increase of blood pressure of the cat, more rapid contractions of the isolated frog heart, relaxation of the isolated non-pregnant uterus and contraction of the pregnant uterus of the cat. Control tests showed that extracts of the feline uterus alone, not mixed with adrenalin, decrease the blood pressure.

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THE MOLECULAR WEIGHTS OF ANTIBODIES

IT was shown by Heidelberger and Pedersen[1] that certain antibodies formed by the horse and the rabbit differed markedly in sedimentation constants and therefore probably also in size. It is of importance, therefore, to make accurate determinations of the molecular weights of these substances and also of the antibodies formed in other animal species.

Types I and III antipneumococcus sera from the horse, rabbit, pig, cow and monkey were used. The antibodies were purified by dissociation with 15 per cent. sodium chloride of the washed specific precipitate or agglutinate formed by adding type specific polysaccharide[2] or a heavy suspension of heat-killed pneumococci. Several of the antibody solutions used were prepared especially for this investigation by Dr. Michael Heidelberger, of the Presbyterian Hospital, New York. The 15 per cent. salt extracts were dialyzed against 0.9 per cent. NaCl and the sedimentation (s) and diffusion (D) constants determined.[3,4] From these values the molecular weights were calculated according to the formula given by Svedberg:

$$M = \frac{RTs}{D(1-V\rho)}$$

Determinations of the partial specific volume for horse antibody gave V = 0.715, which was also assumed to be valid for bovine and pig antibody. The value for normal globulin V = 0.745, was used in calculating the molecular weights of rabbit and monkey antibody. Table I shows the average sedimentation constants, diffusion constants and molecular weights of the various antibodies. In the last column are given the ratios between the experimentally determined molar frictional constant and the molar frictional constant for a spherical particle of the same mass and density.

TABLE 1

Species	$s_{20} \times 10^{13}$	$D_{20} \times 10^{7}$	M	f/f_0
Pig	18.0	1.64	930 000	2.0
Cow	18.1	1.69	910 000	2.0
Horse ...	17.9	1.63	930 000	2.0
Rabbit ...	7.0	4.23	157 000	1.4
Monkey ..	6.7	4.06	157 000	1.5

The high value for the frictional ratio f/f_0 would indicate that the heavy antibody molecule is neither compact nor spherical, as $f/f_0 = 1$ is obtained only when the molecule is spherical and unhydrated.

The proportion of antibody N to total N in the solutions ranged from 40 to 100 per cent. In each case, however, it was possible to obtain solutions showing only a single component with the sedimentation constant in the table. (A very small amount of a heavy component was found in the monkey antibody preparation).

The sedimentation constant was also measured in the 15 per cent. salt solution used for dissociation and found to be the same as after dialysis, indicating that the purification process had not altered the ultracentrifugal properties of the antibody.

In a horse antiserum and a pig antibody solution (each containing two components, $s = 6.7$ and 18.7×10^{-13}) it was possible to demonstrate that the heavy component was the bearer of the antibody activity by using the new analytical cell described in *Nature*.[5] After centrifuging the heavy component into the lower compartment no antibody could be detected in the upper compartment. When the heavy component was centrifuged so that the boundary was only part of the way down, antibody still remained in the upper compartment.

The results indicate that there are two definite groups of animals, one usually producing antibody of the same size as the heavy component frequently observed in normal mammalian sera, and the other forming antibody of the same size as the principal globulin component of normal sera.

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VITAMIN L

THE specific dietary factor for lactation and vitamin B complex had long been confused, and it was not until 1934 that the two were clearly distinguished and the existence of the lactation factor established.[1] Since

[1] M. Heidelberger and K. O. Pedersen, *Jour. Exp. Med.*, 65: 393, 1937.
[2] M. Heidelberger and F. E. Kendall, *Jour. Exp. Med.*, 64: 161, 1936; M. Heidelberger and E. A. Kabat, *Jour. Exp. Med.*, 67: 181, 1938.
[3] For a review see The Svedberg, *Chem. Rev.*, 20: 81, 1937; *Nature*, 139: 1051, 1937.
[4] O. Lamm and A. Polson, *Biochem. Jour.*, 30: 528, 1936.
[5] A. Tiselius, K. O. Pedersen and The Svedberg, *Nature*, 140: 848, 1937.
[1] W. Nakahara, F. Inukai and S. Kato, *Proc. Imp. Acad.*, Japan, 10: 268, 1934; *Sci. Pap. Phys. Chem. Research*, Tokyo, 24: 155, 1934.

that time our knowledge on the subject has been greatly extended, and it now appears that this lactation factor may well be considered as a new vitamin.[2,3]

A diet can be formulated which is entirely adequate *except* for lactation. We found, for example, a mixture of polished rice powder, 75 gr, fish protein, 10 gr, butter, 10 gr, McCollum's salt mixture, 5 gr, adequately supplemented with acid earth adsorbate of yeast extract (vitamin B complex), to be just such a diet. On this diet, in spite of the excellent growth of young rats, normal pregnancy and parturition, rats fail to rear the young at the first as well as at the second births.

In order to secure normal lactation, two hitherto unidentified substances must be added to the diet, namely, factor L_1 and factor L_2. That these two are different substances was proved by the fact that a large amount of the one can not substitute for the other. The two factors are equally essential in that one is without effect in the absence of the other.

We separated factor L_1 from beef liver extract by removing vitamin B complex by adsorption on acid earth at pH 3–4, precipitating from the non-adsorbable fraction with $Ba(OH)_2$ and methanol, removing water-soluble matter (glycogen) from the precipitate, and finally precipitating from the aqueous solution with $WO_3.2H_3PO_4$. This crude preparation proved active in the estimated daily amounts of less than 50 mg per rat.

Factor L_2 was obtained from baker's yeast by similarly removing from the extract vitamin B complex by adsorption on acid earth, precipitating from the filtrate with $WO_3.2H_3PO_4$ and again with $AgNO_3$ and $Ba(OH)_2$. This preparation was effective in daily amounts of 15 mg per rat.

Beef liver does not contain factor L_2, while baker's yeast seems to be devoid of factor L_1.

The exact physiological role of L-factors is as yet far from being clear, but we recently found that if the lactation mechanism is established at the first birth in the presence of L-factors, these latter are no longer needed for the second lactation in so large an amount as is absolutely necessary for the first lactation. It may be that these factors have specific relation to the first establishment or maturation of the lactation mechanism.

From the point of view of nutritional study, the lactation factors in question must be regarded as vitamins, since there is no doubt that animals depend entirely on dietary supply for the substances, which we know must be effective in very minute amounts. We, therefore, propose to call them vitamin L_1 and vitamin L_2, together constituting vitamin L complex.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE VIVI-DIFFUSION APPARATUS

A VIVI-DIFFUSION apparatus which has been found satisfactory for the rapid removal of non-protein nitrogen from the circulating blood is shown in Fig. 1. In contrast to the vivi-diffuser described by Abel and and coworkers[1] this apparatus (a) uses a ready-made membrane, (b) is simple in design, (c) has provision for the stirring of the dialyzing fluid and (d) is equipped with a constant temperature mechanism.

A metal can (36×30 cm) contains a hollow, weighted, removable, spiralled core (31×20 cm) on which is wound 20 feet of $\frac{3}{8}$ inch size Visking sausage casing.[2] This length of casing holds approximately 600 cc of blood. The ends of the casing are moistened and fitted over glass tubes, A and V, tied with light cord, and are then clamped with rubber-lined clamps (C). Tubes A and V are sealed into the can by means of rubber stoppers. Tube A is connected by means of rubber tubing to the arterial canula; tube B is similarly connected to the venous canula.

An electric heater (H), a thermostat (T) and an electric stirrer (N) are fitted in the can cover. These devices are so constructed that they can be dropped into place after the cover has been attached to the can.

The dialyzing fluid consists of 0.7 per cent. sodium chloride solution (14 liters) kept at a temperature of 38° C. During operation the venous end of the membrane is kept at the same level as the venous canula.

Normal and nephrectomized dogs anesthetized with nembutal were used to test the efficiency of the apparatus in removal of non-protein nitrogen compounds from the blood. Heparin was used as an anti-coagulant. Blood was taken from the carotid artery and returned to the jugular vein. When small dogs were

[2] W. Nakahara, F. Inukai, S. Kato and S. Ugami, *Sci. Pap. Inst. Phys. Chem Research*, 29: 47, 1936.

[3] W. Nakahara, F. Inukai and S. Ugami, *Proc. Imp. Acad.*, 11: 362, 1935; 12: 289, 1936; *Sci. Pap. Inst. Phys. Chem. Research*, 28: 31, 1935: 31: 42, 1937.

[1] J. J. Abel, L. G. Rowntree and B. B. Turner, *Jour. Pharmacol. and Exp. Therap.*, 5: 275–316, 1914.

[2] From the Visking Corporation, 4311 Justine St., Chicago, Ill.