logical sciences, with the proviso that the university raise an additional $500,000 for that purpose.

The Ruth Lucie Stern Research Laboratory, the gift of Mrs. Louis Stern, built at the cost of about $97,000, has been opened at the School of Medicine of Stanford University at San Francisco. It is three stories high and has more than 6,000 feet of laboratory space. The second floor is occupied by research in pediatrics and the top floor by research in pathological gynecology, endocrinology and cancer.

Ernest L. Woodward has made a gift of $45,000 to the University of Rochester to support the research in epilepsy of Dr. W. P. Van Wagenen, associate professor of neurological surgery at the School of Medicine and Dentistry. The facilities of the Craig Colony for Epileptics, at Sonyea, and of the Rochester State Hospital have been extended to him during the past year. Previous support of the work had come from the Markle Foundation.

The will of Charles R. Walgreen, founder of the Walgreen drug store chain, who died on December 11, provides for the transfer of the balance of the 19,000 shares of the stock he had pledged previously to the University of Chicago.

Lord Nuffield has placed in the hands of trustees ordinary shares of Morris Motors, Limited, worth approximately £1,250,000, to be the nucleus of a fund for the provinces to finance a scheme of hospital regionalization.

There will be available on September 1, 1940, a research fellowship in the laboratory of pathology at the Collis P. Huntington Memorial Hospital and in the Department of Pathology at the Harvard Medical School. This carries a stipend of three thousand dollars and may be renewed for a second year. The fellow will be expected to devote most of his time to histologic and cytologic studies of the effects of radiation of different types on normal and pathological tissue. Application should be made to Dr. Shields Warren at the Collis P. Huntington Memorial Hospital, Boston.

DISCUSSION

RADIOACTIVITY IN BIOLOGICAL EXPERIMENTS

The successful production of radioactive materials by a cyclotron has led to interesting biological experiments in which these substances are used as tracers. In this new field many results have already been obtained, some of which are in disagreement with previously held opinions. This has given rise to the fundamental question of whether a radioactive element has the same properties as the element in its normal form.

Radioactivity. This question is unfortunately sometimes the result of a misunderstanding of the nature of radioactivity. It is sometimes erroneously believed that radioactive atoms continually emit radiations. A radioactive atom does not emit any radiation at all until the very end of its existence, when it changes into another element. The tracer experiments involve only atoms which have not yet radiated. It is clear that future emission of such radiations can not have any influence upon the present atomic properties.

Atomic Weight. The radioactive atoms have an atomic weight slightly different from normal atoms. This can have an effect upon some of their properties such as the rate at which they diffuse through a membrane. However, effects of this kind are well known to be exceedingly small and barely observable even in specially designed physical experiments.

Normal elements also consist generally of a mixture of atoms of different atomic weights, called isotopes. There is some evidence[1] that the mixture has a slightly different composition when taken from different parts of the animal system. This difference is very small, showing clearly that living tissue does not possess a pronounced ability to distinguish between isotopes. It is obvious that such minute effects need only be considered after the quantitative accuracy of the tracer experiments has been very much improved.

Presence of Radiation. A fraction of the tracer atoms will emit radiations during the progress of the biological experiment. Though such atoms lose their rôle as tracer, one may ask whether the presence of this radiation does not alter the properties of the living organism and influences the result of the tracer experiment. In these experiments the radioactive element is so greatly diluted and the radiation so weak that such an effect seems very unlikely. The following simple observation can verify this in doubtful cases. If the result of the tracer experiment were due to the presence of the radiation, the yield of the experiment should be approximately proportional to the *square* of the amount of tracer administered instead of in direct proportion to it.

In this connection it is also interesting to examine Zwaardemaker's well-known hypothesis that the radioactivity of potassium is responsible for its physiologi-

[1] A. Keith Brewer (*Jour. Am. Chem. Soc.*, 58: 869, 1937) finds that the potassium in bone marrow consists for about 6.75 per cent. of the isotope of atomic weight 41; in other organic and inorganic sources the percentage is 6.58 per cent.

cal action. The basic experiment to support this idea is the beating of an isolated frog's heart when perfused with a certain solution of a mixture of salts, one of which has to be potassium chloride. The amount of potassium in this solution is so small that a simple calculation indicates that only about one potassium atom per hour radiates in the frog's heart. Since the whole experiment can be performed in a much shorter time, it is absurd to connect in this experiment the necessary presence of potassium with its radioactivity.[2]

Conclusion. The above remarks are meant to show that tracer experiments with radioactive elements, if carefully executed, give definitely reliable information about the behavior of the normal element. If unexpected results are found they should certainly not be ascribed to a difference in the properties of the radioactive isotope.

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PSEUDOMETHEMOGLOBIN AND ITS REACTION WITH CARBON MONOXIDE AFTER REDUCTION

IN a discussion in this journal[1] recently, E. Ammundsen published her observations on the presence in the blood of "a kind of hemoglobin" combining with carbon monoxide only after reduction. With reference to that substance the author emphasizes that "for the present its composition and the cause of its appearance will have to be looked upon as unknown." In this connection the following facts may be of interest.

The normal presence of substances in human and animal blood not identical with hemoglobin but combining with carbon monoxide in a similar way was described by Barkan and Berger[2] in 1928. These authors pointed out that of the "easily split-off" blood iron ("leicht abspaltbares" Bluteisen) discovered by Barkan[3] (1925) one portion E combines with O_2 and CO following the distribution equation, while another portion E′ does not react with those gases. In 1937 we[4] demonstrated that both fractions of the "easily split off" blood iron are pseudohemoglobins which are intermediates in the formation of bilirubin from hemoglobin and accompany the hemoglobin within the red cells of the circulating blood. Pseudohemoglobins, according to our definition, are chromoproteins in which the protein is probably an unaltered globin, while the prosthetic group is an iron-containing heme or hemin derivative with an opened porphyrin ring, similar to that in Lemberg's[5] "verdohemochromogen." The two fractions E and E′ differ by the valency of the iron. The latter is bivalent in *E*, which combines with oxygen and carbon monoxide and hence was designated as a pseudohemoglobin *in sensu strictiori*. The iron is trivalent in E′, which does not combine with O_2 and CO and was designated as a "pseudomethemoglobin." By reduction with $Na_2S_2O_4$ we were able to transform the pseudomethemoglobin into pseudohemoglobin, which does combine with carbon monoxide.

Our work was published in different original articles[4, 6] and, in addition, some reviews[7] have been given. Taylor and Coryell[8] in an article (1938) dealing with the magnetic susceptibility of the iron in ferrohemoglobin confirmed our work. Using the same method as was later used by E. Ammundsen,[1] they found too that in normal blood and in oxyhemoglobin solutions there are present hemoglobin-like compounds which combine with carbon monoxide only after previous reduction.

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AN EXPERIMENT ON RETINAL AFTER-IMAGE AND JUDGMENT OF SIZE

BY an almost unconscious combination of elements, we judge the size of an object from the image it produces on the retina and from our judgment of its distance from the eye. If there is uncertainty in this latter judgment, there is corresponding uncertainty in judgment of size because we do not then know how far away to consider the object to be and do not know how to interpret the retinal image. It is common experience that we are incapable of estimating the

[2] A. J. Glazko and D. M. Greenberg (*Am. Jour. of Physiol.*, 125: 405, 1939) have shown that radioactive sodium can not replace the potassium in this experiment. Compare also a critical article by S. G. Zondek, *Biochem. Zeits.*, 121: 76, 1921.

[1] SCIENCE, 90: 2338, 372–373, October 20, 1939.

[2] G. Barkan and E. Berger, *Arch. exp. Pathol. u. Pharmakol.*, 136: 278–299, 1928; *Klin. Wochenschr.*, 7: 1868, 1929.

[3] G. Barkan, *Zeits. physiol. Chem.*, 148: 124–154, 1925; *ibid.*, 171: 179–193 and 194–221, 1927; *Biochem. Zeits.*, 224: 53–62, 1930; *Zeits. physiol. Chem.*, 216: 1–16 and 17–25, 1933; *ibid.*, 221: 241–251, 1933; *ibid.*, 236: 198–200, 1935. See also G. Barkan and O. Schales, *ibid.*, 244: 81–88, 1936; *ibid.*, 244: 257–265, 1936.

[4] G. Barkan and O. Schales, *Zeits. physiol. Chem.*, 248: 96–116, 1937.

[5] *Cf.* R. Lemberg, *Ann. Rev. Biochem.*, 7: 421–448, 1938; and original papers cited therein.

[6] G. Barkan and O. Schales, *Zeits. physiol. Chem.*, 253: 83–103, 1938.

[7] G. Barkan, Lecture in the Wiener Biologische Gesellschaft, June 14, 1937; *Klin. Wochenschr.*, 16: 1265–1268, 1937; *Dtsch. Mediz. Wochenschr.*, 64: 638–640, 1938; Kongressbericht II des XVI Internat. Physiol. Kongresses, Zürich (Schweiz), 1938, p. 250; G. Barkan and O. Schales, *Arch. Ital. di Sc. Farmacologiche*, Vol. Jubil. ad Benedicenti, 1937; O. Schales, Research Meeting of the Rockefeller Institute, Copenhagen, December 3, 1938.

[8] D. S. Taylor and Ch. D. Coryell, *Jour. Am. Chem. Soc.*, 60: 1177–1181, 1938.