TABLE II.
Crystalline Vitamin B_{12} Compared with Vitamin B_{12} Concentrate.

Dietary supplement		No. of chicks	Avg wt gain g/chick	
Choline chloride %	Source of vitamin B_{12} $\cong$ μg per kg diet		7 days	14 days
.1	None	11	16	27
.1	Crystalline vit. $B_{12} \cong 15$	7	30	67
.1	B_{12} conc. No. 1 $\cong$ 15	11	30	72

the basal diet is supplemented with .1% choline chloride than when it is supplemented with .6%. It would be of interest to determine whether the feeding of a low-choline diet to hens would increase the requirement for the "animal protein factor" in the progeny, similar to that noted when the hens were restricted to a diet low in the "animal protein factor".[5,6]

The interesting interrelationship of vitamin B_{12}, choline, and methionine is being studied further in this laboratory.

Summary. 1. Vit. B_{12} was fed to Leghorn chicks receiving a choline-low basal diet supplemented with .6%, .2%, .1%, and .05% choline chloride. The 14-day increment in weight gain over the controls that did not receive vitamin B_{12} was 26 g, 32 g, 63 g, and 21 g, respectively.

2. Crystalline vit. B_{12} fed at a level of 15 μg per kg of diet and at a choline level of .1% was as effective as vit. B_{12} concentrate in a 2-week feeding period.

3. The choline requirement of chicks under the conditions of these experiments was markedly reduced by the supplementation of the diet with vit. B_{12}.

4. It appears that dietary choline has a significant sparing action on vit. B_{12}.

Received April 19, 1949. P.S.E.B.M., 1949, **71**.

17134. An Oxygenator with Increased Capacity: Multiple Vertical Revolving Cylinders.*

KARL E. KARLSON, CLARENCE DENNIS, DAVID SANDERSON, AND CHARLES U. CULMER.
From the Department of Surgery, University of Minnesota, Minneapolis, Minn.

The vertical revolving cylinder has been shown to be an effective oxygenator for blood.[1,2] Its efficiency as an oxygenator is probably increased by making the cylinder shorter in relation to its diameter.[3] These data were applied in the construction of another oxygenator with approximately eight times the capacity of the oxygenator previously studied.

Experimental. Eight concentric cylinders (Fig. 1, C) 21 cm in height, ranging from 27.5 cm to 17.0 cm in diameter are mounted so that the lower edges of the cylinders are approximately one centimeter above the inner surface of a cone (f). The surface area is 14,500 cm^2. Blood is delivered through individual spouts (b) onto the inner surface of each cylinder, drops off of its lower edge onto the inner surface of the cone, flows into the vertical shaft (t), runs down the inner surface of the shaft, and collected in the stationary cup (h) beneath. A 94% O_2 and

* Aided by a grant from the United States Public Health Service, and by a research grant from the Graduate School, University of Minnesota.

1 Gibbon, J. H., Jr., *J. Lab. and Clin. Med.*, 1939, **24**, 1192.

2 Gibbon, J. H., Jr., and Kraul, C. W., *J. Lab. and Clin. Med.*, 1941, **26**, 1803.

3 Karlson, K. E., Dennis, C., and Westover, D. E., PROC. SOC. EXP. BIOL. AND MED., 1949, **70**, 225.

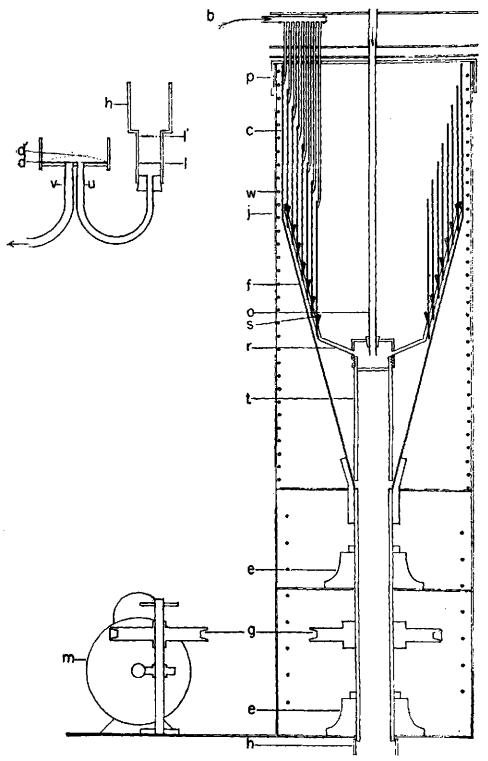

FIG. 1.

Schematic representation of oxygenator. b. blood inlet; c, cylinders upon which blood films; d. rubber dam covering outlet; d', rubber dam raised to permit flow; e, bearing; f, blood collecting funnel; g, pulleys for revolving oxygenator; h, collecting cup; j. insulated jacket; l, level of blood when rubber dam shuts off blood flow; l', level of blood when rubber dam is raised; m, motor; o, oxygen inlet tube; p, plastic cover; r, rack which holds concentric cylinders and conducts oxygen to the cylinders; s, spouts which deliver oxygen to each cylinder; t, hollow shaft which delivers blood to cup, h; u, blood inlet tube to level control; v, blood outlet tube from level control to pump; w, warm water coil.

6% CO_2 gas mixture is piped down into the shaft (o) and through the hollow tubing of the rack (r) which supports the cylinders. There are four oxygen inlets (s) supplying each cylinder. The shaft, cone, and cylinders all rotate as one unit at 150 r.p.m. There is very little foaming of blood.

The blood is pumped from the animal and back to the animal by pumps which have an intermittent pulsatile action. Ball valves give directional flow. Steady flow into the oxygenator is obtained by having 3 such pumps in a parallel arrangement.

The blood level in the collecting cup is maintained by a leveling device which consists of a plate with a sheet of rubber dam (d) stretched over it. A hole in the plate admits blood from the collecting cup, another allows the blood to flow into the "arterial" pump. The level of the plate in relation to the cup determines the level of blood in the cup because hydrostatic pressure of blood in the cup raises the rubber dam (d') off the plate and allows blood to flow under the dam to the pump. When the level of blood in the cup is at the level of the plate (1) the rubber dam is sucked down onto the plate by the pump and no blood flows. Because the action of the pump is intermittent, the dam is again separated from the plate by the blood when the level in the cup rises (1'). Body temperature is maintained with warm water coils (w) around the oxygenator and warm air around the collecting cup and leveling device. A filter with 230 micra spaces is used in the "arterial" stream.

To date 13 perfusions of dogs have been done. In 4 instances blood was withdrawn from the femoral veins, and in 9 the vena cava was cannulated. Blood was infused via the femoral, brachiocephalic, or the subclavian artery. Blood flow rates were estimated with a venturimeter. The volume of the film was measured by turning off the pumps to the oxygenator and allowing the blood on the cylinders to collect in a graduate. Oxygen content of blood as it left the animal (venous) and as it returned (arterial) was determined by the Van Slyke method.[4]

Results. The results of 5 experiments in which data were collected are tabulated in Table I. At the flow rates obtained by pumping all available blood from the vena cava a film could be maintained on only 4 or 5 cylinders. Thus, the total capacity of the oxygenator is considerably greater than that utilized in these instances. It was noted that the animals made very few slight respiratory movements during perfusion even though no pulmonary respiration was maintained. The efficiency of the oxygenator (no. of cc O_2

[4] Van Slyke, D. D., and Neill, J. M., *J. Biol. Chem.*, 1924, **61**, 523.

TABLE I.
Results of Five Perfusions Withdrawing Blood from the Vena Cava and Returning It Through a Femoral Artery.

Length of perfusion (min.)	Blood flow (cc/min.)	Film vol. (cc)	No. of cylinders filmed	$cc O_2$ introd. per cc film per min.	$cc O_2$ introd. per min.	Survival time	Plasma hemoglobin (g%)	
							Before	After
10½	720	300	4	.272	81.7	6 wk*		
12	680	270	5	.272	73.4	1½ hr	.57	.54
11	840	210	5	.284	59.6	10 min.	.25	.23
21	760	200	4	.266	53.2	1½ hr	.70	.71
22	1250	265	6	.295	78.3	3 hr	.80	.94

* Alive.

introduced into the blood per cc of film per minute) is seen to compare favorably with that in earlier experiments (0.247 cc). There was one other survival. The remainder expired at periods of 30 minutes to 36 hours after perfusion. Hemolysis was found to increase very little during perfusion.

Conclusions. 1. An oxygenator consisting of 8 concentric revolving cylinders which utilizes a funnel to deliver the blood into a small cup is described.

2. Animal perfusions demonstrate that its efficiency as an oxygenator is high enough to make it possible to perfuse the entire animal body without using an impractically large amount of blood in the extra-corporeal circulation.

Received April 20, 1949. P.S.E.B.M., 1949, **71**.

17135. Hemagglutination by Normal and Poliomyelitis Stool Suspensions.*

ALBERT MILZER AND PHYLLIS ADELMAN.

From the Department of Bacteriology and Virology, Medical Research Institute, Michael Reese Hospital, Chicago, Ill.

The phenomenon of agglutination of erythrocytes by certain viruses is well known.[1] Viruses known to produce hemagglutination include influenza A & B, vaccinia, ectromelia, mumps, mouse pneumonitis, fowl plague and Newcastle disease. These agglutination reactions can be differentiated from each other by inhibition with specific immune sera. Certain bacteria and pleuropneumonia organisms also have the property of agglutinating red blood cells. Recently, the presence of a hemagglutinin in bacteria-free amniotic fluid of normal embryonated hens eggs has been described by the Army Commission on Acute Respiratory Diseases.[2] This substance was shown to be associated with the globulin fraction of egg albumin and gains access to amniotic fluid when the contents of the albumin sac ruptures into the amniotic cavity between the 11th and 13th day of incubation. Hemagglutination can also be induced by ricin, abrin, crotin and certain inorganic colloidal acids or bases such as salicylic acid and basic proteins as protamine.

In studies on the detection of possible hemagglutination by the poliomyelitis virus, it was found that both normal and infected saline stool suspensions agglutinated the erythrocytes of a wide variety of animal species. This paper is a report describing the agglutination of group "O" human, chick, rabbit, guinea pig and sheep erythrocytes by stool suspensions and some of the properties of the stool hemagglutinin.

* Supported in part by the Michael Reese Research Foundation.

1 Rivers, T. M., Viral and Rickettsial Infections of Man, J. B. Lippincott Co., 1948, p. 77.

2 Commission on Acute Respiratory Diseases, PROC. SOC. EXP. BIOL. AND MED., 1946, **62**, 118.