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Effect of Stimulation on Phagocytic Activity of Vascular Endothelium.

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Opinion differs in regard to the ability of vascular endothelium to ingest particulate matter by phagocytosis. Maximow[1] regarded the phagocytic sinusoidal lining of such organs as the liver and spleen as a distinctive cell type consisting of flattened histiocytes quite different from the usual endothelium. Foot[2] now even suggests that the Kupffer cells of the liver may be monocytes anchored there. Gardner and Smith[3] failed to demonstrate any phagocytic activity of pulmonary endothelium. Seemann[4] also investigating the lung endothelium doubts its ability to phagocytose carbon. Lang[5] found carbon in the endothelium of granulation tissue but in quantity "incomparably smaller" than in the spleen and liver. India ink, as this investigator points out, becomes a rather coarse carbon suspension within the circulation. Although he speaks of the carbon being engulfed by the endothelium he does not regard the entrance of the coarse carbon particles into the endothelial cells as a phagocytic process. Finally he found that the endothelium transfers its carbon to extravascular pericytes (histiocytes) which are not of endothelial origin.

To test the phagocytic property of common endothelium, granulation tissue was produced by injecting into the groins and axillas of rabbits an alcohol-acetone mixture saturated with Sudan III. During the following week the animals were given intraperitoneally

[1] Maximow, A., *Arch. Path. and Lab. Med.*, 1927, iv, 557.

[2] Foot, N. C., *Am. J. Path.*, 1927, iii, 413.

[3] Gardner, L. U., and Smith, D. T., *Am. J. Path.*, 1927, iii, 445.

[4] Seemann, G., *Beitr. z. path. Anat. w. z. all g. pathol.*, 1925, lxxiv, 345.

[5] Lang, F. J., *Arch. Path. and Lab. Med.*, 1926, i, 41.

three 5 cc. doses of 2% trypan blue. A few days after the last trypan blue injection 2 cc. of India ink (Higgins) was injected into the ear vein and again after one hour an additional 2 cc. were given. The half-grown rabbits used for the experiments were lightly etherized and the needle kept in the ear vein for at least 10 minutes during the slow ink injection. The results obtained were based on the microscopic examination of tissues from rabbits living for 3 hours after the second ink injection at which time they were killed and the inflamed Sudan III tissue removed and fixed in both formalin and Zenker's fluid. The trypan blue granules are removed by the latter.

Results. The author[6] has tested the phagocytic activity of the endothelium of granulation tissue of animals that did not receive trypan blue and found that it may remove suspended carbon from the blood stream, but under the conditions of the experiments the number of carbon-marked endothelial cells was not very great. I found, as did Lang,[5] that the amount of carbon in the capillaries of the extremities is "incomparably small" in comparison with the spleen, liver and bone-marrow. After vital staining with trypan blue, the phagocytic activity of the capillary endothelium of granulation tissue is much increased and frequently as many carbon particles appear in the cytoplasm of these cells as are present in the sinusoidal endothelium of spleen and liver. The amount of free carbon within the capillary lumina, however, is always greater in these 2 organs than in the granulation tissue. The carbon is located in all possible positions as regards nucleus and is frequently placed at the ends and external to the nucleus. In the endothelia stimulated by the trypan blue one finds the coarse carbon stuck to the surface of the large endothelial cells, partially engulfed by them and finally completely incorporated within the cells. These stimulated cells ingesting the carbon often have an abundant cytoplasm and are equal in size to Kupffer cells and to the free phagocytes of the granulation tissue itself. So far as may be determined by examination of fixed tissue this entrance of microscopic particles into the cytoplasm of the endothelium is a true phagocytosis. The amount of carbon is greatest where the endothelial cells are largest and is scant in amount in places where these cells are thin.

[6] McJunkin, F. A., *Am. J. Path.*, 1928, iv, 587.