ing the impregnation of wood[60], and for insecticides, where the copper compounds of lecithin also may be used [61]. Another patent applies lecithin emulsion with solid poisons, such as sodium arsenate or Paris Green to increase the dispersion of the active substances and improve their adhesion to plants[62]. As the essential ingredient of a contact insecticide harmless to man and mammals lecithin serves in connection with a dispersing agent such as butanol or sulphonated oils[63].

In electroplating .01% lecithin as a protective colloid is claimed to give finer, denser, more uniform coatings[64].

In pointing out the more or less successful, and wide application of soybean phosphatides, this survey also shows the need for further research, primarily towards gaining a clearer conception of the actual composition of the acetone-insoluble material of the "lecithin" and of its effects, investigations of which have so far been undertaken in but a few fields.

(The large majority of patents has been secured by Hanseatische Muehlenwerke A.-G., abbreviated in the following survey, where the inventor's name is not given, H-M.)

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The Relation of Lipids to Physiological Activity

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ABOUT a century ago studies on the physiological rôle of the lipids of the brain were conducted by investigators interested in the relationship between chemical composition and mental activity. The complexity of the brain lipids and the difficulty of their separation retarded further physiological study at that time, but did stimulate chemical investigation which resulted eventually in an elucidation of the various lipids and their classification. This early conception of the lipids as essential constituents of protoplasm was revived recently by the French school of workers, Mayer, Schaeffer and Terroine. As a result of their work certain lipids have been found to play an essential rôle in the vital economy of living cells. The early studies have been interestingly summarized by Bloor et al. (1)

Two methods of attack have been followed in the development of this concept. The French workers have shown that phospholipids and cholesterol are present in constant amounts in living tissue irrespective of the state of nutrition. They designate the phospholipid and cholesterol as the *élément constant,* considering these lipids to be constant and integral components of protoplasm essential to the vital functions of the living cell. Bloor (2), in this country, has conducted extensive studies which further substantiate their thesis. He has shown that the constituent which was most constant for each kind of organ was the total phospholipid. Analyses on the organs of the beef are in agreement with those of the French authors on the phospholipid and cholesterol content of the organs of different small animals. "The brain, which has the greatest variety and extent of function — that of controlling all the activities of the organism—has the highest content of phospholipid and cholesterol. The liver, which is next in importance in the successful functioning of the organism, comes next to the brain in its content of phospholipids, then the pancreas with two important secretory functions, then the kidney and lung, each with one important function. In the case of the various muscles of beef it was found that the phospholipid content ran parallel with the probable activity of the muscle—those muscles which were more continuously and strongly active having a higher phospholipid (and unsaponifiable) content than those which were less active." In general, changes in cholesterol do accompany alterations in phospholipids, but are definitely less extensive.

A second method of attack developed by Bloor and extended by

Boyd consists of following the changes in the various lipid constituents of a tissue over a period of time during which its physiological activity rises and falls.

The term "physiological activities" as used by Bloor and coworkers is meant to include all the processes of the living cell. "Of these, oxidation is the basic one, upon which the others depend to the extent at least of their energy requirement, and as noted above, oxidation is the function most emphasized in discussions of the mitochondria and the phospholipids. But it should be borne in mind that it is only one form of activity and perhaps not the most important except in muscle where energy transformations are quantitatively the most significant. Yet the muscles (except the heart) have the lowest phospholipid and cholesterol content of all the tissues. In other tissues, such as the brain, liver and kidney, having a much higher lipid content, energy transformations are relatively less important and other activities than oxidation must obviously bear greater significance in the consideration of the total physiological activity of most cells." (1)

Bloor and Snider (3), who report an extensive study on the lipid content of muscle tissues of various animals, relate the activity of the various muscles to the amount of phospholipid and cholesterol present. In a comparison of the lipid content of the muscles of the wild rabbit with that of the laboratory rabbit, it was found that the heart had the highest phospholipid of all the muscles and was the same in both animals. The diaphragm and neck, which are alike in content, follow next in order. The other muscles, leg, back and belly, which are concerned in locomotion, have a much higher phospholipid content in the wild rabbit — sometimes twice as high. "The muscles of the heart, jaw, neck and diaphragm tend to form a group by themselves, with the highest phospholipid content, and are comparable in composition in the wild and laboratory animals. The remaining muscles, especially those having to do with locomotion, are different in lipid content in the two varieties. In the wild animal they are quite similar in composition among themselves and approach the values of the heart group, as though, given the same amount of use, muscles tend to have an optimum phospholipid and cholesterol content. In the laboratory animal the essential lipid (phospholipid and cholesterol) values of the muscles of locomotion are much lower than in the respiration-circulation group and lower than in the corresponding muscles of the wild animal."

Bloor and Snider studied the breast muscles of the pigeon, which flies with an exclusively rapid flapping motion; the owl, which is slow flapping and soars; and the rooster, which is a non-flier. In terms of dry weight, the pigeon muscle contained 4.7 per cent phospholipid fatty acid; that of the owl, 3.7 per cent; and the rooster, 1.4 per cent. The correlation between the phospholipid content of the main flying muscle and the flying power is clearly demonstrated. In a final comparison, these authors show that the normal response (hypertrophy) of a muscle to increased activity is not only an increase in quantity of the muscle but an improvement in quality. Calculated on the body weight basis, the milligrams of phospholipid fatty acid per kilo of body weight in various muscles of the wild rabbit and the laboratory rabbit are as follows:

	Wild	Laboratory
Heart	52	14
Diaphragm	17	10
Back	55	12
Thigh	87	22
Abdominal	22	9

It is very evident that the muscles of the trained wild animal are immensely better supplied with phospholipid than are the muscles of the untrained laboratory animal.

Bloor et al. (1) have made an examination of the lipid content of the corpus luteum of the sow, which tissue passes through a well defined cycle of changes from inactivity through a period of activity to inactivity again. It was found that the phospholipid content and the free cholesterol, to a less extent, of the corpus luteum varied with the activity of the gland. The phospholipid content was two to three times as high during the period of activity, previous to estrus and during pregnancy, as at the time of formation or after retrogression. Cholesterol esters and neutral fat were found to vary inversely with the activity of the gland, a high content being characteristic of the degenerated organ. This work, in addition to reemphasizing the relation of a high content of phospholipid and free cholesterol to a high state of physiological activity in a tissue, indicated the relationship of the cholesterol esters and neutral fat to tissue retrogression and inactivity. These same investigators also studied the variations in the lipids of the uterine mucosa of the pig and came to similar conclusions regarding this tissue.

Recently Boyd, who has made an intensive study of this problem, has contributed much to the support of Bloor's hypothesis. In numerous studies on the lipid composition of the blood leucocytes he has related their changing lipid composition during pregnancy, lactation, and puerperium in women to variations in their activity (4). In post-operative activity (5) he found that the lipid content of the white blood cells varied according to whether recovery from operation was normal or complicated. In those patients who returned to normal health in the usual time, there was a striking rise in the phospholipid and free cholesterol content of the leucocytes (in certain cases an increase of over 200 per cent). Corresponding values for neutral fat and cholesterol ester were usually low. On the other hand, when the patient did not respond normally to operation and had marked post-operative complications, the changes in the leucocytes were the exact opposite of this; phospholipid and free cholesterol fell to a third or a half their value before operation and neutral fat and cholesterol ester tended to increase in amount. In a further study (6) of the lecuocytes in fever and infection, Boyd found that in patients who recovered normally from fever due to a variety of causes, the phospholipid and free cholesterol content of the white blood cells was high, whereas the content of neutral fat and cholesterol ester was low. Convalescence was accompanied by a further rise in phospholipid. In patients who died as a result of infection, low phospholipid values were noted in the blood leucocytes during the febrile period.

A comparison (7) of lipid composition and ovarian activity in pregnant and pseudopregnant rabbits further substantiated the correlation between high phospholipid and free cholesterol values with increased vital activity. Corresponding values for neutral fat and cholesterol ester were low. This relationship was just the opposite when the gland was dormant. A similar study (8) on gravid guinea pigs showed that the ovaries of pregnant guinea pigs, unlike those of pregnant rabbits, undergo no increase in physiological activity. This observation is correlated with the fact that guinea pigs may be castrated in the latter half or two-thirds of pregnancy without abortion ensuing. Inasmuch as the results on active tissues seemed quite conclusive, Boyd has made a further test of Bloor's hypothesis on one of the least active of the body tissues. Determination (9) of the lipid content of the jelly of Wharton from the umbilical cord showed the actual percentages of all lipids, particularly phospholipid and free cholesterol, to be much lower than that of any other tissue of the body. The fact that there was a uniform absence of cholesterol esters led to the conclusion that the presence of large amounts of this lipid in a tissue was indicative of degeneration rather than inactivity.

According to a recent report, Ludewig and Chanutin (10) found no increase in the percentage concentration of the lipid phosphorus in the hypertrophied heart and kidney of rats. These workers claim their data do not support Bloor's hypothesis regarding the relationship between phospholipids and physiological activity. However, they did observe that the lipid phosphorus content per unit of surface area parallels the degree of hypertrophy in the heart and kidney. It may be more difficult to explain the results on heart tissue, but as Bloor specifically stated, the term physiological activity includes all cellular activity and not merely energy-producing activity. The results on the kidney would, therefore, seem to favor the hypothesis, inasmuch as increased work on the kidney increased the number of cells and proportionally the lipid phosphorus content. Since the heart responded in a manner similar to the tissue of organs rather than as muscle tissue, it would appear that the metabolic activities are as different in heart and skeletal muscle as these types of muscle differ structurally and that their responses to increased demands of work are dissimilar. There is one other point evident in this work which may not appear to be significant, but which we think is worth mentioning, especially since all lipid phosphorus values do not agree with directly determined phospholipid values. The work of Bloor and Boyd is based on the direct determination of the phospholipid fatty acids, whereas the work of Ludewig and Chanutin is based on the phospholipid calculated from lipid phosphorus, or, rather, inferred from the lipid phosphorus values.

The preponderance of evidence favors the viewpoint that as histological appearance of a tissue varies with its state of physiological activity, in like manner the lipid composition of tissue varies. When a tissue becomes active for any period of time, its phospholipid content increases and usually also its free cholesterol. Degeneration, retrogression or inactivity is found to be associated with decreasing or low values of these two lipids and in addition usually increasing or high values for cholesterol esters and neutral fat, both of which latter lipids are at low levels in active tissues.

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Variations of Certain Chemical and Physical Properties of Butter Fat as Revealed by Melting Time

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ALTHOUGH the physical and chemical properties of butter fat have been studied by many investigators, the relationships which exist between the properties themselves have received little attention. The iodine number, Reichert-Meissl number, saponification number, hardness index, and melting point are the most important constants usually determined in studying the characteristics of butter fat.

The efforts which have been made to correlate the various constants have not produced uniformly successful results. Hunziker, Mills, and Spitzer (5), while studying the influence of ration on the composition of butter fat, found no regular relationship existing between hardness index and melting point or between iodine number and melting point. Two groups of investigators, however, did find correlation between certain of the properties. Haglund, Wode, and Olsson (4), found that the hardness of butter is inversely proportional to the iodine number of butter fat, while Coulter and Hill (2), determining the hardness index of butter fat rather than that of butter, pointed out a somewhat similar curvilinear relationship existing between the hardness index of butter fat and the iodine number of butter fat.

The constants which have been studied in this laboratory are: melting time, melting point, hardness index, and iodine number. The melting time determination measures the time required for a 25 cc. sample of butter fat, initially at 0° C., to melt completely when placed in a constant-temperature bath held at 45° C., the procedure was devised by Gallup for the purpose of studying the "standing up" qualities of butter fat, but also has proved of value in showing the relationship between all four of the constants studied.

Procedure For the Determination of Melting Time

25 cc. samples of butter fat in 50 cc. lipped tubes* are brought to 65° C. and held at this temperature for 10 minutes in order to expel air. The tubes are then immediately immersed in ice water at a level 1/8 inch below the level of the samples and held upright as the bath is agitated. When the fat is cooled in this way it usually solidifies without occlusion of air and without forming a small crater in the center. The tubes are packed in ice and kept at 0° C. for at least six hours before the contents are tested. At the time of testing the tubes are