the acid-base variation under experimental conditions of 6 patients (2 cases of nephrosis, 2 of diabetes, and 2 of nutritional edema). The normal acid-base balance was displaced toward the acid side by the administration of ammonium chloride or hydrochloric acid, and toward the alkaline side by the administration of sodium bicarbonate. Frequent determinations of the acid-base balance were made during the course of the displacement from and the return to normal. Approximately 7 determinations were made during the 8 hours following the administration of the salts, and several determinations were made on the succeeding days.

The results when plotted on a triaxial coordinate chart may be described as follows: After a change is produced in the serum bicarbonate by fixed acids or alkalies the path taken by the blood is toward a changed pH and CO_2 tension. The change in pH is approximately 2 times the corresponding change in CO_2 tension when the latter is expressed logarithmically. The direction may be stated as being approximately at right angles to the direction taken by the CO_2 absorption curve of blood plotted on the triaxial coordinate chart.

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Coagulation of Egg Albumin by Supersonic Waves.

HSIEN WU AND SZU-CHIH LIU.

From the Department of Biochemistry, Peiping Union Medical College.

Schmitt, Olson and Johnson[1] observed that solutions of egg albumin when exposed to supersonic waves became turbid and the albumin precipitated out in fine shreds. Not only is the mechanism of this novel method of coagulation entirely unknown, but it is not even certain whether the coagulation was caused by the mechanical vibration itself or by the heating effect of electric and supersonic waves, since these investigators did not take the precaution to cool the solution during exposure. The present communication extends their observation and examines the mechanism of coagulation by supersonic waves.

The oscillating current was generated by two 75 watt tubes (UX. 852) connected in a modified Hartley circuit. The quartz

[1] Schmitt, F. O., Olson, A. R., and Johnson, C. H., PROC. SOC. EXP. BIOL. AND MED., 1928, **25**, 718.

plate (about 47x50 mm.) lay between 2 brass electrodes the distance between which could be adjusted. The vibrating part was placed in a dielectric liquid, usually benzene. The quartz plate vibrated at the rate of 1.3×10^6 times per second. On the upper electrode was placed a coil of glass tubing through which cold water circulated.

By adjusting the distance between the 2 electrodes it is easy to produce a mount of several centimeters above the surface of the liquid. We found that the effect of the vibration is greatest at the mount.

About 5 cc. of 1% egg albumin solution was placed in a test tube 15 mm. in diameter. The tube was held so that its bottom was just buried in the mount. A thermometer was placed in the tube. The pH of the solution was about 4.8.

Immediately upon exposure to the waves tiny particles of coagulated albumin are formed throughout the solution. These particles show rapid vibration, but they eventually rise to the surface. Under the microscope they are seen to consist of shreds enclosing air bubbles. The temperature of the solution did not rise more than 2 degrees above the room temperature, thus excluding the possibility of coagulation by heat.

The occlusion of air by the particles of coagulated albumin suggests that air bubbles might be the cause of the coagulation. Accordingly, we prepared some gas-free albumin solution by extraction in Van Slyke's apparatus and carefully transferred the solution to a specially constructed tube out of contact with air. The gas free albumin solution when exposed to the supersonic waves showed no sign of coagulation.

We prepared also gas free albumin solutions and resaturated them with H_2, O_2, CO_2 or H_2S. With H_2 and O_2, coagulation occurred when the solution was exposed to the waves, but no coagulation was observed in solutions saturated with CO_2 or H_2S. The absence of coagulation in CO_2 and H_2S solutions was not due to the acidity, because albumin solutions saturated with air and brought with acetic acid to the same acidity as that of the CO_2 solution showed coagulation.

To explain the difference between air H_2 and O_2 on the one hand and CO_2 and H_2S on the other, we exposed solutions of these gases (without albumin) to the supersonic waves. In solutions saturated with air, H_2 or C_2 gas bubbles were formed immediately upon exposure, while CO_2 and H_2S solutions gave off no gas. We are not certain whether this difference is due to the different solubilities of

the gases, but it is clear that gas bubbles are essential in the coagulation of albumin by supersonic waves. The rapidly vibrating gas bubbles on their ascent to the surface cause coagulation of the albumin at the interface much in the same way as albumin is coagulated by shaking which has been shown to be a surface phenomenon.[2]

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Stimulation of B. typhosus Agglutinin in Typhus Fever.

C. E. LIM AND W. K. CHEN. (Introduced by Hsien Wu.)

From the Department of Bacteriology and Immunology, Peiping Union Medical College.

It has long been recognized that the agglutinin for typhoid bacilli as shown by the Widal reaction is often encountered during typhus fever. In our experience here we observe that the sera obtained from proved cases of typhus may show early Widal test up to a higher titre while the Weil-Felix reaction or the presence of agglutinin for *B. proteus* X19 may appear later or in a much lower titre. Some of these cases may give the history either of previous typhoid infection or prophylactic vaccination, but in others none of these factors could be definitely ascertained. It has been suggested by some observers that during typhus fever the appearance of the Widal reaction is due to non-specific stimulation of latent or low titre antibodies by the fever.[1]

In a recent observation, however, it has been found that experimental typhus in animals (guinea pigs, rabbits and monkeys), previously vaccinated with typhoid bacilli, had no influence on the Widal reaction.[2] This is contradictory to actual findings made in human beings. In view of the value of *B. proteus* X19 as an antigen for the diagnosis of typhus fever, it seems to us of interest to determine whether the introduction of that organism into typhoid inoculated animals would stimulate the production of anti-typhoid agglutinin.

In our present experiment we are not concerned with the action of other microorganisms in this direction, since non-specific stimulation of specific antibodies has been recorded on experimental ani-

[2] Wu, H., and Ling, S. M., *Chinese J. Physiol.*, 1927, **1**, 407.

[1] Felix, A., *J. Hyg.*, 1929, **28**, 418.

[2] Reimann, H. A., and Wu, C. J., *J. Immunol.*, 1930, **18**, 159.