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The relation between the chylomicrons (free granules) and the lipoid content of the blood.

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When blood is examined under a dark field microscope numerous small brilliant dancing particles are visible which are invisible under the bright field microscope. These particles have been called by various investigators elementary particles or granules, free granules, blood dust, fat dust, hemaconia, and ultra or micro particles. Recently, Gage[1] and Gage and Fish[2, 3] have made an extended study of these ultra particles or free granules and they have shown conclusively that the appearance of numerous free granules in the blood is dependent upon the fatty portion of the diet. Carbohydrate or protein diets in man cause no increase in the number of these particles in the blood but if fat is mixed with the diet or taken alone there is a marked increase under normal conditions. Since these granules appear in the blood after ingestion of fat Gage and Fish[2] believe that they must get into the blood by means of the chyle vessels and the thoracic duct and suggest the term chylomicrons (microscopic bodies from chyle) to designate these particles.

Gage and Fish[2] have devised a method by which these chylomicrons can be counted and estimations made as to their amount present in the blood. Although complete accuracy cannot be claimed in counting these particles, the counts are fairly accurate and the blood under various conditions can be conveniently studied. Since these chylomicrons have been shown to be dependent upon the fat absorbed from the diet and are therefore probably visible fat particles it was thought that the determination of the chylomicrons by the method of Gage and Fish[2] would give an index of the total amount of fat present. As the method is simple and requires only a small

1 Gage, S. H., *Anat. Rec.*, 1920, xviii, 235.
2 Gage, S. H., and Fish, P. A., *Jour. Am. Vet. Med. Assn.*, 1921, lviii, 384.
3 Gage, S. H., and Fish, P. A., *Cornell Veterinarian*, 1921, xi, 143.

amount of blood it is obvious that it might be of distinct advantage in clinical work.

With this point in view several experiments were carried out determining the number of chylomicrons in the blood by the Gage and Fish method[2] and the total cholesterol and total fatty acids by the method of Bloor, Pelkan and Allen.[1]

The experiments were as follows:

Experiment 1—Dog 14 was a healthy female mongrel weighing 7.75 kg. A specimen of blood was taken and the dog then fed by mouth 70 c.c. of olive oil. Specimens of blood were then taken two hours after feeding and every two hours thereafter up to eight hours.

Experiment 2—Dog 15 was a healthy male weighing 17 kg. A specimen of blood was taken and then the dog was fed by mouth 70 c.c. of olive oil. Specimens of blood were taken as in Experiment 1.

Experiment 3—Dog 14 as above was given 25 c.c. of glycerol mixed with about 100 c.c. of water and specimens of blood taken before feeding and every two hours thereafter.

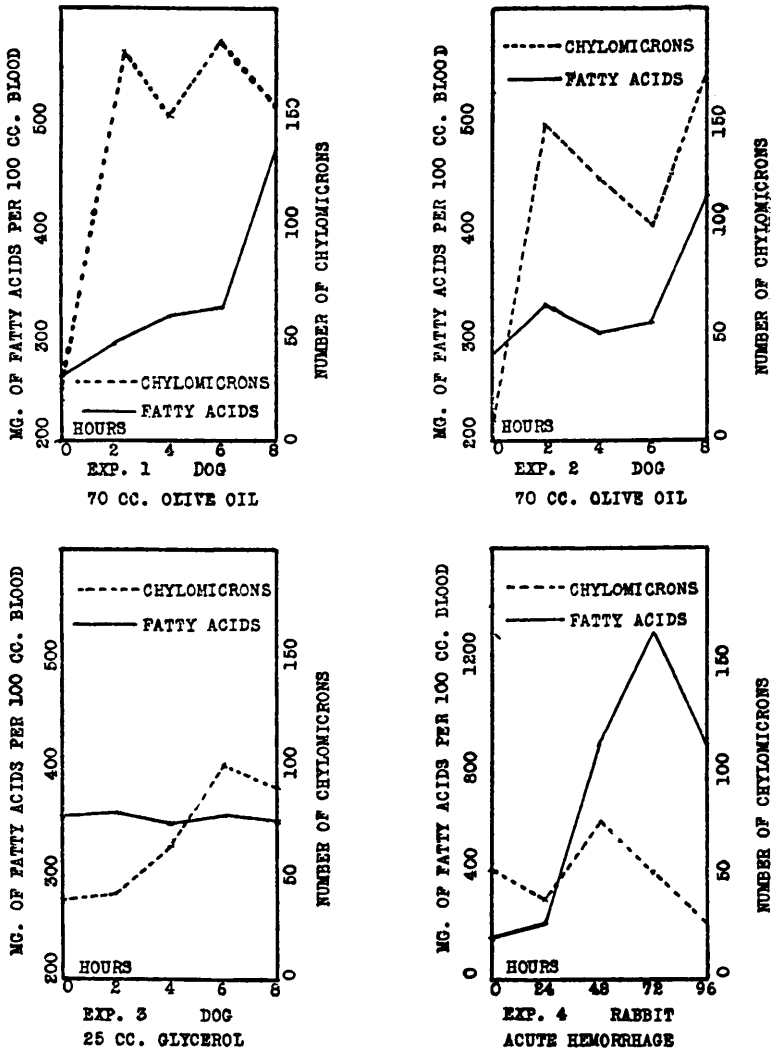
TABLE I.

Number of Experiment.	Time.	Whole Blood.		
		Total Cholesterol.	Total Fatty Acids.	Number of Chylomicrons.
1		mg. per 100 c.c.	mg. per 100 c.c.	
	Before	180	261	19
	2 hrs.	178	290	180
	4 hrs.	172	314	150
	6 hrs.	173	322	186
	8 hrs.	173	471	156
2	Before	171	281	8
	2 hrs.	172	323	145
	4 hrs.	180	299	121
	6 hrs.	184	307	99
	8 hrs.	180	423	170
3	Before	191	352	37
	2 hrs.	194	355	40
	4 hrs.	196	345	62
	6 hrs.	191	353	100
	8 hrs.	182	348	89
4	Before	68	156	51
	24 hrs.	66	209	37
	48 hrs.	122	870	73
	72 hrs.	198	1278	49
	96 hrs.	141	878	25

[1] Bloor, W. R., Pelkan, K. F., and Allen, D. M., *J. Biol. Chem.*, 1922, lii, 191.

Experiment 4—Rabbit 20 was a male weighing 1.60 kg. Lipemia was produced in this rabbit by extensive bleeding. First day 35 c.c. of blood was withdrawn, second day 25 c.c., third day 30 c.c., and fourth day 20 c.c. The diet was carrots and cabbage and remained the same throughout the experiment. Blood was taken each morning before feeding.

The analytical results are given in Table I and the curves below show the relation between the chylomicrons and total fatty acids more graphically.



The table and curves show that there is no constant relation between the number of chylomicrons and the total fatty acids. In experiments 1 and 2 the chylomicrons reach their maximum in about two hours while the total fatty acids do not reach a maximum until eight hours. Usually the height of the curve for total fatty acids occurs in from 4 to 6 hours after a fat meal but in these two dogs there must have been delayed absorption.

In experiment 3 there is an increase of the chylomicrons after feeding glycerin but no appreciable change in the total fatty acids. This increase in chylomicrons is similar to experiments reported by Gage and Fish[2] who were inclined to the view that a sufficient amount of fatty acids can be furnished by the tissues to build up fat from glycerin that has been ingested. Other investigators have shown that if fatty acids alone are administered the tissues are able to furnish sufficient glycerin to form fat, and, if the chylomicrons are taken as an index of the amount of fat in the blood it would indicate that the reverse is possible. However, the total fatty acids remain constant throughout this experiment and the increase in chylomicrons is difficult to explain except on the basis that possibly some of the soluble fat in the blood is changed to a visible insoluble fat.

In experiment 4 the total fatty acids are increased out of all proportion to the increase in chylomicrons. As observed by Horiuchi[1] and Bloor[2] the lipemia produced in rabbits by acute hemorrhage shows a marked increase in cholesterol as well as total fatty acids. The hemorrhagic lipemia has been shown by Horiuchi[5] to be produced on a fat free diet and therefore the increased fat may then originate mainly, if not entirely, in the fat stores. If the chylomicrons are fat, then the fact that there is no great increase of these in this type of lipemia corresponding to the great increase of fatty acids would indicate that a large part of the fat is present in the blood in a form not visible under the dark field microscope.

CONCLUSIONS

These experiments indicate that there is no constant relation between the total fatty acids and the chylomicrons in the blood after feeding of fat and glycerin, and in the lipemia of rabbits

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1 Horiuchi, Y., *J. Biol. Chem.*, 1920, xliv, 363.

2 Bloor, W. R., *J. Biol. Chem.*, 1921, xlix, 201.

produced by acute hemorrhage. The determination of the chylomicrons, therefore, cannot be taken as an index of the total fat in the blood.

That the chylomicrons are associated with the fats in the blood is confirmed.

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A hitherto undescribed pair of isoagglutination elements in human beings.

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Landsteiner, in 1901, discovered three human blood groups, and soon afterward, Decastello and Sturli, pursuing the study with Landsteiner's knowledge and encouragement, found the fourth group. Landsteiner recognized the existence in human serum of two isohemagglutinins, which were designated with small letters a and b, or (by von Dungern and Hirschfeld) α and β and two isoagglutinable substances in the corpuscles which were called A and B.

Quite recently Guthrie and Huck have reported the discovery of a third pair of isoagglutination elements, which, to bring the terminology into conformity with the previously existing one, we will refer to as isoagglutinin c and agglutinable substance C.

The relation of the exceptional individuals observed by Guthrie and Huck to the original four blood groups is shown in Table I.

TABLE I.

Groups	I	II	III	IV
Serum	a. b.	b	a	.....
Corpuscles	.....	A	B	A. B.
Guthrie and Huck.....		b A. C.	c B	