

Comparing the occurrence of radiation and the influences controlling it with the distribution and characteristics of respiratory enzymes, we have no difficulty in recognising radiation as an inseparable part of normal enzymatic activity (oxidase, dehydrogenase).

This deduction links two hitherto unrelated lines of research on malignant growth, namely, (a) Warburg's work on abnormal glycolysis by restricted activity of respiratory enzymes, and (b) Gesenius's investigation on inhibited radiation in relation to disease.

Excluding parasitic inhibition (syphilis, tuberculosis) and passivity caused by suppressed intake of oxygen (pernicious anæmia), the depletion of respiratory enzymes in cancerous cases may be due to enzyme starvation, for which our diet and culinary methods are mainly responsible. To restore normal metabolism in all its phases we should require the introduction of a cellular system capable of regulating glycolysis, the vitamin and hormone equilibrium, to be non-toxic and able to function under partly anærobic conditions. Yeast, especially commercial baker's yeast, in an enzyme-bearing medium (unrefined sugar, honey, etc.) which is respiratorily much more virile than any pure culture, should provide such an enzymatic association.

Local inductive and contact influences (rays, tar, etc.), affecting respiratory enzymes, become, if protracted, carcinogenic.

Research Laboratory, MAURICE COPISAROW,  
145 Alexandra Road,  
Manchester, S.W.  
Nov. 29.

#### Liesegang Rings

Dr. HEDGES is to be congratulated on his book on "Liesegang Rings", which gives for the first time a comprehensive survey of the subject together with a most extensive bibliography. It will be a valuable work. His description of my theory is adequate, except that he is incorrect in stating that it does not account completely for all the facts. The example quoted against it is a beautiful confirmation. The formation of zones of precipitated sodium chloride is due to the oppositely diffusing solutions of hydrochloric acid and sodium chloride being constrained by the capillary tube to pass near the deposited salt. This demonstrates the essential part played by the precipitate in removing the solute from the solution in its neighbourhood.

This experiment is not the first case of so-called rhythmic precipitation without chemical reaction. In 1921<sup>1</sup> I described beautiful bands of tiny gelatin particles suspended in water, which were formed by diffusing alcohol into dilute solutions of gelatin. Further, my adsorption theory explains the formation of banded structures by crystallisation.<sup>2</sup>

Dr. Hedges proposes an alternative theory that the phenomenon requires "(1) a critical condition, which has to be reached before crystallisation, precipitation, coagulation, condensation, or other change involved in the formation of the periodic structure takes place, and (2) mobilisation of the material which can occur during the delay caused by the first condition. In this way material is moved from the zone which eventually become the spaces to those which eventually become the rings." This attempt at generalisation is too indefinite as a working hypothesis. The majority of systems included would give no periodic structures.

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It does not indicate the part played by the precipitate, or specify that it must be held in place. Even if the statement is made more definite by specifying supersaturation as the critical condition and diffusion as the means of mobilisation, only a very small proportion of the many systems that would conform to these conditions would produce good banded precipitates. The theory is incapable of explaining the facts in detail as my adsorption theory does.

S. C. BRADFORD.

Science Museum,  
South Kensington,  
London, S.W.7.  
Nov. 21.

<sup>1</sup> *Biochem. J.*, 15, 561; 1921.

<sup>2</sup> *Biochem. J.*, 12, 360; 1918.

#### Carbon-Oxygen Linkage in the Metal Carbonyls

DADIEU and Kohlrusch<sup>1</sup> have shown that the  $>C=O$  group in aldehydes, ketones and esters, is associated with a Raman displacement of 1,500–1,700  $cm^{-1}$ ; Rasetti<sup>2</sup> found for carbon monoxide a shift of 2,155  $cm^{-1}$ , in satisfactory agreement with the structure  $\overset{\ominus}{C}\equiv\overset{\oplus}{O}$ . Observation of the Raman effect in the metal carbonyls should therefore discriminate between a co-ordinated structure<sup>3</sup>, and any cyclic structure embodying  $>C=O$  groupings.

Through the kindness of Prof. A. Fowler, I have been able to photograph the Raman spectrum of nickel carbonyl, and to find a strong line corresponding with a displacement of 2,038  $cm^{-1}$ , together with a number of diffuse lines of displacements up to 450  $cm^{-1}$ . Since the performance of this preliminary experiment, Dadieu and Schneider<sup>4</sup> have examined the Raman spectrum in detail, and found shifts of 2,125 and 2,039  $cm^{-1}$ , corresponding to the carbon-oxygen linkage, together with lines at 595, 456, 379 and 80  $cm^{-1}$  which have been attributed to the fundamental frequencies of a tetrahedral molecule.

The Raman effect thus affords decisive evidence that the carbon monoxide is present in the molecules of the metal carbonyls as such, the difference between the value 2,155  $cm^{-1}$  found for carbon monoxide itself, and the doublet 2,125 and 2,039  $cm^{-1}$  found in the case of nickel carbonyl being attributable to the modification in the forces operative in the carbon-oxygen linkage brought about by the co-ordination of the carbon monoxide to the metal, and the consequent redistribution of polarities.

It is important to note that this evidence, as also that derived from measurement of the dipole moment<sup>5</sup>, is in full accord with the chemical properties of the carbonyls, in particular the replaceability of the carbon monoxide by amines (cf. the formation of the compound  $Ni(CO)_2 \cdot C_{10}H_8N_2$  and analogous iron and cobalt compounds<sup>6</sup>). The convergence of evidence may therefore be taken as establishing beyond doubt a structure of the type indicated above.

J. STUART ANDERSON.

Imperial College of Science,  
South Kensington,  
London, S.W.7.  
Dec. 5.

<sup>1</sup> Dadieu and Kohlrusch, *Ber.*, 63, 251; 1930.

<sup>2</sup> F. Rasetti, *NATURE*, 123, 205; 1929.

<sup>3</sup> cf. Sidgwick, "Electronic Theory of Valency", p. 216.

<sup>4</sup> Dadieu and Schneider, *Akad. Anzeiger der Akad. der Wiss.*, Wien. Oct. 15, 1931.

<sup>5</sup> Sutton and Bentley, *NATURE*, 130, 314; 1932.

<sup>6</sup> Hieber, Mühlbauer and Ehmman, *Ber.*, 65, 1090; 1932.