concentration as judged by the time period required to anesthetize. Except for vinyl-ethyl ether, the general relationship between chemical constitution and pharmacological action, as we could predict from present theory, seems to hold. Since the vinyl-ethyl ether used by us was from two independent sources and was found to have the same properties, to account for its marked failure to conform to theoretical behavior is difficult. At any rate, further study of this interesting series of agents is justified and is cordially invited.

Summary. Of a series of unsaturated ethers, including vinyl-ethyl ether, di-vinyl ether, allyl-ethyl ether, and its isomer isopropenyl-ethyl ether, and di-allyl ether, only di-vinyl ether was found to have a partition coefficient and anesthetic properties on inhalation in equimolecular concentrations in mice approaching or superior to di-ethyl ether. A close correlation was found between the tentative partition coefficients and anesthetic powers of these unsaturated ethers. With the exception of vinyl-ethyl ether, these compounds conformed in general behavior to what was predicted of them on the basis of present theoretical conceptions of the relationship between chemical constitution and pharmacological action.

5204

Effect of Oxidation-Reduction Potential on Some Enzymic Reactions.

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During the last decade great progress has been made in the study of the intensity factor in oxidation-reduction equilibria. The investigations of Mansfield Clark and others have made possible the quantitative determination of this factor both *in vitro* and *in vivo*.

It has been known for a long time that the activity of the several enzymes essential in life processes is conditioned by a variety of factors, such as temperature, the nature and concentration of electrolytes (notably the hydrogen ion concentration), the dilution of enzyme and of substrate, irradiation.[1, 2, 3, 4, 5, 6, 7, 8, 9] It seems prob-

[1] Compton, A., *Proc. Roy. Soc.*, 1921, **92B**, 1.

[2] Compton, A., *Ann. de l'inst. Pasteur*, 1916, **30**, 497.

[3] Kawakami, T., *J. Pharm. Soc. Japan*, 1929, **49**, 346.

[4] Kita, G., *Mem. Coll. Eng. Kyoto Imperial Univ.*, 1918, **21**, 5.

able on *a priori* grounds that in the case of some enzymes, the oxidation-reduction potential of the system may be important. The experiments of Stephenson[10] which showed a relation between pH and rate of reduction of lactic acid by dehydrogenase, are interesting in this connection.

We have undertaken the study of enzyme action in buffered systems in which the oxidation-reduction potential is kept constant—precautions not hitherto observed as far as we know. The first case investigated was the hydrolysis of starch by takadiastase.

Known amounts of indicator and of starch were incubated at 37.5° in solutions buffered at pH 5.9 (optimal for takadiastase) and poised at various oxidation-reduction potentials, and the maltose formed in the experimental and control tubes was determined at the end of a 30-minute period. To prevent oxidation of the reduced dyes, the reactions were carried out in an atmosphere of oxygen-free nitrogen, which was first passed through a furnace of finely divided copper heated to 750°C. to remove traces of oxygen. The several gas outlet tubes led to one common tube, to insure equal pressure in all vessels, and the tip of this latter tube dipped in mercury to prevent back diffusion of oxygen. Potentials were followed during the run by the usual method, *viz.*, measurement of the potential difference between a platinum electrode in the solution and a reference calomel half-cell. The reaction tubes were painted on the outside with black enamel to exclude light.

We found that the maltose formed from soluble starch in 30 minutes was the same in systems poised at a low E_h with β-anthraquinone, at intermediate E_h with methylene blue, and at high E_h with quinhydrone.

Two experiments on the system muscle extract plus kidney cortex extract + glucose buffered at pH 7.2 and poised with methylene blue, have shown no difference between the experimental tubes and control tubes which did not contain methylene blue, in respect to glycolysis. The muscle extracts were prepared according to the method of Case and McCullagh.[11] These studies are being continued and extended.

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[5] Nishikawa, K., *Biochem. Z.*, 1927, **188**, 386.

[6] Pincussen, L., and Kambayashi, Y., *Biochem. Z.*, 1928, **203**, 334.

[7] Pincussen, L., and Oya, T., *Biochem. Z.*, 1929, **209**, 410.

[8] Sherman, H. C., and Tauberg, A. P., *J. Am. Chem. Soc.*, 1916, **38**, 1638.

[9] Waldschmidt-Leitz, E., "Enzyme Actions and Properties," 1929.

[10] Stephenson, M., *Biochem. J.*, 1928, **20**, 605.

[11] Case, E. M., and McCullagh, D. R., *Biochem. J.*, 1928, **20**, 1060.