the animals receiving pectin are not very different from those of the control animals. If pectin had been stored in the liver to the extent found by Andersch and Gibson[2] for acacia, the furfural values for the livers of the pectin-treated animals would have been of the order of 15 to 18 mg. No attempt was made to determine the time during which the pectin remained in the blood. An analysis was made 7 days after the last injection merely to show that the pectin had been eliminated from the blood.

Our work so far indicates that: (1) Massive amounts of pectin in the form of autoclaved isotonic solutions may be injected into the blood stream of rabbits over a period of some weeks without causing any noticeable effect upon the internal organs of the animals. (2) Chemical analyses showed no deposition of pectin in the liver and kidneys. (3) No pectin could be found in the blood 7 days after injection.

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Utilization of Parenterally Administered Casein Digest for Synthesis of Proteins.*

DWIGHT E. CLARK, ALEXANDER BRUNSCHWIG AND NANCY CORBIN.

From the Departments of Surgery and Medicine, The University of Chicago.

Intravenous or subcutaneous administration of casein digest (representing amino acids and polypeptides) as a means of parenteral nitrogen administration has been studied recently by Whipple and associates[1] in dogs previously depleted of plasma protein and on a low protein diet. Elman and Weiner[2] first reported that casein digests could be safely administered to man when certain precautions were observed. Clinical use of casein digests by parenteral administration in nephrotic children has been reported by Farr and associates,[3, 4] Shohl, Butler, Blackfan and MacLachlin,[5] and Shohl and

* This work was facilitated by a grant from Mead Johnson and Company, Evansville, Indiana.

1 Madden, S., Zeldis, L., Hengerer, A., Miller, L., and Whipple, G., *Science*, 1941, **93**, 330.

2 Elman, R., and Weiner, D., *J. A. M. A.*, 1939, **112**, 796.

3 Farr, L., *J. Ped.*, 1940, **16**, 679.

4 Farr, L., and MacFadyen, D., PROC. SOC. EXP. BIOL. AND MED., 1939, **42**, 444.

5 Shohl, A., Butler, A., Blackfan, K., and MacLachlin, E., *J. Ped.*, 1939, **15**, 469.

Blackfan[6] have made extensive metabolic studies on infants receiving intravenous casein digest and crystalline amino acids.

Preliminary to clinical studies by the writers on the use of casein digests it was desired to ascertain whether the animal organism could actually regenerate plasma proteins with the intravenously administered digests as the *sole source of nitrogen* except for 15 to 30 mg of nitrogen injected intramuscularly in the form of liver extract (analysis of liver extract used showed a content of 15 mg of N per cc). Such a demonstration has not previously been reported as in other studies some protein was always present in the basic diets, although the amount might appear to be negligible.

The product used was an enzymatic hydrolysate of casein (Amigen) kindly furnished by Mead Johnson and Company of Evansville, Indiana, as a 10% solution. One hundred grams of the dried digest yield 12 g of nitrogen and it contains all the essential amino acids.[7]

Dogs were depleted of their plasma proteins by feeding the following nitrogen-free diet: 100 g dextrose, 50 cc olive oil, 50 cc "mineral milk," 10 gtts "Vi-Penta Oil" (Hoffman-LaRoche) containing Vitamins A, B_1, B_2, C, D.

The "mineral milk" was a formula modified after that published by McLance and Widdowson[8] and was made up as follows: Water, 5000 cc; KH_2PO_4, 204 g; calcium lactate, 337 g; $MgSO_4$-$7H_2O$, 65 g; $FeSO_4 7H_2O$, –? g; "iodized" NaCl (commercial), 200 g; copper sulphate, "pinch." The amount given daily supplied the mineral requirements adequately. Liver extract was injected in doses of 1 cc intramuscularly at one- to 2-week intervals throughout the entire periods of observation. The quantity of diet mentioned in the above paragraph supplied about 800 calories. The dogs were fed amounts equivalent to 80 calories per kg of body weight. During the depletion period they ate the diet readily. After the injection of casein digest began, which was carried out by syringe on an average of 5 to 7 times a day in 50 cc amounts, the appetite was frequently lost, necessitating forced hand feeding. This was carried out by placing a bolus of the aliment in the back part of the animal's mouth and inducing deglutition. While cumbersome, the method was satisfactory.

Plasma proteins were determined in duplicate by the micro-Kjel-

[6] Blackfan, K., and Shohl, A., *J. Nutr.*, 1940, **20**, 305.

[7] Mueller, A., Kemmerer, K., Cox, W., Jr., and Barnes, S., *J. Biol. Chem.*, 1940, **134**, 573.

[8] McLance and Widdowson, *Lancet*, 1935, p. 1437.

dahl-titration method.[9] The values for non-protein nitrogen were always within the normal range. Hematocrit determinations were made by centrifuging oxalated whole blood.

In all, 7 dogs were employed. Each experiment consisted of a depletion period on the nitrogen-free diet and then an experimental period during which the basal nitrogen-free diet was supplemented with daily intravenous injections of the casein digest. In 2 dogs on which 2 experiments were performed an intervening period of stock feeding was given permitting protein regeneration in the

TABLE I.
Summary of Experiments on Plasma Protein Regeneration with Intravenous Injection of Casein Digest (Amigen).

Dog	Depletion period N-free diet, days	Duration of inj., days	Avg daily casein digest intrav. (10% sol.), cc		Beginning of inj. period	End
Eddie Exp. I	47	12	165	Wt, kg	6.7	6.1
				Total PP*, g %	4.06	5.64
				Hematocrit	39	34.2
				RBC†, M	6.2	5.8
Eddie Exp. II	21	17	177	Wt, kg	7.0	6.2
				Total PP, g %	4.66	4.91
				Hematocrit,	41	32
				RBC, M	8	5.8
Fuzzy Exp. I	27	21	248	Wt, kg	9.2	8.3
				Total PP, g %	4.74	5.12
				Hematocrit	43	35
				RBC, M	7	5.0
Fuzzy Exp. II	37	15	210	Wt, kg	9.1	9.2
				Total PP, g %	4.31	4.97
				Hematocrit	43	35
				RBC, M	6.1	6.0
Pete	77	18	309	Wt, kg	7.4	6.6
				Total PP, g %	5.0	5.97
				Hematocrit	37	25
				RBC, M	7.5	4.7
Mike	21	11	256	Wt, kg	8.6	8.1
				Total PP, g %	3.98	4.99
				Hematocrit	38.2	27
				RBC, M	7.5	6.14
Kate	76	7	214	Wt, kg	8.1	7.6
				Total PP, g %	5.31	5.7
				Hematocrit	40	36
				RBC, M	5.5	6.1

*Plasma protein. †Red blood count.

[9] Peters and VanSlyke, *Quantitative Clinical Chemistry*, Williams and Wilkins Company, Baltimore, 1932, **2**, 530.

normal physiological manner. The results of 7 experiments are summarized in Table I and show significant regeneration of blood plasma proteins.

In one dog not included in the table, which received the digest intravenously over a period of 33 days, the blood plasma proteins were 4.93 at the beginning of the injection period (Hematocrit 40.2, red blood count, 6.7 M) and 4.82 (Hematocrit 30, red blood count 5.2 M) at the termination with a loss in weight of .7 kg. A second dog was obviously ill during the entire injection period of 13 days during which time the plasma proteins changed from 4.69 (Hematocrit 32, red blood count 5.8 M) to 4.66 (Hematocrit 20, red blood count 4.3 M), the loss in weight being from 8.8 kg to 7.73 kg. Death of the animal terminated the experiment.

Conclusion. Regeneration of plasma proteins was found to occur in dogs with depleted proteins stores and lowered plasma proteins on a nitrogen-free diet receiving intravenously an enzymatic hydrolysate of casein as the sole source of nitrogen. Parenterally administered casein digest constitutes an effective method of parenteral nutrition.

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The Form of Combination of Radioactive Iron and Copper in Plasma Following Ingestion.

H. YOSHIKAWA,* P. F. HAHN AND W. F. BALE. (Introduced by G. H. Whipple.)

From the Departments of Pathology and Radiology, University of Rochester School of Medicine and Dentistry.

It has been generally accepted as a fact that iron in transport in the blood plasma following its ingestion occurs in combination with globulin. The use of radioactive isotopes enables us to distinguish between iron† and copper‡ normally found and that recently added to the body economy. In earlier experiments we reported that, whereas

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† We are deeply indebted to Professor E. O. Lawrence and members of the Radiation Laboratory of the University of California for the radioactive iron used in these experiments, and in particular to Dr. M. D. Kamen, who was directly responsible for preparing the isotope.

‡ The radio copper was prepared in the cyclotron of the Department of Physics of the University of Rochester through the kindness of Dr. Gerhard Dessauer.