem. J. 62,* 99; Olley—*Ibid.* 107; Lovern— *Ibid. 63,* 373). The lipides of the blood of northern pike caught in an Alaskan lake are: total fatty acids 771, sterols 183, and phospholipides 411 mg. per 100 ml. (Wilber— *Trans. Am. Fisheries Soc. 83,* 150). The vitamin A component of sei whale liver oil seems to have six or more conjugated double bonds (Tsuchiya & Tanaka—*Repts. Govt. Chem. Ind. Res. Inst. Tokyo 50,* 367).

α-Glycerol ethers isolated from some marine animal fats were not hydrolyzed by the starfish (Karonsky & Bramm— *J. Biol. Chem. 216,* 689). The galactosyl-glycerol components of wheat flour lipides were isolated and characterized (Carter *et al.*—*J. Am. Chem. Soc. 78,* 3735).

The so-called hitodestrol of shell fish and crustaceans was shown to be identical with α-spinasterol (Toyama & Takagi— *Bull. Chem. Soc. Japan 28,* 469). The 24-methylenecholesterol of mollusc lipides has been isolated, converted to several derivatives and all were characterized (Fagerlund & Idler— *J. Org. Chem. 21,* 372). Similar data were presented for a β-sitosterol derived from the fatty oil of the seeds of *Mucuna pruriens* (Pillai & Anantaraman—*Bull. Central Res. Inst. Univ. Travancore Ser. A. 4,* 41). The sterols of olive oill have the same characteristics whether they are separated by precipitation with digitonin or by chromatography (Tous & Martel —*Grasas y aceites, Spain, 6,* 269). Silicic acid columns are suited for the chromatographic separation of sterols according to the number of hydroxyl groups in their structure (Linford —*Can. J. Biochem. & Physiol. 34,* 1153). The powder x-ray diffraction data and powder diffraction photographs for 40 steroids have been published (Parsons *et al.*—*Anal. Chem. 28,* 1514).

The *p*-anisidine method for the estimation of gossypol in crude cottonseed oils was modified to make it applicable to all crude oil obtained by the newer methods of processing cottonseed (Pons *et al.*—*J. Am. Oil Chemists' Soc. 33,* 324). The bound gossypol derivatives formed in raw cottonseed oil when held for 2–3 hours at 145° can be approximated colorimetrically (Rzhekhin & Chudnovskaya—*Masloboino-Zhirovaya Prom. 21,* No. 7, 27). Polarographic gossypol determinations agree well with those obtained spectroscopically (Markman & Kolesov —*Zhur. Priklad. Khim. 29,* 242). Because aniline is used for removal of gossypol from cottonseed products some aniline derivatives of gossypol were prepared and characterized (Shirley & Sheehan—*J. Org. Chem. 21,* 251). Mild methods of treatment so as to protect the reactive gossypol molecule from decomposition, were developed to convert dianilinogossypol to pure gossypol (King & Thurber—*J. Am. Oil Chemists' Soc. 33,* 169).

The structure proposed for sesamolin from sesame oil by Boeseken & Cohen has been confirmed (Haslam & Haworth— *J. Chem. Soc. 1955,* 827).

Methods for the determination of the hydrocarbon and squalene content of shark liver oil have been published (Higashi *et al.*—*Bull. Japan Soc. Sci. Fisheries 18,* 397, 411). The squalene content of the unsaponifiable of *Centrophorus granulosus* liver oil has been determined chromatographically and by distillation (Romos-Ayerbe & Romero—*Grasas y aceites, Spain, 6,* 141). Squalene has been synthesized to confirm the structure of the natural product (Trippett—*Chemistry & Industry 1956,* 80).

The spectral absorption curves of bixin, β-carotene, and the coal-tar colors, yellow OB and yellow AB were recorded as basic data for determining the coloring materials in butter and margarine (Espoy & Barnett—*Food Tech. 9,* 367). A scheme of analysis designed for separation and determination of sodium, potassium, magnesium, iron, aluminum, and calcium in crude wool fat made use of chromatographic separation and conventional methods (Farnworth—*Australian J. Appl. Sci. 7,* 233). Paper chromatographic tests were designed for determination of iron, copper, manganese, and nickel in fats and oils, in which 0.01 μg. of metal per gram of fat may be detected in one operation (Täufel & Romminger—*Fette-Seifen-Anstrichmittel 58,* 104).

Ultraviolet and visible spectrophotometric methods for determination of micro amounts of melamine and formaldehyde in aqueous media have been modified to obtain desired sensitivity in fats such as lard (Hirt *et al.*—*J. Agr. Food Chem. 3,* 1044). The methods for determination of the insecticide, parathion, were modified so that they may be applied to olive oil (Bazzi—*Montecatini Soc. gen. ind. mineraria, chim. 1956,* 22 pp.; Aiazzi-Mancini & Pepeu—*Arch. ital. sci. farmacol. (3), 5,* 70; Biffoli—*Boll. lab. chim. provinciali, Bologna, 6,* 21). A chromatographic method was designed for isolation of piperonyl butoxide from oils and fats (Williams & Sweeney—*J. Assoc. Off. Agr. Chemists' 39,* 975).

Soaps and Detergents

MANUFACTURE. In India toilet soap formulas and manufacturing processes have been developed that make maximum use of indigenous oils. The oils involved in these activities were from the seeds of: sarson, sesame, peanut, castor (Ahmad *et al.*—*Oil Mill Gaz. 61,* No. 4, 32), khakan, margosa, mahua, kokam (Kelkar & Nathan—*Indian Soap J. 21,* 89), and custard apple (Naidu & Saletore—*Ibid. 20,* 141). The utilization of imported coconut oil in the formulas was at a minimum while still being compatible with good lathering properties of the soap.

Several communications pertained to converting poor soap stock to good soap. To utilize waste fats recovered from hydrogenation catalyst and from used bleaching earths, they should be refined, saponified, and grained independently of the main soap batch and then blended into the main batch of soap (Chiskis & Povlov—*Masloboino-Zhirovaya Prom. 21,* No. 7, 34). Fatty acids derived from refining-foots is convertible to suitable light colored soaps when the light colored fatty acids are segregated with urea-complexing technique (Achaya *et al.*—*J. Sci. Ind. Res., India, 14B,* 665), or by saponifying and treating the soap paste with successive portions of hydrogen peroxide or sodium hypochlorite (Bespyatov & Sibeleva— *Masloboino-Zhirovaya Prom. 21,* No. 7, 37). Tall oil was refined by treatment with sulfuric acid and used at a ratio of 40 parts with 60 parts of animal fat to make suitable soaps (Sokolova *et al.*—*Bumazh. Prom. 31,* No. 2, 16). Tall oil intended for soap making was stabilized against crystallization of rosin during storage by *in situ* conversion to soap to the extent of 10–30% (Bestul—*U. S. 2,745,827*). Hard odorless soap was made from low grade marine animal fats by Twitchell splitting, bleaching the free acids with earth and active carbon and saponifying with anhydrous molten alkalies at 300–50° (Appuhn—*U. S. 2,739,163*). Sperm whale oil was

used to make soap suitable for laundering in sea water by hydrogenation and used as 30% of the stock with coconut oil making up the major portion of other fats (Zaliopo & Baranov —*Masloboino-Zhirovaya Prom. 21,* No. 1, 18). Bleaching methods using sodium chlorite, benzoyl peroxide, urea peroxide, hydrogen peroxide, persulfate, hypochlorite, perborate, and hydrosulfite were investigated for making light soaps from low grade tallows (Lowry & Defromont—*Rev. franc. corps gras 3,* 172). Best results were obtained by bleaching the tallow with 2% sodium chlorite in the presence of 0.5% phosphoric acid and completing the bleaching on the soap with persulfate. The bleaching recommendations of Kolty (*Am. Perfumer Essential Oil Rev. 66,* No. 4, 64) depended on the soap stock being used. Thus chlorine-based bleaches and persulfate were suitable for rosin-free soaps; with rosin present sulfite or a combination of zinc and sulfuric acid was preferred; and after bleaching, all soap should be boiled at least one hour and then "salted-out." A continuous system for bleaching soap or soap stocks is based on continuously mixing bleaching chemical with a stream of soap or stock (James & Humphreys—*U. S. 2,755,294*). Hyposulfite should not be used for bleaching or preserving soaps made from hydrogenated fats, for traces of nickel in these combine with sulfur from decomposing hyposulfite to darken the soap (Borodina & Dmitrieva—*Masloboino-Zhirovaya Prom. 21,* No. 1, 19).

Soaps that suds in sea water were made from castor oil by saponifying in the presence of trisodium phosphate (Hilaire—*Fr. 999,166*). A patented solid shampoo was prepared from palm and coconut oils with a small amount of lanolin alcohol, by saponification with a mixed potassium and sodium lye (Kawakami—*Japan 7240–'54*). Non-hydroscopic potassium soaps were produced by converting high titer tallow acids to potassium salts and reducing the moisture to 1–4% (Sheely & Glynn—*U. S. 2,738,335*). A potassium soap when adjusted to 4–10% free fatty acids and 15–22% moisture could be pumped through conduits at temperatures as low as 150° (Pilch—*U. S. 2,740,760*). To make a lithium soap, the free fatty acids were saponified with a solution of lithium carbonate at 80° and the mixture was autoclaved at 130° (Koda —*Japan 1080–'55*). In the manufacture of a low moisture content soap, the saponifying mixture in a plastic state is subjected to intensive shearing at temperatures below the boiling point of water in a Muller-type mixer (Bradford—*U. S. 2,730,539*). Another low moisture soap making process involves a two-step saponification; first, partial saponification with dry alkali carbonate and then completing the saponification with strong alkali solution (Winer—*U. S. 2,753,363*).

Some new soap making equipment has been patented. Equipment in which reaction components are separately supplied to a rotating chamber in a manner to generate a liquid vortex, is useful for rapid preparation of soap (DeBoer & Meerman—*U. S. 2,743,289*). Another continuous action reactor, in which intense mixing is by means of paddles was designed for saponification of free free fatty acids with alkali carbonates (Tyutyunnikov *et al.*—*U.S.S.R. 103,169*). In a continuous soap making according to Palmquist (*U. S. 2,744,922*) soap is grained with excess alkali, and neat soap is finished by neutralizing the remaining lye with phosphoric or silicic acid. No niger is formed in the process. Another invention relates to continuous saponification and treating the soap formed to obtain directly a saponified mass in the "neat" phase (Union Francaise com. et ind.—*F. 989,596–7; U. S. 2,726,937*). A continuous method for making framed soap involves spray drying into a tank, and transferring into frames with the use of compressed air (Ohashi *et al.*—*Japan 7590–'54*). A valve for conduits in soap factories was provided with water injectors at seating and sealing surfaces so that clogging may be prevented (Benzien—*U. S. 2,774,363*).

Two communications pertain to calculations and control in soap making. Loury & Prevot (*Rev. franc. corps gras 2,* 859; *3,* 852; *Fette-Seifen-Anstrichmittel 58,* 741) designed simple tests for tracing phase diagrams. These involve centrifuging sealed tubes of saponified mixtures, rapidly cooling, dissolving phases in mixtures of glycol and isopropyl alcohol and examining for fatty acids and salt by titrations. Manneck (*Seifen-Öle-Fette-Wachse 81,* 429) demonstrated the determination of components of neat soaps and nigers of a given soap charge and how to use data therefrom to make adjustments during the soap-fitting process.

Soap spray equipment has been designed to produce dried soap particles of desired size agglomerates (Bradford *et al.*—*U. S. 2,730,170*). New equipment has been patented for kneading hard soap chips or powders and extruding as a bar (Marshall—*U. S. 2,767,437*). With another apparatus soap in the beta-form is extruded while an electric potential is passed across the interface of soap and orifice so as to produce bars with smooth surfaces (Head—*U. S. 2,748,070*).

Some communications pertained to the treatment of the crude glycerol produced in soap making. The solubilities of sodium and calcium sulfates in aqueous glycerol solutions were determined for use in designing glycerol processing equipment (Till *et al.*—*J. Am. Oil Chemists' Soc. 33,* 443). Conditions and the effect of variables were worked out for purification of glycerol by ion exclusion (Asher & Simpson—*J. Phys. Chem. 60,* 518). When pure glycerol was distilled from solutions containing sodium acetate and sodium hydroxide some glycerol acetates were formed and distilled in the early fraction (Gavriloff—*Ind. chim. belge 20,* Spec. No., 704). In a study on the thermal dehydration of pure glycerol, it was heated at 110–200°, 200–40°, 240–50° and 250°, respectively, and the volatile decomposition products formed and the characteristics of the residue were recorded (Hauschild & Petit—*Bull. soc. chim. France 1956,* 878). At about 170–250° for 15 minutes, glycerol is 10% dehydrated with formation of simple dehydration and more complex polycondensation products.

The builder or filler used was of prime interest in some soap formulas. Specially prepared sodium silicate was the builder in two patented soap formulas (Kano *et al.*—*Japan 228–'55*; Osawa & Koike—*Japan 887–'55*). Addition of alkali or ammonium salt or phytic acid as a builder increased the efficiency of soap in hard water and inhibited the tendency to formation of insoluble precipitates (Eckey—*U. S. 2,739,942*). In one soap the builder was formed *in situ;* i.e., a mixture of methyl oleate, acetic acid and phosphoric acid was neutralized with sodium carbonate to form the soap (Hirao—*Japan 8686–7–'54*). Soaps and detergent compositions were patented which included: partially acetylated polyvinyl alcohol (Fong & Lundgren—*U. S. 2,775,252*), oxidized cellulose materials (Nieuwenhuis—*Dutch 78,087*), natural or synthetic rubber, gums, or resins (Bayac—*Fr. 990,277*), and colloidal clay (Bigourdon—*Fr. 992,303*). Alkali metal pyrophosphates and triphosphates of low bulk density were made for use in detergents by spray drying solutions or melts so as to form particles of 0.04–0.5 mm. in their largest dimensions (Chem. Fabrik Budenheim A.-G.—*Brit. 744,576*).

Various materials are added to soaps and detergents to induce special properties. An additive made by condensing one mole of hydroxylalkyl primary amine with two moles of fatty acid induced opaqueness in shampoos (Epstein *et al.*—*U. S. 2,732,212*). Behenic acid was used for the same purpose and to stabilize against phase separation (Henkin—*U. S. 2,770,599*). Urea also inhibits phase separation in shampoos (Anderson—*U. S. 2,773,835*). A sodium alkyl sulfate paste shampoo contained small amounts of sodium stearate, stearic acid, sodium sulfate and lanolin to induce a desirable consistency (Patterson—*Soap & Chem. Specialties 32,* No. 3, 47).

A dental cream comprising calcium phosphate and organic detergents contained partial fatty acid ester of glycerol to prevent hardening in the tube, separation of liquid, and formation of graininess (Salzman & Schiraldi—*U. S. 2,744,049*). Fatty acid sarcosides were added to dental creams containing carbohydrates to inhibit fermentation (Salzman—*U. S. 2,772,203*).

The additives to induce germicidal properties in toilet soaps were halogenated trisphenols (Beaver *et al.*—*U. S. 2,730,502, 2,735,872, 2,749,320, 2,749,314*), alkylidenebis-(nitrophenols) (Chiddix & Hesse—*U. S. 2,739,941*), and monomethylol dimethyl hydantoin (Henkin—*U. S. 2,773,834*). The germicidal additives used in cleaners were condensates of one mole of nonyl phenol with nine moles of ethylene oxide (Kopp—*U. S. 2,742,434*), quaternary ammonium salt (Little & Chen—*U. S. 2,727,007*), and silver salt (Farmacopea Fontansa S.a.r.l.—*Ital. 486,313*).

One investigation has demonstrated that there was no significant advantage of adding organic solvents to paste detergents (Oldenroth—*Fette-Seifen-Anstrichmittel 58,* 225).

Soaps or detergents were rendered nondusting by incorporation of condensates of ethylene oxide with phenol (Jenkins—*U. S. 2,742,436*), oxyethylene ethers (Fike & Seaton—*U. S. 2,744,874*), and liquid fatty acids (Bradford—*U. S. 2,730,507*). The tendency of soap particles to form lumps when poured into heated water is reduced by incorporating an ammonium salt of a mixed monosulfate monoglyceride derived from coconut oil (Compa—*U. S. 2,738,332*). In packaging spray dried detergents, the weight can be adjusted to the bulk by proper additions of aluminum silicate (Ricciardi—*U. S. 2,770,600*). Foaming was inhibited in alkyl sulfate detergents by presence of a mixture of spindle oil and N,N′-distearyl ethylene diamide (Caviët—*U. S. 2,751,358*).

The staining of German silver and copper by detergent

compositions containing polyphosphate salts is inhibited by the presence of salts of fatty hydroxamic acids derivatives (Ruff—*U. S. 2,733,215*) or nonheterocyclic ammonium derivatives having at least one hydrogen attached to a nitrogen atom and free of an amide or thioamide linkage (Sylvester—*U. S. 2,731,420*).

Several new fluorescent whitening agents were described for use as detergent additives (Satori—*U. S. 2,715,632, 2,737,516;* Lubs & Satori—*U. S. 2,720,528;* Moessinger—*U. S. 2,720,538;* Pressner—*U. S. 2,730,503;* Leavitt—*U. S. 2,773,869;* Libby *et al.*—*U. S. 2,733,242;* Hendrik—*U. S. 2,763,618;* Siegrist—*U. S. 2,765,239;* Fleck—*U. S. 2,766,239;* Cassela Farbwerke Mainkur A.-G.—*Brit. 734,981;* Badische Anilin- & Soda-Fabrik A.-G.—*Brit. 741,798;* J. R. Geigy A.-G.—*Swiss 276,692, 302,-363-8, 302,793-4;* Inukai & Maki—*Repts. Gov. Res. Inst. Nagoya 1,* 98, 101). A pharmacological study of one whitening agent, diaminostilbenedisulfonic acid, has demonstrated that it is not irritating and there is no estrogenic activity due to its stilbene radical (Schneider—*Berufsdermatosen 3,* 201).

Various detergent mixtures were designed for specific uses. Special mixtures of phosphate salts were used in dishwashing compositions to prevent water spotting of glassware (Albrecht —*U. S. 2,756,214*). A liquid detergent for washing glasses was prepared by dissolving sulfated fatty alcohol in a mixture of acetone, ethanol, amyl acetate and water (Calvo—*Span. 218,115*). A flannel cloth for cleaning eye glasses, windshields and other glassware was impregnated with soap solution and one side was covered with precipitated chalk and potato flour for precleaning (Brukit—*Ger. 827,414 Cl. 42h*). A cleaner for removing grease from aluminum and one for cleaning aluminum dairy equipment are mixtures of alkaline salts containing sulfonated detergents (Pullen & Swan—*U. S. 2,750,309;* Wright—*Dairy Eng. 73,* 167). An aqueous solution of nicotin containing a small amount of blue indigo was said to efficiently clean textiles, painted surfaces, leather, etc. without damage (Combs—*U. S. 2,739,130*). A cleaner and polisher of the consistency of milk contains glycol stearate, dimethylpolysiloxane, polyethylene stearate, polyethylene glycol *tert.*-dodecyl-thioether and water (Guss—*U. S. 2,757,094*). A molded general purpose cleanser contained fish oil soap, pumice and washed clay (Torralba—*Span. 212,422*). A process for cleaning of greasy and carbonized incrustations from baking pans comprised degreasing with chlorinated solvent and boiling in a solution containing inorganic detergent salts and a wetting agent (Dinley & Duncan—*U. S. 2,740,734*). An abrasive detergent cleaning agent patent pertains to the particle size of abrasive, salt and detergent constituents (Manchot—*U. S. 2,-739,129*). Another abrasive cleanser contained sawdust besides the conventional ingredients (Sainz de la Maza—*Span. 220,-036*). A steel wool scouring pad was impregnated with corn starch and a synthetic detergent (Maxcy & Sanders—*U. S. 2,733,211*).

Research on methods of manufacture and new products has been published for the synthetic detergent industry. In a new continuous sulfonation process for dodecylbenzene, sulfonation agent is injected at five points with violent agitation, and is regulated in a manner to serve for dispersing the acid and control the temperature (Huber *et al.*—*J. Am. Oil Chemists' Soc. 33,* 57). An analysis of products formed on sulfonation of various fatty acids and *n*-propyl oleate has suggested that with free carboxyl groups, the acyl sulfate or the mixed anhydride with sulfur trioxide first forms, and this is followed by hydrogen replacement in the methylene group, probably in an allyl position to the double bond with a sulfonic acid group (Sauls & Rueggeberg—*Ibid.* 383). Methods have been developed for converting oils derived from grapeseed and the seeds from the family of *Composaceae* to good sulfonated detergents (Dima *et al.*—*Acad. rep. pop. Romane, Stuctii circetari stiint 5,* No. 1 & 2, 159). Forty-six sulfonated products were prepared from vegetable oils, pure glycerides, resinates and many pure hydrocarbons as the sodium, potassium, ammonium and triethanolamine salts and their physical properties as related to detergency were compared to those of some popular commercial synthetic detergents (Petrascu & Mihutescu—*Ibid.* 4, No. 1 & 2, 79). Of the substances tested 19 were promising as wetting agents. Sodium allyl α-sulfopalmitate and sodium allyl α-sulfostearate, prepared by esterification of an α-sulfonated fatty acid with allyl alcohol resembled sodium alkyl α-sulfopalmitates and stearates in surface activity, detergent properties, and stability to hydrolysis (Bistline *et al.*—*J. Am. Oil Chemists' Soc. 33,* 44). These allyl esters, when polymerized to a magnitude of 10 formed thick gels and were good emulsifiers, but had poor wetting properties. A comparison of built synthetic detergent containing sodium salts of sulfated hydrogenated tallow alcohols, disodium salts of α-sulfonated hydrogenated tallow acids, or sodium dodecylbenzene sulfonate has demonstrated that the first named detergent is most effective, but partial substitution of this detergent with either or both of the others is possible without loss in detergency (Stirton *et al.*—*Ibid.* 290). Esters prepared from sugars and fatty acids were efficient detergents (Osipow *et al.*—*Ind. Eng. Chem. 48,* 1459, 1462; *Soap & Chem. Specialties 32,* No. 12, 47; *J. Am. Oil Chemists' Soc. 33,* 424). Analysis of such a compound made with lauric acid and glucose indicated that the principal component has the lauroyl alcohol at the 6-position of the glucose moiety.

A refining by-product from petroleum was treated with silica gel and bleaching agents to render it suitable for sulfonation in manufacture of detergents (Ashimov *et al.*—*Izvest. Akad. Nauk. Azberbaidzhan. S.S.R. 1955,* No. 10, 45). A product suitable as a surface-active agent is prepared by sulfonating a mixture of one mole of naphthalene and two moles of isoamyl alcohol (Osaki & Yamada—*Repts. Govt. Ind. Res. Inst., Nagoya 1,* 140).

A cationic surface active agent was made by reacting equal moles of fatty alcohol and formaldehyde with 1-4 moles of acrylonitrile (Sakakibara *et al.*—*J. Chem. Soc. Japan, Ind. Sect. 58,* 616). In alcohol solution, stearic acid combines with guanidine stearate to yield an acid guanidine soap (Mikumo *et al.*—*Ibid.* 595).

Other literature on synthetic detergents are patents on products or manufacturing techniques. For convenience of presentation these are cited below under the name of the assignee or the patentee:

Aarhus Oliefabrik A/S.
Neutralizing nonionic detergents (*Dan. 79,798*).

Allied Chem. & Dye Corp.
Sulfonation of alkylate (*U. S. 2,723,990*).

Am. Cyanamid Co.
Sulfosuccinate ester of fatty acid mono- and diglyceride (textile softener) (*U. S. 2,734,833, 2,761,795*). Ethenoxy N-monoethanolamides of tall oil (*U. S. 2,744,888*).

Anciens Etablissements J. Canouet
Reaction at 200–300° for decarboxylated rosin with halogenation agents. (*Fr. 991,637*).

Anorgana
Triethanolamine soap rendered nonyellowing with sulfur dioxide (*Brit. 734,409*). Purifying polyglycol derivatives of organic hydroxyl or carboxyl compounds (*Ger. 828,839 Cl. 12o*).

Armour & Co.
Manufacture of fatty quaternary ammonium compounds (*U. S. 2,775,617*).

Atlas Powder Co.
Solid mixtures of urea and polyoxyethylene derivatives (*U. S. 2,724,699–700*). N-Hexityl fatty acid amides (*Brit. 745,036*).

Badische Anilin- & Soda-Fabrik A.-G.
Quaternary ammonium compounds (*Ger. 845,515*). Sulfonated petroleum and bituminous compounds (*Ger. 860,-216, 863,051, 885,543, 917,781 Cl. 12o*). Condensates of fatty alcohols and ethylene oxide (*Ger. 931,768 Cl. 12o*).

Böhme Fettchemie G.m.b.H.
Sulfonated primary and secondary alcohols (*Brit. 734,191, Ger. 859,306 Cl. 12o*), condensates of hexamethylenetetraamine with organic sulfonic acids (*Ger. 882,992 Cl. 12p*). Sulfonates obtained by treating sultones containing fatty alcohol or phenolic radicals (*Ger. 930,687 Cl. 12o*).

Bonewitz Chemicals Inc.
Sodium salt of gluconic acids (*U. S. 2,767,146*).

Bray Chem. Co.
Hydrocarbon sulfonates (*U. S. 2,739,982, 2,746,980*).

British Petroleum Co. Ltd.
Manufacturing condensates of ethylene oxide with fatty and rosin acids or fatty alcohols (*Brit. 748,877–81*).

California Research Corp.
N-alkylaminoacetic acid (*U. S. 2,731,421*), and *p- n*-alkyl phenol used to induce foam stability of alkyl sulfates (*U. S. 2,772,339*). Non-caking alkyl aryl sulfonate detergents (*U. S. 2,773,833*). Non-soap synthetic detergent bar (*U. S. 2,734,870*). Quaternary ammonium compounds as germicidal additives for alkyl aryl sulfonates (*U. S. 2,-746,928*). Odorless alkyl aryl sulfonate detergents (*U. S. 2,757,195*).

Chimiotechnie Union Chim. du Nord et du Rhone
Sulfonates of partial fatty or rosin esters of poly alcohols (*Fr. 988,005*).

Ciba Ltd.
Polyoxy esters for use in dyeing (*U. S. 2,763,528–30*).

Colgate-Palmolive Co.
Sulfonated detergents containing saturated fatty alcohols (*U. S. 2,731,422, 2,746,932*). Sulfonated detergents containing higher fatty acid amides (*U. S. 2,733,213, 2,746,931–2*). Esterification product of alkylolamine with a fatty acid amide (*U. S. 2,738,333*). Addition of alkali silicate and a hypochlorite to synthetic detergent (*U. S. 2,738,365*). Synthetic detergent bar *U. S. 2,749,315*). Soap-synthetic detergent bar (*U. S. 2,774,735*).

Compagnie products chim. et electrometalluriques Alais, *et al.*
Decarboxylated rosin (*Fr. 992,203*).

Dehydag G.m.b.H.
Aliphatic amino aromatic sulfonamides (*Ger. 938,127*). Alkylsulfonic acids (*Ger. 854,515, 763,809 Cl. 12o*).

Dow Chem. Co.
Polyalkylenepolyamines (*Brit. 738,529*).

E. I. du Pont de Nemours & Co.
Sulfated telomers (*U. S. 2,733,255*).

Esso Research & Engineering Co.
Sulfonation (*U. S. 2,723,219*). Alkyl aryl sulfonate solutions (*U. S. 2,723,240*). Sulfonated naphthenic alcohols (*U. S. 2,734,923*).

Etablissements G. Maubec
Detergent mixtures containing coconut fatty acid amides (*Fr. 990,299*).

Farbenfabriken Bayer A.-G.
Detergent-builder mixture (*U. S. 2,734,830*).

Farbwerke Hoechst A.-G.
Non-yellowing triethanolamine soaps (*U. S. 2,754,305*). Refining naphthenic acid soaps (*Brit. 744,048*). Product of introducing ethenoxy groups into condensates of fatty acids and protein hydrolyzate (*Brit. 750,791*). Sulfonated halogenated saturated nonaromatic hydrocarbons (*Ger. 917,428 Cl. 12o*).

Farmaceutici Italia, Soc. Anon.
Cationic detergents (*U. S. 2,744,138*).

General Aniline & Film Corp.
Nonionic detergent containing quaternary ammonium germicide (*U. S. 2,742,434*). N,N′-Polyoxyethylated rosin amines (*U. S. 2,742,455*). Ammonium salt of an alkylphenol polyglycol ether sulfate (*U. S. 2,758,977*). Sulfated esters of polyoxyalkylene compound (*U. S. 2,766,212*).

General Mills Inc.
Inactivation of primary amines in β-alanine detergent compositions (*U. S. 2,720,536*). 4,4-Dialkylthiomorpholinium chlorides (*U. S. 2,729,636*), sulfomethyl fatty ureas (*U. S. 2,758,133*). Phosphono-ammonium detergents (*U. S. 2,774,786*).

Gillette Co.
Shaving cream containing sulfonated fatty oils, partial esters of polyhydric alcohols, and a fatty acid (*U. S. 2-738,304*).

Gulf Research & Development Co.
Mahogany acid concentrate (*U. S. 2,733,263*).

Henkel & Cie *G.m.b.H.*
Sulfonated fatty acid nitriles (*Brit. 741,770*). Alkylbenzene sulfamide derivatives (*Ger. 938,728 Cl. 12o*). Sulfonation of secondary alcohols (*Ger. 852,692 Cl. 12o*). Amides from carboxylic acids and hydroaromatic amines (*Ger. 859,619 Cl. 12o*). Fatty acids condensed with $H_2NCH_2CH_2SO_3H$ (*Ger. 920,364 Cl. 12o*).

Imperial Chem. Industries Ltd.
Monoacidic ester of phosphoric acid (*Brit. 743,752, 744,845*).

Kawakami Research Inst. Ltd.
Reaction product of polyoxyethylene oleylamine and lactic acid (*Japan 8272–'54*).

Lever Bros. Co.
Acyl phenol monoethers to improve foaming of alkyl aryl sulfonates (*U. S. 2,768,956*).

Metallgesellschaft
Bar of soap and aminophenyl phosphonic acid (*U. S. 2,765,279*).

Monosanto Chem. Co.
Mixtures of polyalkylene ethers and anionic detergents (*U. S. 2,744,874*). Builder-anionic detergent combinations (*U. S. 2,746,929–30*). N-Carboxymethyl-substituted alkylene and polyalkylene polyamines (*Brit. 742,055*).

N. V. de Bataafsche Petrol. Mattschappij
Refining sulfuric acid-ester salts (*Dutch 79,767, Ger. 825,405 Cl. 12o*).

Nippon Wax Refining Co.
Reaction product of hydrocarbons with sulfur dioxide and chlorine (*Japan 1250–'55*).

Olin Mathieson Chem. Co.
Quaternary ammonium salts of N-β-aminoethylcarbamates (*U. S. 2,721,208*).

Oguri, A.
Mixture of sodium higher alcohol sulfates and polyethylene glycol esters (*Japan 1081–'55*).

Pecks' Products Co.
Special alkyl aryl sulfonates (*U. S. 2,758,092*).

Petrolite Corp.
Esters or salts of sulfoaromatic fatty acids in which the fatty acid is esterified by oxypropylation (*U. S. 2,716,126*). Oxyalkylated derivatives of proteins (*U. S. 2,727,027*).

Pile, V. *et al.*
Sulfonated fats and oils (*Czech. 84,692*).

Poor & Co.
Salt of aldonic acid and oxyalkylated fatty amines (*U. S. 2,739,980*).

Process Chemicals Co.
Mixtures of organic sulfonic acids and a higher acid amide of monoisopropanolamine (*U. S. 2,757,143*).

Procter & Gamble Co.
Detergent-alkali phytate combinations (*U. S. 2,739,942–3*). Anticaking synthetic detergent (*U. S. 2,742,435*).

Putt, J. W.
Simultaneously alkylating and sulfonating aromatic hydrocarbons (*U. S. 2,773,896*).

Rayette, Inc.
Condensation products of protein degradation products with fatty acyl chloride (*U. S. 2,763,269*).

Rohm & Haas Co.
Non-foaming mixtures of alkylphenols and nonionic detergents (*U. S. 2,746,927*). Polyethoxy ether esters of bis (chlorophenyl) acetic acid (*U. S. 2,752,384*).

Ruhrchemie A.-G.
Pure white alkyl aryl sulfonates (*U. S. 2,740,807*). Removing hydrocarbons from sulfuric acid esters (*Ger. 763,934 Cl. 12o*). Neutralizing sulfonated products with sodium carbonate (*Ger. 868,907 Cl. 12o*).

Saigo, S.
Mixture of soap and nonionic detergents (*Japan 7239–'54*).

Samuel, A.
Synthetic detergent-builder mixture (*Fr. 989,284*).

Shell Development Co.
Petroleum sulfonates (*U. S. 2,738,326*). Detergents containing sulfone-substituted carboxylic amide (*U. S. 2,743,236*). Detergents containing high molecular polyamides (*U. S. 2,751,358*).

Smirnov, O. K. *et al.*
Alkyl phosphinic base detergents (*U.S.S.R. 103,162*).

Soc. d'innovation chim. Sinnova ou Sadic.
Alcohol sulfonates (*Fr. 990,742*). Monosulfonic acids of isopropyl- or di-*tert.* butylphenoxthine (*Fr. 992,582*). Synthetic detergent-soap-resin mixture (*Fr. 998,810*).

Stepan Chem. Co.
Liquid alkyl aryl sulfonated detergent (*U. S. 2,768,957*).

Sun Oil Co.
Sulfonation of mineral oil (*U. S. 2,717,265*).

Takahama, S.
Tallow fatty acid esters of methyltriethanol ammonium chloride (*Japan 5949–'54*).

Tennessee Corp.
Monosulfonated fatty acids (*U. S. 2,743,288*).

Textilana Corp.
Alkanolamide-phosphate salt mixtures (*U. S. 2,758,093*).

Thibaud Gibbs & Cie
Tertiary amines or analogous sulfur, phosphorus and arsenic compounds converted to ammonium, phosphonium, etc. compounds and treated with urea (*Fr. 988,827*).

Universal Oil Products Co.
Fractionated mahogany soaps (*U. S. 2,720,537*). Alkyl aromatic sulfonic acids (*U. S. 2,718,526*).

There were other communications on soap and detergents which were reviews or contained general information on history, economy, manufacture or descriptions of known commercial products. For convenience of presentation, these are classified and cited under the subject treated:

Reviews:
History of soap making (Gellendien—*Indian Soap J. 20*, 105, 125). Benjamin Franklin-soap maker (Fourman—*Soap & Chem. Specialties 32*, No. 7, 33). Progress in fine soap making (Zilske—*Fette-Seifen-Anstrichmittel 58*, 792).

Manufacturing processes:
Continuous processes (Kluge—*Fette-Seifen-Anstrichmittel 58,* 787; Tyutyunnikov *et al.*—*Masloboino-Zhirovaya Prom. 21,* No. 3, 23). Clarity in liquid soap (Smith—*Am. Perfumer Essent. Oil Rev. 66,* No. 3, 55). Amount of free alkali in soap (Smith—*Am. Perfumer Aromet. 67,* No. 4, 50). Remedies for cracking of soap (Smith—*Ibid.* No. 5, 54). Use of vacuum double plodders (Zilske—*Seifen-Öle-Fette-Wachse 82,* 6). Centrifuge for the separation of soap-paste from spent lye (Polstyanoi—*Masloboino-Zhirovaya Prom. 21,* No. 6, 32). Drum and spray drying of soap under vacuum (Gäbler—*Fette-Seifen-Anstrichmittel 58,* 282). Spray drying from an autoclave (*Lesyuis—Masloboino-Zhirovaya Prom. 21,* No. 6, 19). Preventing soap scum in shampoos (Smith—*Am. Perfumer Essential Oil Rev. 66,* No. 6, 55). Air in soap. (Smith—*Am. Perfumer Aromat. 68,* No. 3, 57).

Raw Materials:
Synthetic fatty acids for soap manufacture (Bokov—*Masloboino-Zhirovaya Prom. 21,* No. 7, 18). Oleic acid for soap making (Smith—*Am. Perfumer Aromet. 67,* No. 1, 76).

Builders and fillers:
Phosphates in detergency (Schneider—*Univ. Microfilms, Ann Arbor Mich., Publ. No. 13047* 80 pp.). Defining the condensed phosphates (Markowitz—*J. Chem. Ed. 33,* 36). X-ray and chromatographic studies of condensed phosphates (Pfrengle—*Fette-Seifen-Anstrichmittel 58,* 81). Sodium tripolyphosphate (*Am. Perfumer Aromat. 68,* No. 2, 47). Builders for synthetic detergents (Vaughn *et al.*—*Parfums. cosmet. savons. No. 119,* 29). Sequestering agents (Smith—*Chemistry & Industry 1956,* 1284; Smith & Womersley—*Chem. Products 19,* 152). Active materials in washing powders (Mauri—*Grasas y Aceites, Spain, 6,* 284). Use of tetra sodium ethylenediamine-tetraacetate in soap (Schmidt—*Seifen-Öle-Fette-Wachse 81,* 721, 756; Smith—*Am. Perfumer Aromat. 68,* No. 3, 57). Carboxymethylcellulose in washing (Stüpel—*Seifen-Öle-Fette-Wachse 82,* 99; Stawitz & Klaus—*Fette-Seifen-Anstrichmittel 58,* 45). Natural gums for soaps (Smith—*Am. Perfumer Aromat. 67,* No. 6, 67).

Soap and detergent additives:
Oxygen compounds in soap making (Dörfel—*Seifen-Öle-Fette-Wachse 82,* 25, 77, 101, 127, 153). Disinfecting and deodorant soaps (Hausam—*Reichstoffe u. Aromen 5,* 342, 370). Symposium on detergent sanitizers (Several authors—*Chem. Specialties Mfrs. Assoc. Dec. Proc. 1955,* 106, 107, 109, 111, 113, 117). Hydrosulfite to inhibit rancidity (Muscari-Tomajoli—*Olii minerali, grassi e saponi, colori e vernici 33,* 57). Brightening agents (Zussman *et al.*—*Soap & Chem. Specialties 32,* No. 8, 35). Hexachlorophenol germicidal soaps (Meyer—*Fette-Seifen-Anstrichmittel 58,* 239). Pine oil for soaps (Smith—*Am. Perfumer Aromat. 67,* No. 1, 76). Perfuming soaps (Pickthall—*Fette-Seifen-Anstrichmittel 58,* 763; Schmidt—*Ibid.* 40; Wells—*Soap & Chem. Specialties 32,* No. 11, 35; No. 12, 53).

Synthetic detergents:
Annual review of soap and syndets (Snell—*Ind. Eng. Chem. 48,* No. 1, 38A). Synthetic detergents (Kariyone—*Kagaku no Ryoiki 10,* 703, Pai—*Bombay Technologist 4,* 78, Marcus—*Rev. chim., Bucharest 6,* 467; Kato—*Ann. Proc. Gifu Coll. Pharm. No. 4,* 4; Komori—*J. Japan Oil Chemists' Soc. 5,* 189). Cost of manufacture (Tomlinson—*Mfg. Chemists 26,* 404). Applications (Mikumo—*J. Chem. Soc. Japan Ind. Sect. 58,* 842; Gomez-Herrera—*Grasas y aceites, Spain, 6,* 94). Syndets in bar or shaped form (Sisley—*Rev. franc. corps gras 3,* 405, 483; Brooks—*Perfumery Essent. Oil Record 46,* 123). Mersols and Mersolates (Sorin—*Rev. chim., Bucharest, 6,* 78). Alkylolamide detergents (Sanders *et al.*—*Soap & Chem. Specialties 32,* No. 1, 33; *Chem. Specialties Mfrs. Assoc. Proc. 1955,* 176). Acylated amino acids in shampoos (Zussman & Lennon—*J. Soc. Cosmetic Chemists 6,* 407). β-alkylaminopropinates for shampoos (Freese & Anderson—*Am. Perfumer Aromat. 67,* No. 3, 37). Nonionic detergents (Karabinos & Metziger—*Trans. Ill. State Acad. Sci. 48,* 118; Moore & Bell—*Soap, Perfumery & Cosmetics 29,* 893). Polyethylene glycol esters of fatty acids (Schneider—*Fette-Seifen-Anstrichmittel 58,* 549). Lauric acid diethanolamine condensation products (Kroll & Lennon—*Proc. Sci. Sect. Toilet Goods Assoc. No. 25,* 37). Petrochemical detergents (Chiddix & Stevens—*Am. Chem. Soc. Div. Petrol Chem. Symposium No. 28,* 95). Sulfated alcohols from olive oil (Gomez-Herrara & Ayerbe—*Grasas y aceites, Spain, 7,* 170). Spans, Tweens etc. (Schuster—*Pharm.-Ztg. 100,* 447). Theory and glossary of surfactants (Vermeersch—*Textielwezen 9,* No. 12, 49; *10,* No. 1, 45; No. 2, 29; No. 3, 27; No. 4, 41). Quaternary ammonium type detergents (Borowsky—*Soap & Chem. Specialties 32,* No. 3, 157). Toxicity of synthetic detergents (Gomez-Herrera—*Grasas y aceites, Spain, 7,* 156).

General analytical and evaluation.
Analysis and evaluation (Tomlinson—*Mfg. Chemist 27,* 100); Gomez-Herrera—*Grasas y aceites, Spain, 6,* 144; Proposed official methods for the analysis of sulfated oils (Burton *et al.*—*J. Soc. Leather Trades Chemists 40,* 248). Analytical control of sulfonated oils (Bernasconi—*Rev. fac. cienc. quim. nacl. Eva Peron 26,* 15). Standards and tentative standards for soap and detergents (*Am. Soc. Testing Materials, Standards 1955,* 163 pp.). Soap and detergents sampling and testing (*Federal Test Method Standard No.* 536). Analytical research on synthetic detergents (Coughlin—*J. Am. Water Works Assoc. 48,* 70). Determination of the surface tension of wetting agent solutions (Wannow—*Melliand Textilber. 36,* 1041). Analysis of nonionic detergents (Kurata—*J. Japan Oil Chemists' Soc. 4,* 293). Characterization of nonionic detergents (Steele & Berger—*Chem. Specialties Mfrs. Assoc. Proc. Dec. 1955,* 185). Evaluation of alkyl sulfates (Crockett—*J. Soc. Cosmetic Chemists 6,* 124). Viscosity and solubilization of polysoaps (Ammondson—*Univ. Microfilms, Ann Arbor, Mich., Publ. No. 16670,* 222 pp.). Surface activity of detergents (Moreno-Calvo—*Rev. cienc. apl., Madrid, 10,* 111, 210). Estimation of detergency (Harris—*Parfums cosmét. savons No. 112;* 31, Uhl—*Fette-Seifen-Anstrichmittel 58,* 408. Determination of soil-suspending capacity (Manneck—*Seifen-öle-Fette-Wachse* 81, 627). Radioactive tracer technique in washing studies (Manos—*Soap & Chem. Specialties 32,* No. 7, 31). Structure of sodium soaps from C_4 to C_{18} (Kokotailo—*Univ. Microfilms, Ann Arbor, Mich. No. 12872,* 84 pp.).

Detergents in use:
Surface-active agents for the food industry (Aylward—*Rev. fermentations et inds. aliment 11,* 75). Removal of fission products by detergents (Segura *et al.*—*Rev. franc. corps gras 3,* 107). Liquid detergent disinfectants (Neu—*Seifen-Öle-Fette-Wachse 81,* 479, 503, 530, 584, 603, 629, 672, 696). Spotting agents for washable fabrics (Stanley & Davis—*Chem. Specialties Mfrs. Assoc. Proc. Dec. 1955,* 181). Wetting agents in metal-finishing processes (Halliday—*Product Finishing London, 9,* No. 3, 50). Scouring wool with "Sulfonol" (Sherishev & Rozhkova—*Tekstil. Prom. 15,* No. 9, 7).

Glycerol
Standards (British Standard Inst.—*Brit. Standard 2621-5,* 58 pp.). Purification of crude glycerol by ion exchange (Prielipp—*J. Am. Oil Chemists' Soc. 33,* 103; Kellar *et al.*—*Ibid.* 435; Eckelaers—*Rev. franc corps gras 2,* 2, 681; Houweling—*Ibid. 3,* 672). Extraction of glycerol from soap (Fox—*Soap Perfumery & Cosmetics 29,* 541). Continuous app. for preliminary purification of glycerol liquor (Bokov—*Masloboino-Zhirovaya Prom. 22,* No. 4, 22). Salt solids removal in a glycerol-recovery system (Muir—*Soap & Chem. Specialties 32,* No. 1, 45). Vacuum filtration of glycerol liquors (Spinor & Shkuropatova—*Masloboino-Zhirovaya Prom. 21,* No. 6, 33). Glycerol determination (Thomopoulos—*Chimka Chronika, Greece 21,* 158).

CHEMICAL ANALYSIS. Novel methods were proposed for determination of fatty acids in a soap. One method comprises adding a solution of the sample to an aqueous solution of carboxymethylcellulose sodium salt, neutralizing with acetic acid, adding copper sulfate solution, filtering, washing and titrating the copper in the precipitate iodometrically (Povlovich & Abuladze—*Tekstil. Prom. 15,* No. 10, 56). Soap samples in alcohol solution may be passed through an ion exchange resin to remove cation and the fatty acids released may be separated and titrated (Jenkins—*J. Am. Oil Chemists' Soc. 33,* 225). A method of releasing fatty acids from soap with inorganic acids and segregating with centrifuge was also described (Zhurba—*Masloboino-Zhirovaya Prom. 21,* No. 1, 27). Refining soap stocks from coconut oil have higher iodine numbers than those of the corresponding refined oils (Zajcew—*J. Am. Oil Chemists' Soc. 33,* 306).

Some analytical procedures pertain to soap builders and additives. A method for triphosphate is based on removing the ethanol soluble portion and precipitation of the triphos-

phate with tris (ethylenediamine)-cobalt chloride (Weiser—*Anal. Chem. 28,* 477). Because some pyrophosphate also coprecipitates, an empirical curve from known mixtures was developed to correct results. Ortho- and trimetaphosphates do not interfere. The total P_2O_5 is determined and by subtracting the contribution of various determinable phosphates, the pyrophosphate content is available. A mixture of ortho-, pyro-, tri-, trimeta-, and tetrametaphosphate was separated on an anion-exchange column and developed with a buffered potassium chloride solution, which was increased from 0.1 *M* to 0.7 *M* during the run (Grande & Beukenkamp—*Anal. Chem. 28,* 1497). Paper chromatography was used for differential analysis of phosphate mixtures employing a basic ascending solvent, developing with acid solvent and various novel indicators to identify spots (Karl-Kroupa—*Ibid.* 1091). The R_f values for both solvent systems are given for ortho-, pyro-, tri-, tetra-, penta-, hexa-, hepta-, trimeta-, and tetrametaphosphate.

Silicic acid in laundering compositions can be determined by heating a sample with nitric acid and sodium nitrate until light colored and homogeneous, cooling, diluting with water, boiling off nitrogen oxides, and weighing the precipitated silicon dioxide (Heinerth—*Fette-Seifen-Anstrichmittel 56,* 595). A volumetric method for soluble silicates comprises titrating with hydrochloric acid to the first color change; adding sodium fluoride and ethanol and titrating again to an excess of the acid with reference to a mixed indicator of methyl red-cyanol; and back titrating with sodium hydroxide to a gray color (Lawson *et al.*—*Anal. Chem. 27,* 1810). Adjustments were made for this procedure when carbonates or surfactants are present. In a newly designed apparatus for determining carbon dioxide in detergents, the conventional horizontally arranged train of decomposition flask, bubble counter, drying bulbs, etc. is replaced by a vertical apparatus that requires little bench space (Blank & Kelley—*J. Am. Oil Chemists' Soc. 33,* 75). Hexachlorophene germicide is determined in liquid soap by a differential spectrophotometric method consisting of the measurement of the absorbance of a diluted sample at 312 mμ at pH 8 and pH 3 (Childs & Parks—*J. Am. Pharm. Assoc. 45,* 313).

Bennewitz (*Fette-Seifen-Anstrichmittel 28,* 832) has discussed the choice of pH for identification of nonionic, cationic and anionic detergents. A method for analysis of ionic detergents is based on complexing with ionic dyes, extracting with organic solvent, and spectrophotometric analysis (Mukerjee—*Anal. Chem. 28,* 870). Details of such a method for the detergents, *n*-alkyltrimethylammonium bromides and dodecylpyridinium bromide were published (Few & Ottewill—*J. Colloid Sci. 11,* 34). New tests for characterizing and classifying detergents described by Quinn & Karabinos (*Soap & Chem. Specialties 32,* No. 11, 39) are based on foaming depression produced with dilute solutions of phenol, phenol plus sodium carbonate, sulfuric acid, barium chloride, and formamide.

Anionic and cationic detergents have been segregated by paper chromatography (Franks—*Analyst 81,* 390). A paper partition chromatographic separation method has been developed for the sodium alkyl sulfates with chains of 12 to 18 carbon atoms (Franks—*Nature 176,* 693). Cationic surface agents of the alkylpyridinium chloride type, where alkyl is a straight chain of 8–18 even carbon atoms, were separated and identified by electrochromatographic paper techniques with a method similar to that of Foster (Fumasoni *et al.*—*Chemistry & Industry 1956,* 69).

A rapid method for the determination of fatty materials in sulfonated oils is based on treatment with hydrochloric acid and extraction with carbon tetrachloride (Ceamis & Kiriteseu—*Rev. chim., Bucharest 7,* 56). Invert soaps such as benzalkonium chloride or (alkylbenzal) trimethylammonium chloride can be determined gravimetrically based on precipitation with phosphotungstic acid (Yoshimura & Morita—*Bull. Natl. Lab. Tokyo No. 73,* 141) or colorimetrically by reaction with phosphomolybdic acid (Yoshimura & Morita—*Pharm. Bull., Japan 3,* 432). With the latter method, calculations for both the amount of a quaternary ammonium cation and its ionic weight have been described (Lincoln & Chinnick—*Analyst 81,* 100). One method for determination of surface active compounds was based on titration of anion-active with cation-active agents, or *vice versa,* with the use of fluorescent indicators (Dolezil—*Chem. Listy 50,* 1588).

Nonionic detergents can be characterized through the complexes they form with phosphomolybdic acid, silicotungstic acid and ferrocyanic acid, determination of ethoxyl groups and density-cloud point relationship (Steele & Berger—*Soap & Chem. Specialties 32,* No. 2, 48). When nonionics in comixtures with quaternary ammonium compounds are to be determined by precipitation, the quaternary compound should be removed with an ion-exchange resin (Barber *et al.*—*Analyst 81,* 18). In this work the interference of the nonionic in observing the end-point on determining quaternary ammonium compounds with the bromophenol blue method was overcome by making a blank titration without nonionic present, and using the blue ethylene dichloride layer of this as a match for titrations of samples containing some nonionics.

A field test for indicating concentrations of the quaternary ammonium compound, Hyamine, is based on color reaction with an indicator composed of methyl orange, bromophenol blue, sodium bicarbonate and salt adjusted to pH of 6.5–11.2 (Negoro & Seno— *Ann. Rept. Takamine Lab. 7,* 122). Traces of fatty amines in water are determined by titrating in the presence of eosin with an anionic surface-active agent until the disappearance of a pink color due to an amine-eosin complex (Milun & Moyer—*Anal. Chem. 28,* 1204). Methyl green was found superior to methylene blue in the Faust modification of the Jones method for determining anionic detergents in surface waters and sewage (Moore & Kolbeson—*Anal. Chem. 28,* 161).

Investigations on developing tests for evaluation of crude glycerol quality have shown that glycerols of low pH foamed most during distillation; that judgment based on distilled color did not evaluate color stability; and that nitrogen content correlated poorly with quality (Miner—*Soap & Chem. Specialties 32,* No. 4, 45). The determination of color impurities in glycerols of high concentrations by light absorption is affected by the glycerol itself but accurate estimation of colored impurities is possible when the glycerol is diluted to below the 72% point (Weiss—*Chem.-Ztg. 80,* 129).

PHYSICAL CHARACTERISTICS OF SOAP AND DETERGENTS. Two soaps made by the Mazzoni process were investigated by X-ray analysis to determine the crystalline phases present (Fock—*Seifen-Öle-Fette-Wachse 81,* 348, 382). In a sample containing coconut oil fatty acids the ω-phase predominated, and with a soap made from low titer tallow acids the β-phase was three times as dominate as the ω-phase. Another investigation on soap phases has indicated that toilet soaps consist largely of the ω-phase, the β-phase being essentially absent but may be produced by special apparatus with temperature control (Dobbelman—*Ind. chim. belge 20,* Spec. No. 700). This work describes methods of preparing the β-, ω- and δ-phases of sodium palmitate. By a dilatometric method, curves depicting volume change with temperature were obtained for a number of sodium laurate-water and sodium laurate-water-salt systems (Aggarwal *et al.*—*J. Applied Chem. 6,* 391). In these curves, the appearance of the neat and middle soap phases is marked by a discontinuity. The importance of the kettle-wax phase in determining various equilibria in soap boiling is discussed. The various modifications of thin layers of alkyl sulfate soaps as observed by X-ray at various temperatures were attributed to tilt of the chain and to the number of water molecules added to the hydrophilic groups (Prins & Prins—*Nature 177,* 535). Wirth *et al.* (*J. Phys. Chem. 60,* 919, 921, 923) recorded the dielectric constants of the various phases of hydrous sodium palmitate. The dielectric constant is practically constant for the α- and β-phases for moisture content up to 3%, above which the constant increases rapidly. Definite changes in dielectric constant are associated with crystal-subwaxy, subwaxy-waxy, waxy-superwaxy, and superwaxy-subneat transitions in the anhydrous soap. These reports also included the isothermal dehydration curves of α-, δ-, ε-, and ω-sodium palmitate. The phases show sharp breaks in equilibrium pressure of water at water content of 3.14%. The results were interpreted in terms of hydrate formation, strong absorption, or solid solution of water in the anhydrous soap phase.

A method of characterizing soap texture is based on the pressure used to force the soap through a tapered cylindrical channel (Ravich & Nechitailo—*Doklady Akad. Nauk S.S.R. 87,* 69). In this work data obtained at 18 and 90° are reported for the sodium and potassium soaps of lauric, myristic, palmitic, stearic, and oleic acids.

By pouring soap water onto surface of soap water it was possible to produce thin spherical shells of air in water, i.e., inverted soap bubbles (Skogen—*Am. J. Phys. 24,* 239). Two intermolecular compounds of sodium lauryl sulfate and lauryl alcohol with, respectively, 1:1 and 2:1 molecular ratios of components were isolated as crystal precipitates from aqueous solutions (Wilson—*J. Soc. Cosmetic Chemists' 6,* 392). These compounds were believed to be responsible for formation of slow-draining films because they form surfaces of high viscosity.

Vallee & Hirschmann (*Rev. franc. corps gras 3,* 676) have applied the apparatus of Thibaud for the determination of the surface tension of detergent solutions and recommended the

technique for determining temperature and concentration conditions for highest efficiency of a detergent and in control and development of built mixtures. In an investigation on solutions of 18-carbon soaps the surface tension activity decreased as saturation increased, but the stearate was an exception (Kivalo—*Suomen Kemistilehti 29B*, 126). Like studies on the C_2 to C_{16} sodium alkyl sulfate solutions gave no surface activity maximum for C_2, C_4, and C_6 members, but there were sharp maximums for the others, the C_{12} being the sharpest (Raison—*Mem. services chim. etat, Paris, 39*, 291). In this work critical micelle concentrations were also determined by pinacyanol titrations. The data agreed closely with that obtained by surface tension measurement. The critical micelle concentrations (c.m.c.) were also determined for polyoxyethylated nonionic detergents (Hsiao *et al.*—*J. Phys. Chem. 60*, 657). The c.m.c. increases with chain length and decreases with increasing electrolyte concentration. The surface activity of many detergents was also evaluated by measuring contact angles of aqueous solutions and these data were discussed in reference to comparable data obtained by conventional surface tension determinations (Asabara & Goto—*J. Chem. Soc. Japan, Ind. Sect. 58*, 864).

Contrary to previously published reports, equilibration across cellophane membranes was observed on a series of salt-free and polar hydrocarbon-free anionic and cationic detergent solutions (Klevens & Carr—*J. Am. Chem. Soc. 60*, 1245). The addition of dissolved hydrocarbon caused little change, and long chain alcohols and amine additives increased markedly the time necessary for equilibration. A minimum in overall diffusion coefficient *versus* concentration curve for sodium sulfate occurs at a concentration limit close to the critical micelle concentration (Brudney & Saunders—*J. Pharm. & Pharmacol. 7*, 1012). Relative concentrations of simple soaps and micelles can be calculated from the curves. The micellar radii of dodecansulfonic acid in perchloric acid solutions have been estimated from diffusion experiments at 25° (Abbott & Tartar—*J. Phys. Chem. 59*, 1193). Micellar molecular weights of many detergents have been determined by the light scattering technique (Tartar—*Ibid.* 1185) and for dodecyltrimethylammonium sulfate by the electrical conductivity methods (Voeks & Tartar—*Ibid.* 1190). Conductivity methods were also applied to solutions of the sodium alkyl sulfates of chain length of 8–19 carbon atoms and to compounds with the sulfate radical ranging from terminal to medial positions (Evans—*J. Chem. Soc. 1956*, 579). In similar work on three isomers of dodecylbenzene sulfonate solutions both electrical conductivity and optical turbidity were used to study the micelles (Ludlum—*J. Am. Chem. Soc. 60*, 1240). In general, increase in hydrophobic nature lowers critical micelle concentration and increases micelle size.

The coagulation of dispersed colloids, such as ferric hydroxide, arsenic sulfide, dyes, titan white, and others, with small amounts of various detergents and their redispersion with larger amounts have been investigated for concentrations that produce the flocculation and the redispersion (Meguro & Kondo—*J. Chem. Soc. Japan, Chem. Sect. 76*, 642; Kondo—*Ibid.* 1374; Meguro—*Ibid. 77*, 72, 77; *J. Chem. Soc. Japan, Ind. Sect. 58*, 905). Tentative theories of the phenomenon were suggested. Similar observations and measurements made with many detergents on polyacrylic acid dispersions were interpreted to suggest that initially detergents are adsorbed on the surface, making it hydrophobic and causing coagulation, whereas the subsequent portion coats the neutral surface of the coagulum, causing it to become charged and hydrophilic (Saito—*Kolloid-Ztg. 143*, 66).

A test of methods for determining critical micelle concentration (c.m.c.) of α-sulfonated fatty acids and their esters has indicated that conduction methods are preferred with c.m.c. values over 0.001 *M*, and the surface and dye-titration methods are better when values are less than 0.001 *M* (Weil & Stirton—*J. Phys. Chem. 60*, 899). These α-sulfonated acids and their alkyl esters had c.m.c. values in the same region as do other surfactants of equal carbon chain length. At below the c.m.c. the micelles of colloidal soaps were said to be spherical and completely ionic, and at and after the c.m.c. the long chains of the soaps aggregate in parallel groups (Gupta—*Sci. & Culture, India, 21*, 470). Diagrams for possible shapes of the latter were illustrated. Freeze-drying techniques have been developed for use in studying formation and shape of micelles of surface active substances by means of the electron microscope (Kehren & Rösch—*Melliand Textilber 37*, 680). One such technique was used to study the coagulation of stearic acid sols with cationic wetting agents (Roy & Bhattacharya—*J. Indian Sci. 37A*, 254). Original colloidal particles were elongated and laminar; on addition of wetting agent the shape changed, and there was a tendency toward coagulation; and further adsorption of detergent by the particles tended to make them spherical.

Some investigators studied micelle formation with regard to the theories on the subject. Prins & Hermans (*Koninkl. Ned. Akad. Wetenschap Proc. Sers. B. 59*, 162)., found that Debyes' procedure of calculating micelle weight from light scattering does not lead to the exact micellar weight. They then suggested improvements by taking into account the activity coefficients of the micelles as derived from a volume exclusion principle. Reich (*J. Phys. Chem. 60*, 257) rejected the Debye theory on micelle formation because it led to incorrect calculations of micelle size, and since it depends on ionic repulsion it is unable to account for the formation of micelles by nonionic detergents. He outlined a theory for formation of micelles by nonionic detergents based on the Hartley picture of micelle structure. Data from heat of micelle formation were not readily explainable by the Debye theory of micelle formation (Goddard & Benson—*Trans. Faraday Soc. 52*, 409).

De Jong & Bakker (*Koninkl. Ned. Akad. Wetenschap. Proc. Ser. B 59*, 124, 136, 149) suggest that when detergent ions are taken up in the sandwich micelle of a phosphatide, an electrical decompensation results, provided the detergent ions are taken up in such a manner that their charged groups lie in the surface of the micelle, and that the counterions of the detergent are either unbound or partly bound to the surface of the micelle. Salts in general have a neutralizing effect on the electrical decompensation. In this work the influence of a few detergents and many salts on phosphatide suspensions were measured. The effect of many electrolytes and mixtures of electrolytes on critical micelle concentrations in detergent solutions have been measured and several equations were proposed to represent the effect (Dorst *et al.*— *Ibid.* 190; Ooshika & Ikeda—*Kolloid-Z. 145*, 3; Minassian-Saraga—*J. chim. phys. 53*, 555).

Many fundamental investigations pertained to the interaction of the paraffin-chain of fatty alcohols on colloidal detergent solution. According to Passinen, Ekwall and their coworkers (*Acta Chem. Scand. 9*, 1438, 1450; *10*, 215, 227, 237) when decanol is added to a fatty acid soap or a sodium alkyl sulfate solution conductivity decreases with small amounts, as the decanol is increased a new phase forms and conductivity decreases rapidly, and further addition does not alter conductivity. They observed and measured the phase changes as indicated by conductance, turbidity and viscosity and as influenced by type, chain-length, and concentration of detergent and by chain-length of the alcohol. The data are discussed with regard to limit association concentrations, and structure of the micelles. In similar studies, Bose *et al.* (*Z. physik. Chem. 204*, 16; *J. Colloid Sci. 11*, 250; *Kolloid-Z. 145*, 154) made use of viscosity and conductivity measurements on soap solutions containing, respectively: alcohols, urea, hydroquinone, benzoic acid, various phenolic compounds and *m*- and *p*-nitrobenzoic acids. An increase in viscosity of 10–30% is produced by 2 *N* concentrations of the phenols, this is attributed to hydration of these molecules. The solubilization effect and increase in viscosity are smaller at 40–50% alcohol concentrations than at lower concentrations. The solubility of benzene and octanol in various concentrations of some sorbitan ester-type nonionic surface-active agents was measured by turbidity determinations (Kita *et al.*—*J. Chem. Soc. Japan, Ind. Sect. 58*, 855). The data were discussed with regard to correlation of limit of solubility and cloud point with degree of condensation of oxyethylene. Dilute aqueous solutions of the nonionic emulsifier, Triton X-100, have a cloud point at 64°; which is increased by C_{10}–C_{16} normal alkanes, but is decreased by aromatic hydrocarbons, dichloroethane or butyl acetate (Maclay—*J. Colloid Sci. 11*, 272). Measurements of the partial molal volumes of *n*-hexyl and *n*-octyl alcohols, or salts in sodium decyl and dodecyl sulfate solutions show that for these materials dissolution occurs with almost no change in apparent volume (Hutchinson & Mosher—*J. Colloid Sci. 11*, 352).

Okuyama (*Bull. Chem. Soc. Japan 28*, 548) measured the diffusion of hydrocarbons, alcohols, and esters into aqueous solutions of a cationic detergent. The soluble compounds diffuse in the solution at about the same rate as in water, and the polar campounds diffuse in accordance to their solubility in water, i.e. as single molecules and others as complexes associated with micelles.

The property of soap solutions of developing a viscoelastic consistency when electrolytes are added was attributed to a change in the shape of the soap micelles from small, detached spheres to long interlinked cylinders (Pilpel—*J. Phys. Chem.*

60, 779). Data on viscosity studies of three different polyethylene glycol nonionic detergents have shown differences which were interpreted to indicate that some of these detergents form globular micelles whereas those of others are far from globular (Kuroiwa—*J. Chem. Soc. Japan, Ind. Sect.. 58,* 859).

The viscosity of solutions of fatty derivatives of poly-4-vinyl-pyridine passes through a minimum on addition of potassium bromide and then rises with increasing salt concentrations and at 37.9% it leads to jelly formation (Strauss—*J. Phys. Chem. Soc. 60,* 577).

Soap added to a nicotine-water system lowers the upper solution temperature and raises the lower one (Langbridge *et al.*—*J. Colloid Chem. 11,* 585).

Viscosities cloud points, and foaming heights have been recorded for lauryl polyoxyethylene sulfates as influenced by the chain-length of the ether moiety, presence of salt, concentration and temperature (Braude *et al.*—*Soap & Chem. Specialties 32,* No. 8, 45). Cloud points decrease with increasing ether chain, while foaming heights reached a maximum at ether chain length 2-4.

PERFORMANCE AND USE TESTING. The foaming of potassium soaps of C_{12} to C_{18} fatty acids were studied in a "vibration foaming apparatus" at temperatures of 20 to 25° and pH 10 to 11 (Kaufmann *et al.*—*Fette-Seifen-Anstrichmittel 58,* 724). Elaidic soap gave a curve close to that of stearic soap. Great foam stability occurred at the lower temperatures, at the higher concentrations, and at lower pH's. Due to erratic courses of the curves no general statement could be made concerning stearic *versus* oleic soaps. Data on the collapse of foams of detergent solutions by addition of alcohol and other organic solvents and the influence of foam stabilizers were graphically recorded (Kurz—*Soap & Chem. Specialties 32,* No. 9, 38). The response to the organic solvents and foam stabilizers are peculiar to the individual foamer. In other similar work the same general conclusion was reached and a theory for the mechanism of collapsing foams with alcohol was proposed (Villar—*Bol. fac. ing. y agrimensura, Mondevideo, 6,* 199).

Two dimensional soap froths made between two parallel glass plates partitioned the space into polygonal cells with 3 to 12 sides (Kikuchi—*J. Chem. Phys. 24,* 861).

In a thermochemical investigation of wetting it was calculated that 80 calories is necessary to produce one unit of mass of associated water and an equation was developed to characterize hydrophilic nature. This was then used to appraise oil-soap-water systems and study washing systems (Dumanskii—*Izvest. Akad. Nauk S.S.S.R., Khim Nauk 1956,* 270).

A new laboratory-scale tumbler-type washing machine was said to permit evaluation of detergents in close proximation to conditions in full-size laundry machines (Steveson—*J. Textile Inst. T46,* 677). A preliminary report was published on a rapid method of evaluating detergency by means of an ultrasonic transducer (Sherrill & White—*J. Am. Oil Chemists' Soc. 33,* 23).

Some communications on evaluating laundry detergents pertained to the soil and test cloth. A test swatch used for screening detergents was soiled with dirt from a hotel vacuum cleaner (Ferris & Leenerts—*Soap & Chem. Specialties 32,* No. 7, 37). Another test soil contained radio-active labeled tripalmitin which could be traced by a Geiger counter (Ehrenkranz—*Soap & Chem. Specialties 32,* No. 3, 41; Ehrenkranz & Jebe—*Nucleonics 14,* No. 3, 96). Radio-active carbon was used to measure the capacity of detergent to inhibit deposition of carbon (Phansalkar & Vold—*J. Phys. Chem. 59,* 885).

An equation has been designed to characterize a detergent from data obtained in a laboratory laundering test (Stüpel—*Textil Praxis 9,* 264). This "Soil Retension Value" is defined as the ability of a system to prevent redeposition of soil and is based on relationships between whiteness of test cloths unwashed, washed in water, and washed in detergent solution. Takei *et al.* (*J. Japan Oil Chemists' Soc. 4,* 128) modified the Launder-Ometer test, developed a test soil, and recorded detergency results obtained from the soaps of myristic, lauric, palmitic, and stearic acids at temperatures of 25 and 40°. Merlo & Coletti (*Olii minerali, grassi e saponi, colori e vernici 33,* 138) recommended that all Launder-Ometer results be recorded as a relationship to results obtained from a standard detergent, and they proposed a soap containing 25% each of sodium oleate, laurate, palmitate, and stearate for use as a standard for comparison. Test on measuring reflectance in laundering tests showed that a white background gives maximum differentiation (Stephens & Brown—*ASTM Bull. No. 214,* 45.)

Fava & Eyring (*J. Phys. Chem. 60,* 890) studied the absorption of detergents from the point of view of equilibrium, and rates of adsorption and desorption. They proposed a theory of action which postulates that in addition to the usual stabilizing of dirt in the solvent by micelle formation, adsorption of detergent on the fabric surfaces weakens the bond of dirt to fabric and so speeds up the breaking point of such bonds. Durhams' (*J. Applied Chem. 6,* 153) viewed a detergent system as a lyophobic colloid system and the interaction between particulate soil and fibers in an electrolyte solution was represented by the superposition of the potential due to London-von der Waals' attraction, the Born repulsion, and double layer repulsion. The resultant potential energy curves were used to interpret the influence of electrical forces in soil removal and redeposition. A study of relation between detergency and adsorption of surfactant on wool fibers has shown that increasing temperature increases detergency with adsorption to the fiber, and beyond an optimum acidity, adsorption increases and detergency decreases unless excess detergent is is available (Goodall—*Textielwezen 9,* No. 11, 25). Another adsorption study pertained to the effect of builders on adsorption of detergents to cotton and soil (Boyd & Bernstein—*J. Am. Oil Chemists' Soc. 33,* 614). The work confirmed Meader & Fries' earlier work in respect to cotton adsorbing less detergent in presence of sodium pyrophosphate than when sodium sulfate was the builder, but conversely to Meader & Fries the present work showed that with increase of these salts and other salts, except sodium chloride, there was a decrease of adsorption of detergent. The phenomena are related to the charge on the anion of the builder. A new test for soil retention and how this may be influenced by detergent are based on the ratio of the number or fine particles, silicon carbide, on a cellophane surface to the number of particles that fall off the surface when the whole apparatus containing suspension of these is inverted (Tachibana & Tsuzuki—*J. Chem. Soc. Japan, Ind. Sect. 58,* 895).

A washing technique developed for hydrophobic fibers, such as nylon, dacron, and orlon comprises working the detergents directly into the soiled, dry fabric, then flushing away surfactant and oily soil with water (Stanley & Davis—*Soap & Chem. Specialties 32,* No. 1, 40.

Detergents of the German market were studied for washing in waters of 20 and 30° hardness (Oldenroth—*Fette-Seifen-Anstrichmittel 58,* 753). Efficiency in general was good. The presence of dodecyl alcohol in dodecyl sodium sulfate improved the washing properties of the detergent for wool (Huttenlocher—*Seifen-Öle-Fette-Wachse 81,* 757). The pure detergent was rated at 12.5, with 5% dodecyl alcohol 17.5; and with 10% dodecyl alcohol 14. A study of the C_{10}-C_{18} series of alkyl sulfates showed that maximum foam at 30° occurred at the C_{15}; and with binary mixtures of C_{10} and C_{15} maximum foam at 30° was at 1:2 mixtures, respectively, and at 60° at 3:1 mixtures (Wemelle—*Industrie chim. 42,* 173). In general, the synergism of alkyl sulfate mixtures to surface tension, detergency, and foaming occurred at the same composition of binary, ternary and quaternary mixtures. With pure lauryl ether-ethylene oxide condensates, optimum soil removal in detergency studies was with compounds of about seven ethenoxy units, and optimum whiteness retention of the test cloths washed occurred with compounds of about four ethenoxy units (Karabinos & Quin—*J. Am. Oil Chemists' Soc. 33,* 223). With such compounds containing a ratio of 2:3 oxyethylene group for each carbon atom in the hydrophobic portion of the molecule, detergency increases up to 140°F. followed by a decrease at 180°F. (Karabinos *et al.*—*Euclides, Madrid, 15,* 253). Addition of carboxymethyl, ethyl, benzyl, etc., amylopectins to soap or synthetic detergents considerably improved detergency for textile or for dishes (Vallee—*Rev. franc. corps gras 3,* 112).

A test for measuring the ability of detergent to disperse lime soap is based on treating various standard dilutions of the test sample with 10 ml. of 250 p.p.m. calcium hardness solution, filtering and titrating filtrate with standard hydrochloric acid (Becher—*J. Am. Oil Chemists' Soc. 33,* 113).

A test for evaluating shampoos comprised thoroughly washing the hair of men subjects, applying 2 ml. of a standard hair oil, shampooing with 0.25 g. samples, rinsing, and repeating the shampoo and rinse until abundant lather forms (Fredell & Read—*Soap & Chem. Specialties 32,* No. 8, 40). Results are reported in amount of shampoo required to form a stable lather.

A plastic washing device for soiled glass test samples was designed for evaluating dishwashing detergents (Leenerts *et al.*—*J. Am. Oil Chemists' Soc. 33,* 119). The synthetic soil for the test may contain egg, grease, milk, flour, etc. accord-

ing to the needs for the particular test. Phosphorus-32, strontium-89, and calcium-45 compounds have been recommended as tracers to measure hard water scum formation in dish washing tests (Martin *et al.—Proc. Minn. Acad. Sci. 20,* 28).

The spreading rate of a drop of oil on a metal surface was correlated with the requirements for cleaning the oil from the metal and was used in a study of the cleaning efficiency for metals of two detergents (Bisio—*Ind. Eng. Chem. 48,* 798).

In paraffin degreasing of wet pickled sheep skins, the efficiency of the process is improved with either nonionic or anionic detergents, but the former gave best results (Innes & Pankhurst—*J. Soc. Leather Trades' Chemists 40,* 99).

Tests have indicated that anionic, nonionic and cationic detergents do not corrode nickel (Holness and Langstaff—*J. Applied Chem. 6,* 140). There was one exception, cetylpyridinum bromide corroded the metal in distilled water. Cationic and nonionic type detergents did not protect iron from corrosion in water solution, but were effective against hydrochloric acid solutions (Mikumo *et al.—Res. Rept. Nagoya Ind. Sci Res. Inst. No. 8,* 53). Various washing agents were tested for erosiveness to washing equipments (Walter—*Fette-Seifen-Anstrichmittel 58,* 750). Copper, zinc, enamel, and aluminum were most apt to be eroded by detergents, builders or other washing chemicals. Good silicate enamels and heavy-fired zinc coatings seemed most stable. In a polemic of Uhl *versus* Nieuwenhuis on copper corrosion by optical brighteners, the latter resupported his position that the brighteners do not corrode copper or brass washing equipment (*Ibid.* 29). Use of optical brighteners in iron containing wash waters may cause staining of the wash (Viertel—*Ibid.* 748). The presence of phosphates in the detergent may inhibit this staining.

The antibacterial activity of soaps containing germicidal additives were investigated. A bacteriological plate method was devised for quickly recognizing compounds which deserve further evaluation after formulation into soap bars (Bechtold —*Drug & Cosmetic Ind. 78,* 326). The following commercial agents were evaluated by this method: Anobial, G-11, DCMX, DMDTC, Bithionol, PCP, TMTD, and Aptan. In another series of tests soaps containing Raluben P and hexachlorophene were evaluated for their effectiveness against eight different types of microörganisms (Hausam *et al.—Seifen-Öle-Fette-Wachse 81,* 675, 703). The effectiveness of soaps containing hexachlorophene was demonstrated in washing tests in which the germicidal soaps were compared with controls (Meyer—*Fette-Seifen-Anstrichmittel 58,* 239). In a series of tests with potassium laurate solutions containing various phenols, the germicidal action was related to the solubility of the phenol in the soap solution (Berry *et al.—J. Pharm. & Pharmacol. 8,* 425). Soap containing 1% tetramethylthiuram produced after one week use a reduction in the transient and resident bacteria population of the skin, and this reduction persisted for at least two days after cessation of use (Baer & Rosenthal—*J. Invest. Dermatol. 23,* 193). Physicians have been alerted to this soap, for patch tests have shown that some persons are sensitive to the germicide present in this soap (Blank—*J. Am. Med. Assoc. 160,* 1225). Detergents containing alkyl sulfate, alkylbenzenzolsulfate, and sulfonated fatty acid condensed products inhibited growth of gram positive bacteria at physiological pH ranges; whereas, in acid ranges they destroyed gram negative bacteria (Doll—*Fette-Seifen-Anstrichmittel 58,* 778). In disinfection of hands for surgery with quaternary ammonium salts a high degree of hardness of the water, whether carbonate or noncarbonate, is advantageous (Günther & Sprössig—*Z. Hyg. Infectionskrankh. 142,* 416).

Aerobic bacterial growth causing dark brown spots on soaps has been observed (Hollo—*Fette-Seifen-Anstrichmittel 58,* 739).

For quantitatively assessing the germicide efficiency of cleaning agents for equipment, the organism, Streptococci faecalis is deposited as a wet film on the surface of tinned steel, dried, cleaned, incubated in tubes of media containing test sample and the pH is measured (Hirsh & Muras—*J. Appl. Bacteriol. 18,* 425).

Detergents were studied with regard to compatibility with the skin. Götte & Herzberg (*Fette-Seifen-Anstrichmittel 58,* 31) presented a basis for understanding this problem by reviewing the defensive forces of the skin, the effect of structure of its acid coat and the mechanism of keratinization. Hofmann & Bolland (*Pharmazie 10,* 345, 515) prepared a similar review and demonstrated that at ordinary use of concentrations of synthetic detergents there was no skin irritation or change in elasticity of human hair. Their communications contained results of patch tests, and acute and chronic toxicity tests of some commercial synthetic detergents. The presence of certain detergents in mineral oil that was applied to rabbit corneal epithelium was not irritating, whereas, the detergent alone was (Weisser *et al.—Arch. Ind. Health 14,* 265). Strong alkaline cleaning agents especially when combined with strongly defatting alcohol sulfonates, lower the pH of the skin for a few hours and the alkali resistance of the skin is strongly reduced (Laube—*Dermatologica 112,* 453). In a test on 200 dermatological patients a neutral detergent toilet bar was tolerated by 85% (Swanson—*J. Am. Med. Assoc. 162,* 459). Among a series of 57 clinical cases of hand dermatitis none could be shown to be attributable to a suspected soap or detergent (Jambor & Suskind—*J. Invest. Dermatol. 24,* 379; Jambor—*Ibid.* 387). An effort in collecting all that is known concerning the toxicity of the synthetic detergents has indicated that nonionics and anionics are quite mild; but, cationic substances are more toxic (Gaultier & Fournier—*Arch. mal. profess. 16,* 110).

Nonionic surface active agents decrease the anesthetic action of cocaine on rabbit cornea, anionic detergents strongly augment the anesthetic action, and cationic detergents have a weak somewhat augmenting effect (Quevauville & Blanpin—*Compt. rend. soc. biol. 149,* 1113). Anionic detergents augment the action of procaine on frog nerve-muscle preparations, while cationic and nonionic agents have little or no effect (*Ibid.* 1248).

A cooperative study group of the American Water Works Association has classified the general problems accruing from the presence of synthetic detergents in water supplies as: foam on settling basins, taste and odor, coagulation and sedimentation, presence of iron, foaming of finished waters, and quality deterioration in distribution system (Vaugh & Falkenthal—*Ind. & Eng. Chem. 48,* 241). Coagulation with alum and active silica, chlorine dioxide, activated carbon, ferrous sulfate-lime coagulation and other treatments are recorded in regard to their helpfulness and limitations. In a study on synthetic detergents and their adjuncts it was noted that phosphates interfered with alum coagulation at concentrations of about 1 p.p.m. (Smith *et al.—J. Am. Water Works Assoc. 48,* 55). Synthetic detergents caused little difference in bacterial removal by rapid sand water filters (Stanford & Gates—*Ibid.* 45).

The situation of presence of detergents in sewage as analyzed by a committee of the Association American Soap & Glycerine Producers includes information on: present opinions, froth in sewage, degradation, phosphates and current research projects (Coughlin—*Soap & Chem. Specialties 32,* No. 2, 51; *Am. J. Pharm. 128,* 57). In an investigation with sulfonates alone and built sulfonates, concentrations greater than may be encountered, normally, in sewage treatment practice were found to exert no noticeable detrimental effect on sewage oxidation at marginal aeration rates (House & Fries—*Sewage & Ind. Waste 28,* 492). A study of the biological behavior of commercial detergents has shown a varying degree of biological attack and a half-life of about 16 days in the river water under summer conditions was indicated (Sawyer *et al.—Ind. Eng. Chem. 48,* 236). In another study: froth persistence in sewage was closely related to susceptibility of the detergent to biological degradation; biological liberation of the detergent molecules from the surfaces of sewage solids prepares the activated sludge for frothing; and the presence of branched structure alkyl group in any detergent appeared to be conducive to foaming because they resisted biological attack (Bogan & Sawyer—*Sewage & Ind. Wastes 28,* 637, 917). This resistance of certain detergents to biological attack has also been recognized in England where it has been recommended that investigations be made on producing efficient washing agents based on materials which can be readily oxidized or eliminated at a sewage works (Southgate—*Nature 178,* 118). In one study of the activated sewage process, 50 p.p.m. of branched alkyl sulfonate detergent had no effect after two weeks because the process adapted itself to the detergent and difficulty in the intermittent period could be avoided by increased aeration (Degens *et al.—Sewage & Ind. Waste 27,* 10). Manganelli (*Water & Sewage Works 103,* 427) recorded the effect of various detergents on activated sludge as influenced by type and amount of detergent, pH, solids, etc. In general, endogenous respiration of the activated sludge organisms was affected to a lesser extent than the oxidative mechanism.

In investigations on the effect of synthetic detergents on the B.O.D. test, cetyl trimethyl ammonium bromide and cetyl pyridium chloride, exhibited an iodine demand at concentrations greater than 10 p.p.m.; Santomerse, Tide, Fab, Tween 80, CTAB, and Igepal interfered with B.O.D. titration, and all anionic detergents tested increased the apparent B.O.D. value

of the sewage (Sheets & Malaney—*Sewage & Ind. Wastes 28,* 10). The same type of work on detergent builders showed that 100 p.p.m. of Versene and sodium carboxymethylcellulose increase five-day B.O.D. by 35 and 70%, respectively; salt, bicarbonate, sodium tripolyphosphate were inactive; and other phosphates, carbonate, and silicates diminish B.O.D. in sewage (Malaney & Sheets—*Ohio State Univ. News in Eng. 28,* 30).

Addition of nonionic synthetic detergent to wool scouring waste and flocculation with aluminum compounds permit disposal of the waste without pollution of the stream (Crowely —*U. S. 2,762,681*).

The interaction of proteins with surface-active agents was studied mainly to elaborate certain structures in protein. With gelatin sodium dodecyl sulfate is bound in acid solution, whereas dodecylamine binds at pH values greater than the isoelectric point (Tamaki & Tamamushi—*Bull. Chem. Soc. Japan 28,* 555). The maximum values of detergent binding at each pH were said to correspond to the acid- and base-combining power of the gelatin at that pH. Reaction products of egg albumin and sodium dodecyl sulfate at above the isoelectric point where no precipitate is formed give rise, depending on concentration, of electrophoretic patterns which may be divided into three groups (Aoki—*Bull. Chem. Soc. Japan 29,* 369). The changes occurring with changes in pH are interpreted to indicate that the detergent reacts as a single ion and not only as a micellar former. Electrophoretic studies show that sodium dodecyl sulfate combines with α-keratose in amounts far in excess of that required for stoichiometric binding of the positive groups on the protein (O'Donnell & Woods—*Proc. Int. Wool Text. Res. Conf. Australia B, 1955,* 71). An amount equivalent to the number of positive sites is more firmly bound than the remainder. The observation that sodium dodecyl sulfate bound to legumin was removed by dialysis was interpreted to indicate that detergent ion pairs rather than paraffin chain ion alone were largely bound (Brand & Johnson—*Trans. Faraday Soc. 52,* 438). A small amount was considered adsorbed without major change. Ovalbumin, bovine serum albumin, and serum globulin are precipitated by lower concentration of cationic detergent when treated with carbon monoxide or hydrogen cyanide (Stary & Tekman—*Bull. fac. med. Istanbul 19,* 39).

The hemolysis by hexadecyl shows a definite phase of latency; the activity of the solutions decrease on standing; short boiling and quick cooling double the activity of fresh solutions and increase that of old ones; and the activity is independent of concentration beyond certain critical concentrations (Jung *et al.—Naunyn-Schmiedebergs Arch. exptl. Pathol. Pharmakol. 229, 281,* 293).

It was impossible to detect the presence of alkoloids when nonionic detergents were present, except with the reagent silicotungstic acid, because other agents and alkaloid are precipitated together (Gallo & Casadio—*Bull. Galenica 16,* 98).

The minimum percentage of soap required in water for complete wetting, in insecticide uses, has been worked out for different kinds of leaves (Srivastava & Srivastava—*J. Econ. Entomol. 49,* 266). In general soap in excess of 0.5% is superfluous for use as a spreader. The influence of natural fleece on the interfacial activity of surface active agents has been determined as basic knowledge for application of insecticide emulsions to sheep fleece (Addison & Furmidge—*J. Sci. Food Agr. 7,* 552, 556).

In tests on influence of 10 detergents on ascarid development: Duponol 80 and Nacconol NR were most effective; more eggs were destroyed by detergents at 38 than at 31°; and the eggs of various species differ in their resistance to the detergent (Jaskoski—*Am. Midland Naturalist 52,* 142).

The surface areas of carbon blacks were determined by soap adsorption (Maron—*J. Colloid Sci. 11,* 21).

The chief requirements for the use of detergents to produce foam in the manufacture of light concrete has been recorded (Pfanner—*Silikattech. 6,* 396).

In a discussion on removal of scale from automotive cooling systems, it was suggested that surface active agents appear to be the best prospects for development of compounds for inhibiting or the removal of the scale (Singer—*Soap & Chem. Specialties 32,* No. 9, 43).

Nonionic detergents decompose rapidly in soil; cationics decompose after an initial lag period; while anionics resist decomposition (Ivarson & Pramer—*Soil Sci. Soc. Am. Proc. 20,* 371). The cationics reduce the total number of microörganisms in soil and inhibit nitrification and anionics are more determinal.

Feeding detergents may have value in cockerel raising (McDonald—*Agr. N. S. Wales 67,* 39, 375). The detergent sodium tetrapropylenebenzene sulfonate stimulated growth of chickens up to 12 weeks of age, particularly when procaine penicillin was also used to improve growth.

Some Problems Involved in the Water Wash of Neutralized Vegetable Oils

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CONVENTIONAL ALKALI-REFINING of vegetable oils involves the neutralizing of the free fatty acids by caustic soda and separating of the soapstock from the neutral oil. Whether this separation is carried out by gravity settling or by centrifugal separation, the neutral oil still contains a certain amount of soap. According to Boekenoogen (3), a dry neutralized peanut oil dissolves 0.10% of sodium or potassium soap at 75°C. and 0.025% at 20°C. Although this solubility is rather low, small amounts of water or fatty acids in the neutralized oil may increase the solubility of the soap to a considerable degree. The soap also may be colloidally dissolved in the oil. Thus Newby (15) found 0.03–0.7% of soap in continuously neutralized soybean and cottonseed oils.

A high soap content of the neutralized oil may impair the refining operations to follow. Especially when activated earth is used for bleaching, it has been found (16) that the FFA rises when the soap content is high and that the amount of earth necessary to obtain a desired color is increased. Soap is also a catalyst poison for the hardening process. Furthermore soap may interfere with deodorization of the oil or lead to an increase in the FFA, especially with oils containing fatty acids of high molecular weight such as rapeseed oil.

Although the soap content of neutralized oils may be reduced by prolonging the settling time or by drying and filtering the oil, these operations are time-consuming and difficult to carry out as the filter cloths are easily clogged by the soap. It is therefore customary to remove the soap by washing the oil with water, usually at 70–90°C. Because the sodium soaps are easily soluble in water, the partition coefficient is favorable for an extensive reduction of the soap content of the oil. Despite this fact the refiner knows that the washing of neutralized vegetable oils often is a tedious procedure; several successive washings may be necessary to obtain complete removal of the soap (1, 11). Some producers (5, 6) of continuous centrifugal refining plants recommend a double water-wash to reduce sufficiently the soap content of the neutral oil.