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Colorimetric Studies on the Blood Exchange in Parabiotic Rats.*

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While in cattle twins with anastomosing chorioallantoic blood vessels and in amphibians grafted together at an early embryonic stage sex hormones are exchanged in sufficiently large amounts to cause sex transformation, little, if any effect so far has been reported from experiments on parabiosis in fowl and in rats. This faces us with the double problem of the amounts of active hormones that may be transferred from one animal to its parabiotic twin and of the threshold values of the hormones considered. Witschi[1] states that the capillary connections in chains of a newt let pass enough of the hypophyseal hormones to stimulate the processes leading to metamorphosis, but too little to bring about the expansion of the melanophores.

From this it becomes obvious that the quantitative factor should be taken into consideration at the outset of parabiosis experiments. The author, therefore, has started some colorimetric studies on the amount and speed of exchange of blood in parabiotic rats. The technique developed by Dawson, Evans and Whipple[2] and by Smith[3] in their work on the blood volume of dogs has been adapted to the special conditions of our experiment.

One-tenth of a cubic centimeter of 1% Brilliant Vital Red (Evans) was injected into the heart of one of the twins. At the end of one hour samples of 3 to 4 cc. of blood were taken from both

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1 Witschi, E., PROC. SOC. EXP. BIOL. AND MED., 1930, **27**, 763.

2 Dawson, Evans and Whipple, *Am. J. Physiol.*, 1920, **51**, 232.

3 Smith, H. P., *Bull. Johns Hopkins Hosp.*, 1925, **8**, 177.

members of the pair, mixed with oxalate solution and centrifuged. The clear dye-plasma-oxalate solution thus obtained was compared with a standard by use of the micro combination of the Leitz Universal Colorimeter. In all cases dealt with in this paper the parabiotic pairs consisted of 2 normal female litter-mates. The members of each pair were of practically the same size and so we may assume identity of blood volumes at the time of making the tests. Colorimetric readings, therefore, were simply calculated into percents to obtain the respective amount of dye circulating in each twin.

TABLE I.
Percent of dye in each animal at the end of 1 hour.

Group No.	Uninjected animal	Injected animal	Age in days	No. of days in parabiosis
	%	%		
IX	12.1	87.9	225	191
X	12.9	87.1	225	190
XII	26.5	73.5	226	184
XIV	10.8	89.2	227	187
XV	11.9	88.1	243	184
XVI	35.5	64.5	226	160
XVII	12.8	87.2	218	159
XX	21.0	79.0	221	154
XXI	17.7	82.3	158	121
XXII	26.3	73.7	180	124
XXVI	22.2	77.8	180	121
XXVII	20.0	80.0	177	121
XXVIII	34.0	66.0	183	118
XXXI	21.3	78.7	172	105
XXXIII	10.9	89.1	139	105
XXXV	19.6	80.4	134	99
Average	19.7	80.3	196	145

Examination of Table I shows considerable variation in the amount of dye in the uninjected animal at the end of one hour, varying from 10.8% to 35.5%. There is apparently no relationship between the amount of dye in the uninjected animal and the length of time that the animals have been in parabiosis. It is quite surprising that on the average only about 20% of the dye is found in the uninjected animal at the end of one hour. This indicates that the rate of blood exchange is relatively low and that the vascular connections are of capillary nature only.

With respect to the pairs of normal females listed in Table I we may say that their oestrous cycles are not synchronized, though some interference is quite obvious.