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Reciprocal Oxygen Changes on Both Sides of Placenta During Uterine Contraction and Relaxation.

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Attention has been directed to the intermittent character of intrauterine fetal respiratory movements and it has been suggested that prelabor uterine contractions may be related to this phenomenon.[1] Other motor activities of unanesthetized fetuses delivered with the placental circulation intact varied with contraction and relaxation of the uterus. With each contraction, reddening of umbilical veins and corresponding improvement of fetal color was observed. Uterine relaxation led to darkening of the blood. It was evident that alteration of respiratory gas content of the fetal blood was related to the fluctuations in fetal activities. The umbilical vein blood was richer in oxygen during uterine contraction than during relaxation.[2] Do these changes occur normally *in utero* or are they, perhaps, the result of operative interference with the placental exchange mechanism? The present experiments were planned to help determine the answer.

Large superficial tributaries of the uterine veins carry blood from the maternal side of the placentæ of the cat. It was possible to obtain 0.2 cc samples of blood principally from the placenta from these vessels for analysis by the Van Slyke and Neill[3] micro-manometric method for combined carbon dioxide and oxygen determinations. The cats were not anesthetized but had been decerebrated by tying the carotid and basilar arteries an hour or more before. The uteri were exposed after immersing the animals in a constant temperature bath of Locke's solution.

If the undisturbed fetuses are removing more oxygen from the maternal blood during uterine contraction than during relaxation, the blood leaving the placenta on the maternal side should be lower in oxygen in the period of contraction. Estimations of the blood oxygen are presented in the Table I. The placental samples were

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1 Windle, W. F., Monnier, M., and Steele, A. G., *Physiol. Zool.*, 1938, **11**, 425.

2 Windle, W. F., and Steele, A. G., 1938, *J. Physiol.*, in press.

3 Van Slyke, D. D., and Neill, *J. Biol. Chem.*, 1924, **61**, 523.

taken as close to one another as possible but the maternal femoral arterial and the umbilical blood samples were drawn earlier and later; often 30 minutes or more elapsed between them. The values for carbon dioxide fluctuated widely, depending upon variations in maternal respiratory conditions,[4] and can not serve so well as the oxygen estimations for comparison. In most of the experiments, it was found that the maternal placental blood contained less oxygen

TABLE I.
Oxygen Content in Vol. % of Blood.

Cat		Fetus		Placenta	Maternal	Maternal vein from placenta				Umbilical vein	
No.	Age days	No.	wt g	wt g	artery O_2	C→R O_2	R O_2	R→C O_2	C O_2	R O_2	C O_2
1	23	2	0.2	2.0	19.4		10.0		8.6		
									9.9		
3	35	1	4.0	10.0	14.2		6.8*		5.1		
							10.3				
4	38	1	6.5	11.0	13.2		3.2	2.4	2.7		
6	—	1	16.0	14.0	13.5	2.9	6.3		4.6		
		2	18.0	14.0			9.2†			1.0	
		3	17.0	17.0							4.0
7	—	3	19.0	20.0	13.3	1.7	6.2	6.6			
							7.0				
8	46	1	15.0	10.0	18.5	7.2	5.9*		7.5		
		2	19.0	13.0					4.7		
10	46	1	17.0	24.5‡	14.5		7.1		5.5		
		3	23.5	15.5			6.2		3.3		
11	48	1	25.5	15.5	15.9	7.0	9.0		8.7	4.9	
		2	27.5	17.0		9.0	9.0				
		3	31.0	15.0							8.1
12	—	2	29.0	17.0	13.3				2.8		
									7.9†		
15	—	1	30.9	14.0	13.4		5.6				
		4	45.7	17.4		4.2	6.5			3.7	8.4
23	—	1	77.0	23.0	11.0		2.9	3.5		4.1	1.6
24	—	1	78.0	17.0	11.2	2.8					
		3	75.0	18.0		4.5		3.9			
26	—	1	103.0	25.0	10.5		6.6		1.2		
		2	90.0	15.0		0.2		1.9			
27	—	1	104.0	22.0	12.2		2.7		1.1	1.8	2.5
		2	100.0	20.0			1.2		0.6‖		
28	—	1	99.0	20.0	—	5.0	5.9				7.7
							8.7				
		2	106.0	27.0	12.0§					5.3	8.1

* = Hypertonic uterus; † = umbilical cord occluded; ‡ = placenta serving twin fetuses; § = oxygen capacity; ‖ = under pitocin.

when the uterus was contracted (C) or when a contraction wave was passing (C → R) than it had during relaxation (R) or at the very beginning of a contraction (R → C). It was sometimes very

[4] Steele, A. G., and Windle, W. F., 1938, *J. Physiol.*, in press.

difficult to determine the state of uterine activity exactly, especially when the contractions were not very strong.

During a few experiments not presented in the table, the uterus lacked tonus and conditions suggesting shock obtained; all venous blood was reduced. Hypertonicity of the uterine muscle apparently favored the placental exchange of oxygen (see cats 3 and 8) but when the uterus was tightly contracted, as after pitocin injection, blood vessels were occluded.

That fluctuation in the gas content of placental blood may be related to the amount of gas taken up by the fetus was indicated by experiments in cats 6 and 12. The gas values marked by the dagger (†) were obtained from blood samples drawn from distended uteri but after clamping the umbilical cords of the fetuses. In cat 6, the blood passing back to the mother from the placenta and fetus contained 6.3 volumes % oxygen but that returning from the placenta only contained 9.2 volumes %. Similarly in the other experiment results were 2.8 and 7.9 volumes %. It will be seen that these fetuses obtained about 2.9 volume % oxygen during relaxation and 5.1 volume % during contraction of the uterus.

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Adsorption of Heterophile Antibody by Pneumococci of Different Types.

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It has been shown[1] that a large proportion of strains of pneumococci of types I, II, and III contain heterophile antigen conforming to the Forssman characteristics. Experimental data establishing this point comprise both the results of active immunization of rabbits, and of adsorption of the antibody under controlled conditions *in vitro*. It has become of interest to test by the adsorptive method the heterophile-antigen content of pneumococcal strains of the higher type-numbers since the rapid typing methods have identified these types on a scale sufficiently large to merit close study of both species-antigens and type-antigens in more detail.

Heterophile antibody was prepared in rabbits by 6 intravenous injections of the usual increasing doses of heat-killed pneumococci from culture DRI, and R-variant of the Neufeld type I strain. The

[1] Bailey, G. H., and Shorb, M. S., *Am. J. Hygiene*, 1931, **13**, 831.