2 (2525)

Observations on bacteria in films, and the surface tension factor in phagocytosis.

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The behavior of small solid bodies in contact with two immiscible liquids has been much discussed, especially in connection with phagocytosis. Direct observation of interfacial phenomena is possible with bacteria or other particles in films viewed in the darkfield microscope. A small drop of each phase, one of them containing the suspended bacteria, is placed on a clean slide. A cover slip is laid on top. The boundary between the two liquids appears as a brilliant band and the bacteria as shining motes. Bacteria in two phase films of water with a variety of organic liquids have been studied.

Ordinary Gram-positive or Gram-negative bacteria have been trapped in the liquid-liquid interface of all preparations examined. The trapping mechanism is much stronger in preparations with high (*e. g.*, hydrocarbon-water) than with low (*e. g.*, alcohol-water) liquid-liquid interfacial tension. Bacteria in the interface exhibit characteristic gliding movements along the interface, moving in the boundary line from regions of low to regions of higher liquid-liquid interfacial tension. Escape from the interface is possible in a variety of ways, *e. g.*, by sticking to the glass slide or cover slip, by Brownian movement, strong action of the flagella, jolting by other bacterial clumps, or even by centrifugal force while streaming rapidly around a curve in the interface. The efficiency of the interfacial trapping mechanism may be decreased by adding substances, *e. g.*, Na-oleate, lowering the liquid-liquid tension.

Acid-fast bacteria behave entirely differently. They exhibit little or no stability in the interface and pass readily or even spontaneously into the organic phase.

To account for these phenomena it is necessary to consider three interfacial tensions, Tow the liquid-liquid tension, Tso the solid-organic phase tension, and Tsw the solid-water tension. If neither solid-liquid tension is greater than the sum of the other solid-liquid tension plus the liquid-liquid tension, the bacterium will be trapped in the interface. If either solid-liquid tension exceeds the sum of the other two tensions, one liquid will spread on and engulf the bacterium; *i. e.,* if Tsw > Tso + Tow, the organic phase will spread on and engulf the bacterium. This is the condition with acid-fast organisms in a water-oleic acid interface. The tension between the bacterial fat and fatty acid envelope and the oleic acid is low, Tow is not high, and Tsw is greater than their sum. The bacterium passes spontaneously into the organic phase.

Similarly if Tso > Tsw + Tow, the bacterium would pass into the water phase spontaneously. Clearly with the ordinary bacteria, Tsw < Tso + Tow and Tso < Tsw + Tow, the inequality being greater as Tow is higher.

Earlier attempts to formulate the surface tension factor in phagocytosis have assumed that surface tension would tend to carry the bacterium completely into either cell or plasma.

Fenn[1] has indicated the correct expectation to be that surface tension would retain the bacterium in the interface unless the condition of complete spreading obtained. Our observations substantiate the formulation of Fenn. The details will appear in an early number of the *Journal of Experimental Medicine.*

3 (2526)

Antirachitic properties imparted to lettuce and to growing wheat by ultraviolet irradiation.

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Wheat which was grown in the dark (etiolated) was found to have no antirachitic potency. Wheat which was grown in the light and irradiated with mercury vapor lamp conferred protection when fed to rats (10 gm. daily).

The same difference in regard to protective action against rick-

[1] Fenn, W. O., *J. Gen. Physiol.*, 1922, iv, 373.