will doubtless stimulate renewed investigation of them. The book reveals very fully the fundamental significance of inflammation in relation to infection and immunity.

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PHOTOELASTICITY

Elasticité et Photoélasticimétrie. By H. LE BOITEUX and R. BOUSSARD. 361 pp. Paris: Hermann and Cie, 1940. 180 francs.

ALTHOUGH the technique of photoelasticity, a practical method to determine complicated two-dimensional stress distributions experimentally, was originated in France by Mesnager in 1901, this is the first French book giving a comprehensive account of the theoretical and practical aspects of the method. It is divided into four sections, of which the first is an exposition of the theory of elasticity in the classical manner. The second section does the same for optics, first of isotropic and later of anisotropic mediums. These two sections comprise half the book and do not as yet mention photoelasticity. In the third section the two theories are combined and a discussion is given of apparatus, experimental techniques and properties of the materials used. The last quarter of the book is devoted to methods of numerical integration for finding the principal stresses individually, which is necessary since the photoelastic pictures only determine the difference between these stresses at each point. It is noted that the authors show a number of colored pictures of stress distributions, which represented good practice a decade ago. Although the superiority of monochromatic light and black-and-white pictures over colored pictures is casually mentioned in the text, the authors evidently do not use the improvement in their own laboratory.

A very complete and encyclopedic book, entitled "A Treatise on Photoelasticity," on the subject was published in 1931 by Coker and Filon (Cambridge University Press) which from a technical standpoint is now somewhat out of date. The present French volume is more clearly written; it is easily readable and presents the theory quite adequately; but, although appearing nine years later, it is no better than Coker-Filon in the technical parts of the subject. And it is just in the technical direction that great advances have been made lately, making the now obtainable accuracy in reading stresses about ten times better than that shown in the book.

Another recent volume on the subject written by Mesmer is entitled "Spannungsoptik."[1] The first half of its total of 220 pages follows the French book in its general structure, while the last half discusses experimental techniques and the more modern applications. The bibliography appended refers principally to the last decade, listing 240 papers published since 1930, whereas the French bibliography practically stops with the year 1931.

The most interesting recent development of photoelastic technique is its extension to three-dimensional stress distributions. This is done by exposing the bakelite model to a load at a fairly high temperature and then cooling it under load. A subsequent removal of the load leaves the model without stress but with optical properties that can be correlated to the stress that existed in it before the load removal. Although not yet developed to the point of being a practical engineering tool, this method shows great promise of becoming such a tool in the near future. It is discussed briefly by Boiteux-Boussard as well as by Mesmer.

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SPECIAL ARTICLES

ON THE INTERDEPENDENCE OF RESPIRATION AND GLYCOLYSIS[1]

THE following definition of the Pasteur effect has recently been suggested by Burk:[2] (a) O_2 inhibition of fermentative processes, and at times also (b) O_2 stimulation of anabolic syntheses, the latter effect not being invariably concomitant with the former. Crabtree[3] in 1929 found that the respiration of transplantable tumors was about 12 per cent. lower in the presence of glucose than in its absence and suggested that glucolytic activity exerts a checking effect on the capacity for respiration of tumors. This phenomenon has been called a reversed Pasteur effect (or the Crabtree effect). The occurrence of the Crabtree effect in transplantable tumors has been confirmed.[4,5] Likewise, the effect was observed in lymph nodes of leukemic mice.[6]

We have noticed that the inhibition of respiration by the addition of glucose occurs also in normal tissues with an aerobic glucolysis. In the renal papilla of the rat, which is known to have a metabolism similar to tumors,[7] the inhibition amounted to 20 per cent.

[1] From the Laboratory of Orthopaedic Research of the Harrison Department of Surgical Research, Schools of Medicine, University of Pennsylvania, Philadelphia, Pa.

[2] D. Burk, Cold Spring Harbor Symposia on Quantitative Biology, 7: 420, 1940.

[3] H. G. Crabtree, *Biochem. Jour.*, 23: 536, 1929.

[1] Berlin: Julius Springer, August, 1939.

[4] E. Krah, *Biochem. Zeit.*, 219: 432, 1930.

[5] K. A. C. Elliott and Z. Baker, *Biochem. Jour.*, 29: 2433, 1935.

[6] J. Victor and J. S. Potter, *Brit. Jour. Exp. Path.*, 16: 253, 1935.

[7] P. György, W. Keller and Th. Brehme, *Biochem. Zeit.*, 200: 356, 1928.

In bovine articular cartilage which possesses an exceedingly low respiration and thereby a relatively higher aerobic glycolysis than the other tissues mentioned, the inhibition averaged 57 per cent.

Results of a representative experiment with calf cartilage are listed in Table 1. It is seen that glucose

TABLE I

THE ACTION OF GLUCOSE ON THE RESPIRATION OF CARTILAGE*
Mean rates over three-hour period

Substrates	None	Glucose	Pyruvate	Succinate	Glucose + Pyruvate	Glucose + Succinate
		(M/100)	(M/50)	(M/25)		
Q_{O_2}†	.079	.029	.079	.103	.062	.080
Inhibition by Glucose	...	−.050 (− 63%)	...	...	−.017 (− 22%)	−.023 (− 23%)
Acceleration by Pyruvate and Succinate	...	...	± 0	+.024	+.033	+.051

† Cmm. O_2/mg dry weight/hour.
* Articular cartilage from the metacarpal-phalangeal and metatarsal-phalangeal joints of a calf two months old. About 125 mg dry weight of cartilage slices per experimental vessel. $k_{O_2} = .98$
Gas: Air Medium: Phosphate-Ringer's

retards oxygen consumption by 63 per cent. Similar effects were obtained by the addition of mannose, but no effect was obtained with fructose which is not glycolyzed by cartilage. The inhibition observed in oxygen (53 per cent.) was of the same order as in parallel determinations in air (59 per cent.). The magnitude of the respiratory inhibition in cartilage is neither due to a drop in the pH of the medium incident to the high rate of acid formation after the addition of glycolyzable hexoses to the slices nor to an accumulation of glycolytic splitting products or their derivatives (lactate, pyruvate, succinate). Table 1 shows an example of the results obtained with pyruvate and succinate. Pyruvate does not alter the rate of the spontaneous O_2 consumption, but it induces an acceleration of the oxygen uptake if the respiration is inhibited by glucose. Succinate[8] accelerates respiration in the presence of glucose to a greater extent than in its absence. Apparently the addition of glucose suppresses cellular processes which result in the formation of pyruvic and succinic acids since the addition of these acids abolishes more than half of the respiratory inhibition by glucose (*cf.* Table 1).

Elliott and Baker[5] as well as Victor and Potter[6] observed that the retardation of respiration by the addition of glucose was paralleled by a rise of the R.Q., indicating a replacement of respiratory substrates of the tissue by the added glucose. The latter authors pointed out that the change of the R.Q. after the addition of glucose was compatible with a shift from protein oxidation to carbohydrate combustion. Warburg and colleagues[9] showed that the formation of ammonia in tissue slices deprived of glucose is especially high in glycolytically active tissues and that the addition of glucose inhibited the excretion of ammonia. This inhibition was considered an expression of the protein sparing action of glucose. The investigation of Dickens and Greville[10] indicate that the oxidation of glucose rather than its glycolysis is responsible for the retardation of the protein catabolism. It seems possible that the addition of glucose causes a decrease of oxygen consumption in such tissues in which the hexose is not oxidized with the same velocity as the cellular substrates, the oxidation of which it replaces. Such a mechanism would explain the frequent occurrence of the Crabtree effect in aerobically glycolyzing tissues where a relatively sluggish oxidation of glucose coincides with a high protein catabolism in the absence of sugar.

This tentative explanation does not intend to imply that glucose oxidation replaced only the combustion of protein nor that glucolysis does not prevent to a certain extent protein catabolism, as was suggested by Warburg.[9] The explanation supports the view, however, that the Crabtree effect is not a reversal of the checking action of respiration on glycolysis but a separate process which indicates the sparing of cellular substrates by the combustion of extracellular glucose. Thus, the Crabtree effect may belong to the reactions which underlie the stimulative action of respiration on cellular anabolism (Pasteur effect b).

The mechanism of the effect is being investigated further.

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APPEARANCE OF SKELETAL ABNORMALITIES IN THE OFFSPRING OF RATS REARED ON A DEFICIENT DIET

THE following observations were made when rats, which were reared on deficient diets, were bred. All rats used were of the Sprague-Dawley strain. One group of females was reared on a diet consisting of yellow cornmeal 76 per cent., wheat gluten 20 per cent., calcium carbonate 3 per cent., sodium chloride C.P. 1 per cent. (Steenbock and Black rachitogenic diet No. 2965),[1] which was supplemented with viosterol (each rat received 60 I.U. every tenth day). On this diet the animals were retarded in growth and

[8] Lactate behaves similarly.

[9] O. Warburg, K. Posener and E. Negelein, *Biochem. Zeit.*, 152: 309, 1924.

[10] F. Dickens and A. Greville, *Biochem. Jour.*, 27: 1123, 1933.

[1] H. Steenbock and A. Black, *Jour. Biol. Chem.*, 64: 263, 1925.