

Lot 4 received ergosterol on April 4 and FeI_2 on April 16, exhibiting remarkable weight increase from the iodide of iron, and rising from an average of 62 gm. on April 16 to the high point of 85 gm. on May 2, but rapidly dying off. Apparently irradiation of the animals in lots 1 and 3 had a beneficial effect in aiding in the catalysis initiated by the iron-iodin. It is well known that the catalytic effect of ferrous iron is produced when it is oxidized to a ferric salt. Ferrous salts are not readily oxidized by iodine, but the digestive chlorine readily furnishes the oxidizer.

Lot 5 were controls receiving Sherman No. 380 and distilled water, and all of them died in April. In another paper, we shall show the probable effect had they also received ergosterol.

Lot 6 were controls receiving the deficiency diet until April 17 when they were also given 1 drop of Patch's Cod Liver Oil daily. The Cod Liver Oil group were completely protected against symptoms of Vitamin A deficiency, and grew steadily. It was not until June 6, however, that they began to show slight superiority (7 gm. average) to the animals in Lot 1, receiving ergosterol and ferrous iodide, with supplemental irradiation.

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The Nature and Importance of Surface Films on Chylomicrons.

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(Introduced by Stuart Mudd.)

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It is generally recognized that blood transports free fat as an emulsion of minute droplets.^{1, 2} Gage and Fish¹ in their classical study of the digestion, absorption and assimilation of fat, call these droplets chylomicrons, because they enter the blood with the chyle, the milky fluid containing absorbed food from the intestine which pours directly into the blood stream.

Blood serum containing chylomicrons forms an oil-in-water emulsion system³ which may be called the chylomicron emulsion. Oil-in-

¹ Gage, S. H., and Fish, P. A., *Am. J. Anat.*, 1924, **34**, 1.

² Bloor, W. R., *Physiol. Rev.*, 1922, **2**, 92.

³ Ludlum, S. DeW., Taft, A. E., and Nugent, R. L., *Colloid Symposium Annual*, 1929, **7**, 233.

water emulsions which may be as concentrated as the chylomicron emulsion always involve a third substance, the protective or emulsifying agent which is adsorbed in the oil-water interface. Protective films are thus formed around the disperse oil drops which prevent their coalescence, thus stabilizing the emulsion.⁴ The authors are the first to study the protective films on the chylomicrons and to point out their importance in the transport of fat by the blood and their presumptive importance in its assimilation from the blood and its storage and final utilization.

The experiments have all been done with chylomicrons in human serum, but the extension of the results to human plasma and to the serum and plasma of animals should be a relatively simple matter.

Consideration of the known facts with regard to protective film formation and the composition of human serum indicates that the chylomicrons should be surrounded by protein films, very possibly consisting of serum albumin, serum globulin, or both. If they are surrounded by protein films their surface properties should be those of protein. Thus their isoelectric point should fall within the range characteristic of proteins,⁵ very possibly within the range of pH 4.7—pH 5.4 characteristic of the ordinary serum proteins.

The pH of the isoelectric point of the chylomicrons in human serum has been determined both by maximum flocculation and cataphoretic methods. Both lead to values between pH 4.7 and pH 5.4, definitely within the range of the isoelectric points of the serum proteins. Six of 7 cataphoresis determinations gave values between pH 4.8 and pH 5.0. These results afford the best experimental evidence that can be brought to prove the correctness of the hypothesis that the chylomicrons are actually surrounded by protein films. If the chylomicrons possessed lipid surfaces their isoelectric point would be much lower. With lecithin surfaces, for example, it would lie between pH 2 and pH 3.

The position of the isoelectric point between the isoelectric points of serum albumin and serum globulin, points to the interesting possibility that the protein films on chylomicrons consist of a mixture of the two.

The behavior of the chylomicrons when protein precipitants are added to sera containing them, and the behavior of isoelectric aggregates of chylomicrons when examined by means of the Mudd Inter-

⁴ Bancroft, W. D., "Applied Colloid Chemistry," McGraw-Hill Book Co., New York, 1926, 351.

⁵ Abramson, H. A., Colloid Symposium Monograph, 1928, **6**, 128; *J. Gen. Physiol.*, 1929, **13**, 169.

face Technique,⁶ have also been shown to be in accord with the theory that the chylomicrons are surrounded by protein films and thus confirm the conclusion from the isoelectric point determinations.

These protein films around the chylomicrons determine the stability of the chylomicron emulsion and thus the very act of the transport of free fat by the blood.

If, as seems probable, cells take up chylomicrons as such in the assimilation of fat from the blood,² the surface properties are presumably of the greatest importance. It has been shown⁷ that particles with lipid surfaces (acid-fast bacteria) are not readily taken up by cells (phagocytized), whereas those with serum-protein surfaces (acid-fast bacteria treated with the proper serum) are readily taken up. The protein films on chylomicrons give them a protein surface which may well be the all-important factor in determining their direct assimilation from the blood by cells.

After assimilation chylomicron fat may be stored in the form of larger fat drops² or may be acted upon chemically in its final utilization by the body. Both must involve the destruction of the protein films, which must therefore be considered in the study of these problems. This destruction could readily be brought about by proteolytic enzymes.

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Hexylresorcinol in the Treatment of Hookworm Disease.*

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Hexylresorcinol was recently found by us to be an effective ascaricide, killing *Ascaris suum* quickly *in vitro*, removing in single therapeutic doses practically 100% of the ascarids from dogs and 90% or more from man.^{1, 2, 3} Leonard has found this substance

⁶ Mudd, S., and Mudd, E. B. H., *J. Exp. Med.*, 1924, **40**, 633, 647; Seifriz, W., in Alexander, J., "Colloid Chemistry," The Chemical Catalog Co., Inc., New York, 1928, **2**, 437.

⁷ Mudd, S., Lucké, B., McCutcheon, M., and Strumia, M., Colloid Symposium Monograph, 1928, **6**, 131; *J. Exp. Med.*, 1930, **52**, 313; Strumia, M., Mudd, S., Mudd, E. B. H., Lucké, B., and McCutcheon, M., *J. Exp. Med.*, 1930, **52**, 299.

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