superficial. Mimicry deceives the artist but not the anatomist. Moreover the details of the likeness between model and mimic are not the same. It is a commonplace that apparently the same effect may be produced by different means, a fact also in accord with natural selection.

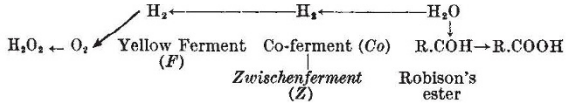
G. D. HALE CARPENTER.

Hope Department of Entomology,
University Museum,
Oxford.
Oct. 1.

[1] See NATURE, **135**, 194 (Feb. 2, 1935).
[2] NATURE, **123**, 661 (April 27, 1929); **124**, 183 (Aug. 3, 1929).

Keilin's Cytochrome *c* and the Respiratory Mechanism of Warburg and Christian

ACCORDING to the investigations of O. Warburg and his co-workers[1] on the reaction



the yellow ferment (F) acts as a more or less specific dehydrogenator of the di-hydro-co-ferment (CoH_2), which cannot be oxidized either by molecular oxygen, or by methylene blue. The *cozymase* reacts in a manner analogous to the co-ferment (H. v. Euler and co-workers[2]).

Until now it has been uncertain whether the direct re-oxidation of the leuco-form of the yellow ferment (FH_2) by molecular oxygen really takes place to any considerable extent in the living tissue cells, where the oxygen pressure is often very low, and whether the FH_2 possibly could be re-oxidized by other substances in the cells, for example the cytochromes.

I have recently investigated the kinetic relations between oxygen, cytochrome *c* and the yellow ferment. The experiments were performed in the following manner: *Co*, *Z*, HCN, *m*/50 $NaHCO_3$ and in certain cases F were mixed in a glass cell of 1 cm. thickness to the volume of 3 ml. Z was used in such small amounts that the oxidation velocity of Robison's ester was proportional to the quantity of Z. After ten minutes the solution was saturated with nitrogen or oxygen or mixtures of both, and then a small quantity of oxidized cytochrome *c* ($Fe\cdots OH$; pure, from beef heart[3]) was added. The *p*H of the solution was 7·35. The light absorption at 550 mμ was determined photo-electrically. Now the substrate, the potassium salt of pure Robison's ester, was added and the light absorption at 550 mμ was followed.

A priori, three different reactions would be expected to be possible:

$$O_2 + FH_2 = H_2O_2 + F \quad \ldots\ldots\ldots (1)$$
$$2Fe\cdots OH + FH_2 = 2Fe^{\cdot\cdot} + F + 2H_2O \quad \ldots (2)$$
$$2Fe\cdots OH + CoH_2 = 2Fe^{\cdot\cdot} + Co + 2H_2O \quad \ldots (3)$$

The experiments proved that reaction 3 does not take place. Thus cytochrome *c*, like oxygen and methylene blue, is unable to oxidize the di-hydro-co-ferment directly.

Reaction 2, on the contrary, takes place most rapidly. If molecular oxygen and oxidized cytochrome *c* were both present in the solution, the relative velocities of reactions 1 and 2 were dependent on the oxygen pressure, but within wide limits independent of the concentration of oxidized cytochrome. The accompanying table shows the relation between the oxygen pressure and the relative reaction velocities at 22° C.

Oxygen pressure (mm.)	Per cent FH_2 oxidized by oxygen	Per cent FH_2 oxidized by cytochrome *c*
760	69	31
150	54	46
38	20	80
0	0	100

About the same values for an oxygen pressure of 150 mm. were found at 31° C.

In the living tissue cells, the average oxygen pressure is much lower than 38 mm. *Thus the re-oxidation of the yellow ferment by cytochrome seems to be the physiological method* occurring in cells containing the Warburg-Keilin iron-porphyrin system—that is, nearly all known cells. It should be pointed out that nothing is said above about another problem, namely, how much of the total cell respiration takes place by means of the yellow ferment.

HUGO THEORELL.

Chemical Department of the
Caroline Institute,
Stockholm.
Aug. 29.

[1] O. Warburg and W. Christian, *Biochem. Z.*, **254**, 438 (1932); **257**, 492 (1933); **260**, 499 (1933); **266**, 377 (1933); Warburg, Christian and Griese, *Biochem Z.*, **279**, 143 (1935); **282**, 157 (1935), etc.
[2] H. v. Euler, E. Adler and H. Hellstrom, *Svensk Kem. Tidskr.*, **47**, 290 (1935); *Z. physiol. Chem.*, **241**, 239 (1936), etc.
[3] H. Theorell, *Biochem. Z.*, **279**, 463 (1935); **285**, 207 (1936).

An Effect of X-Radiation on the Blood

IN the treatment of malignant disease by X-rays or radiation, a highly important question is that of dosage. So far as we are aware, there is no simple method of determining quantitatively, even only approximately, the effect of a given dose except by observation of the effect on the irradiated tumour.

It is well known that irradiation produces marked changes in the blood, but no systematic examination of the cause of these changes during a prolonged course of treatment appears to have been made. We have undertaken therefore to investigate whether such irradiation produces a measurable change in some definite constituent of the blood, so that there may be a check on the effect of the radiation administered. By a new and accurate photo-electric method of estimating the total (and also the acid-soluble) phosphorus in the red cells, plasma, serum and whole blood of the patient under treatment, we have been able to ascertain, by taking measurements before and after irradiation by X-rays or radium, that the ratio of the whole phosphorus in the red cells to that in the plasma (a ratio which is usually high in the case of cancer patients but of the order of 5 or less in that of other patients) is reduced, even after only one treatment, by so much as 50 per cent in extreme cases, so that the phosphorus-partition falls within the normal range.

Our results indicate that it may be possible to judge of the effect of X-ray dosages by measuring changes in the phosphorus partition in the red cells