tents (after hydrolysis) in the normal and diabetic cases consistently show a reduction of 1 to 2 mg. per cubic centimeter, whereas both ulcer patients are consistently below 1 mg.

Although all curves of gastric mucin secretion from patients actively suffering from gastro-duodenal ulcerative disease have not been as classic as the ones reproduced here, they have been consistently of the same pattern and suggest a true quantitative mucin deficiency.

7197 P

Reactions of Hemoglobin and Hematin with Sodium in Liquid Ammonia.

R. G. ROBERTS AND C. O. MILLER. (Introduced by C. J. Farmer.)

From Northwestern University Medical School.

We have shown[1, 2] that certain proteins and peptones are acidic in liquid ammonia and react with sodium with liberation of hydrogen. Proteins and peptones liberate approximately one-half of a molecular weight of hydrogen for each gram atom of nitrogen in the substance when an excess of sodium is used.

Hemoglobin and hematin react profoundly differently toward sodium in liquid ammonia than do the other proteins which we have studied. They liberate hydrogen continuously when excess sodium is present and in quantities disproportionate to the acidic groups present. Their behavior resembles the catalytic action of a rusty iron nail in decomposing the ammonated sodium atom to give sodium ion, amide ion, and hydrogen.

The analytical procedure was essentially the same as that described previously. The substances were dried for 48 hours in an electric oven at 80°C. and then kept in a vacuum desiccator over sulphuric acid.

Hemoglobin is not appreciably soluble in liquid ammonia. It swells, softens, and the particles tend to coalesce. Within a few moments, the supernatant liquid is yellow, but slowly turns to a reddish color after 20 min. After standing for 4 hours, the solu-

[1] Miller, C. O., and Roberts, R. G., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 535.

[2] Roberts, R. G., and Miller, C. O., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 821.

tion is a light green. The change in color may be due to impurities present. There is a persistent increase in rate of boiling of liquid ammonia following the addition of hemoglobin suggesting that ammonation of the molecules is taking place exothermically.

When 0.1 gm. of sodium is added to 0.1 gm. of hemoglobin in liquid ammonia, hydrogen is evolved rapidly during the first 15 min. After that the rate was slowed up considerably, but it proceeded until the blue color of the solution was decolorized. If more sodium was then added, the reaction would start again and continue until the solution was decolorized again. This could be repeated several times. The volume of hydrogen evolved was far in excess of the amount liberated by the same weight of silk, zein, egg albumin, casein, and edestin. The rate is characteristic of a substance containing a carboxyl group, as an amino acid. Hemin contains 2 carboxyl groups, and globin probably contains some free carboxyl groups, although the basic groups in it are in excess. It is possible that our method of drying did not remove all of the water. Water, being acidic in liquid ammonia, reacts rapidly with sodium liberating hydrogen. Hofner reports that 100 gm. of hemoglobin contains 9.25 gm. of water of crystallization.

It seemed likely that the hemin part of the hemoglobin molecule was responsible for the unusual activity rather than the globin fraction because the hemin contains iron, whereas globin is a protein. Two-tenths gm. of hemin prepared from dog hemoglobin was placed in 150 cc. liquid ammonia. It was slightly soluble. The solution turned to dark red. After it had reacted with 0.1 gm. of sodium, it was a light cherry red, and later turned to a dark reddish brown. The first 25 cc. of gas was liberated rather fast at first and then continued slowly for several hours. The sodium was absorbed rapidly. The rate of evolution of the gas resembled that of hemoglobin. Seven hundred cc. of gas was liberated in the first 2 hours with the consumption of 1.4 gm. of sodium. If every hydrogen atom in the sample of hemin had been liberated, this would have accounted for only approximately 100 cc. of gas. The catalytic action of hemoglobin was apparently due only to the hemin fraction. When hemin is added to liquid ammonia in an open Dewar at —33.5°C., the rate of boiling increases. After 2 hours the above solution was greenish in color.

Since iron wire or oxides of iron alone do not have the marked catalytic effect of iron incorporated into the porphyrin molecule as in hemin, hematoporphyrin (from ox blood) was used to see if any catalytic effect was due to porphyrin. One-tenth gm. of hemato-

porphyrin was added to 150 cc. of liquid ammonia along with 0.1 gm. of metallic sodium. The solution immediately turned blue and remained so for 1½ hours. A few cc. of gas came over during the following 45 minutes, apparently from the pyrrol groups themselves, then all evolution of gas ceased. Hematoporphyrin alone apparently does not have a catalytic effect on the following reaction: $Na + NH_3 = NaNH_2 + ½ H_2$. It is worthy of note that hemoglobin beside its remarkable property of very quickly forming oxyhemoglobin can have such a powerful catalytic action on the system just mentioned and to be able to continue that action in the presence of one of the strongest reducing agents known, the solvated electron.

We think of the marked catalytic activity of the hemoglobin as being due to the presence of the iron in the porphyrin ring, and to that metal's ability to accept electrons from the metallic sodium, thus becoming reduced, and to pass them on to the hydrogen, thereby becoming oxidized again and ready to repeat the cycle.

7198 P

Effects of Partial Adrenalectomy on Experimental Diabetes and on Sensitivity to Insulin.

B. O. BARNES, V. B. SCOTT, H. W. FERRILL AND J. M. ROGOFF.

From the Department of Physiology, University of Chicago.

In view of evidence (1) that the severity of pancreatic diabetes is greatly diminished by previous hypophysectomy, (2) that hypophysectomy leads to some atrophy of the adrenals and (3) that the adrenals are in some way connected with carbohydrate metabolism, it seemed necessary to reinvestigate in more detail the effects of adrenalectomy on pancreatic diabetes. The literature will not be reviewed here but it is sufficient to say that the reports have been conflicting and inconclusive. Nine dogs have been used in our studies, 5 of which have had the pancreas removed.

In 3 cases the adrenal on one side was removed first and the pancreas removed 10-18 days later. These animals received no insulin and 2 of them are still alive, now 22 days since pancreatectomy. The third animal died from an infection. These animals showed a mild glycosuria but not as severe as is usually found after extirpation of the pancreas. Within a few days the sugar excretion fell to