The implanted marrow contributes as much as 80% of the peripheral erythrocytes.

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## A Simple Circulatory Bypass System.* (22083)

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Some method of total circulatory bypass is necessary to accomplish open intracardiac surgery. Ideally such a system should entail a minimum of danger to the subjects accompanied by a maximum of simplicity of working parts and operability. The use of homologous and heterologous lungs in combination with some type of mechanical pump has been shown by others(1,2) to most closely approach this ideal. This is a report of experimental work with an homologous lung system which has been further simplified.

*Methods.* Mongrel donor dogs weighing 10 to 20 kg were bled to death after receiving one mg of heparin per kilo of body weight. Heparin was then added to this blood in amounts of one mg per 100 cc of blood. This blood was used to prime the extracorporeal system, to replace blood loss, and to maintain the operated dog's blood pressure during surgery. No blood was given to any of the dogs after completion of the experimental surgical procedure. Following exsanguination of the donor dog, the left lung was removed and the bronchus and pulmonary artery were cannulated, the former being connected to a respirator and the latter to the discharge end of a 300-cc graduated cylinder. Experimental dogs weighing from 9 to 20 kg were then anesthetized with morphine and nembutal and the

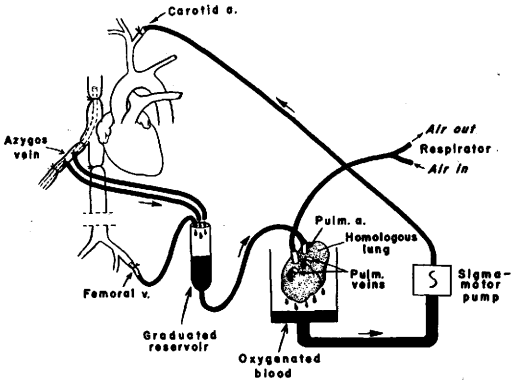


FIG. 1. Cannula connections of homologous lung blood oxygenator.

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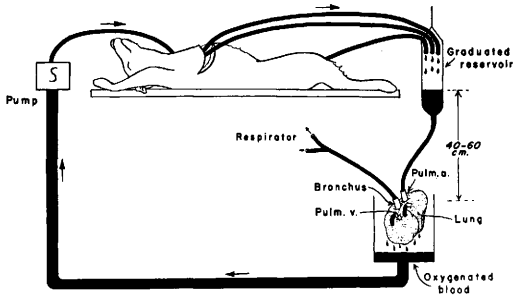


FIG. 2. General arrangement of homologous lung blood oxygenator.

femoral artery and vein cannulated and connected to an electronic recording manometer. Cannulae were also placed in the other femoral vein, the distal portion of the azygos vein, and the superior vena cava via the proximal portion of the azygos vein. These cannulae were all led to the intake portion of the 300 cc graduated reservoir. Another cannula was placed in the proximal portion of the dog's carotid artery and led through a Sigmamotor pump to a bottle collecting the oxygenated blood. All cannulae were filled with a saline solution containing one mg of heparin per kilo of body weight of the dog. The details of the various cannula connections are shown in Fig. 1 and the general arrangement of the lung and pump is shown in Fig. 2. During operation of the extracorporeal system, venous blood is drained into the graduated cylinder, which can be used as a flowmeter, after equilibration of arterial and venous flows. Venous blood is then forced by gravity through the artificially respirated lung, pressures of 40 to 60 cm of water (blood) being more than adequate for flows needed in these experiments. Oxygenated blood then flows out of the pulmonary veins, is collected in an inverted bottle, and pumped back to the dog with a Sigmamotor pump of variable speed. With the circulatory bypass system in operation as described, 12 experimental ventriculotomies have been done, under clean but not sterile conditions, during a period of 30 minutes of complete bypass of the heart and lungs, this period being preceded and followed by 2- to 3-minute periods of partial bypass. During the ventriculotomies the right ventricle was kept open for a period of 5 minutes. Continuous recordings were made of the arterial and venous pressures and usually 2 measurements were made of the blood flow. Low blood flows were used according to the azygos flow principles determined by others(3). After the experimental animal was disconnected from the circulatory bypass system the heparin in its blood was neutralized by the addition of protamine sulfate. The amount of protamine to be given was determined by dividing the total amount of heparin used by 2 and giving one cc of 1% protamine sulfate for every 10 mg of heparin. This was diluted in 100 cc of 5% glucose and given by intravenous drip over a 15- to 20-minute period. After administration of the protamine, titration tests were done to determine if sufficient quantity had been given.

*Results.* Twelve experimental animals have been subjected to this procedure. The first 5 animals survived the experiment without sequelae. The next 5 animals all died in the immediate postoperative period, severe bleeding being the cause of death. Despite the fact that adequate protamine had been given these dogs to neutralize the heparin by *in vitro* testing, their blood did not clot *in vivo*. In attempting to discover the cause of this reduced coagulability, it was discovered that the glass and plastic equipment that was being reused in successive experiments was not being adequately cleaned. All of this equipment was then either replaced or cleaned thoroughly with acid solution. The 2 dogs that have undergone the experiment since then have sur-

TABLE I. Blood Flow during Homologous Lung Experiments in 12 Dogs.

| Survival | Flow (cc/kg/min.) | Flow (cc/min.) | Remarks |
|---|---|---|---|
| + | 44–58 | 540–720 | Aborted 1st day postop. |
| + | 52 | 540 | |
| + | 36–40 | 540–600 | |
| + | 20–25 | 240–300 | |
| + | 44 | 600 | |
| 0 | 39 | 420 | |
| 0 | 44 | 600 | |
| 0 | 27 | 480 | |
| 0 | 40 | 420 | |
| 0 | 25–29 | 240–280 | |
| + | 33 | 420 | |
| + | 31–35 | 420–480 | Ventricular fibrillation |

vived without sequelae and have shown no evidence of bleeding tendency.

*Summary.* The use of an homologous lung is at present the simplest and most efficient method of providing extracorporeal oxygenation of blood. A simplified method of using such a lung experimentally has been described. In this experimental study of 12 animals there were 7 survivors, the 5 fatalities being caused by severe bleeding resulting from contaminated equipment.

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## Relationship of Salivary Tryptophane to Lactobacillus Colony Morphology and Dental Caries.* (22084)

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In a previous investigation of the salivary microflora of dental caries-free and caries-susceptible humans, an association of smooth colony morphology of lactobacilli with saliva of caries-free subjects has been described(1). Rough colony types predominated in saliva of the caries-susceptible subjects. The observation that a tryptone medium as well as tryptophane induced rough to smooth dissociation in colony morphology of oral lactobacilli prompted the present study of this action of tryptophane on lactobacillus colony morphology, and the possible relationship of salivary tryptophane to caries resistance.

*Materials and methods.* The lactobacilli used in this study were of human oral origin. The cultures were classified into 3 types, smooth, intermediate and rough on the basis of colony morphology on tomato agar. The rough colony type is flat, translucent, with an indented to serrated edge, and is stable on consecutive passage on tomato agar. Tomato juice agar was prepared according to the Hadley method(2). Rogosa's Lactobacillus Selective Medium(3), used for growth and fermentation studies, was modified for general use as a liquid medium by omission of the agar, glacial acetic acid, and 5 g of sodium acetate per liter.

To test the action of tryptophane the medium was modified to contain 10 g acid hydrolyzed Casamino Acids (Difco) instead of trypticase; 0.013 g dl-tryptophane; and 15 g agar. Additional amounts of dl-tryptophane were added as required. Modifications of the Ehrlich (paradimethylaminobenzaldehyde) and Hopkins-Cole (glyoxylic acid) tests were studied for determination of tryptophane in saliva, and the latter test was selected. The procedure has been described by Block(4), with the essential modification that the concentration of $H_2SO_4$ was reduced to avoid undesirable reactions with other constituents of saliva.

Three ml of resting and 3.0 ml of stimulated saliva were collected from a subject and mixed. Two ml of the mixture were placed in a 10.0 ml volumetric flask and 0.5 ml of M/25 $CuSO_4$ and 0.5 ml of glyoxylic acid were added. The flask was held in an ice-and-water bath for 5 min., then 5.0 ml of 80% $H_2SO_4$ were slowly added. The flask was held in the cold bath for 10 min. then placed in boiling water for 5 min. After cooling 2 min. at room temperature the contents were mixed

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