

A SPECTROSCOPIC COMPARISON OF FŒTAL AND MATERNAL BLOOD OF THE RABBIT AND GOAT.

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RECENT investigations concerning the conditions of foetal circulation [Barcroft, 1933] have shown that the oxygen dissociation curves of foetal and maternal bloods are dissimilar. It was suggested that such a dissimilarity could be accounted for by differences in character of foetal and maternal hæmoglobin. McCarthy [1933], working with purified solutions, has substantiated this suggestion by showing that the oxygen dissociation curves of foetal hæmoglobin have a greater affinity for oxygen than maternal hæmoglobin. He found no apparent difference in the molecular weights of the two hæmoglobins. More recently Eastman, Geiling and de Lawder [1933] have demonstrated that in human foetal blood oxygen is absorbed more effectively than in the blood of the mother.

It was thought that maybe a spectroscopic analysis of hæmoglobin would offer some additional evidence as to whether or not the differences in the oxygen dissociation curves are due at least to some extent to the specific form of the hæmoglobins.

METHODS.

The procedure employed was described in a previous paper [Hall, 1934]. Blood was diluted approximately one hundred times in the following manner. One cubic centimetre of whole blood was added to 4 c.c. of distilled water. When hæmolysis was complete the blood was centrifuged for 5–10 min. A portion of the supernatant hæmoglobin solution was pipetted into a phosphate buffer solution (1/15 *M*) of the desired *pH*. Dilution was made so that the spectral absorption bands of saturated oxyhæmoglobin of the various samples of blood were of the same intensity as judged by the eye.

Equilibration was accomplished by shaking the tonometer in a water bath maintained at a constant temperature of 37·0° C. Fresh solutions were used for each point on the curve. Following equilibration at various

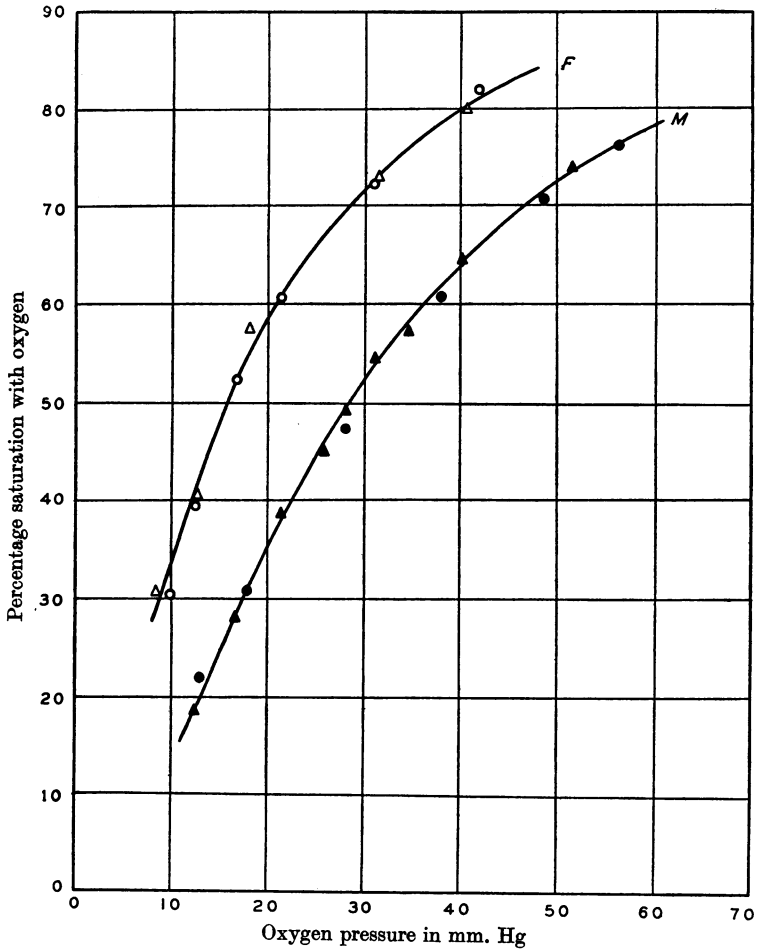


Fig. 1. Oxygen dissociation curves of foetal and maternal haemoglobin from goats, in phosphate buffer at pH 6·8. Δ , from foetus; \blacktriangle , from mother. 15 weeks' gestation. \circ , from foetus; \bullet from mother. 18 weeks' gestation.

oxygen pressures the samples of haemoglobin solutions were tested for methaemoglobin by reducing the oxygen pressure in the tonometer to approximately zero and then matching with the reduced haemoglobin on the spectroscope. Only in haemoglobin solutions which had been frozen

and thawed at intervals over a period of several weeks was any appreciable methæmoglobin found.

The curves are plotted according to formula devised originally by Adair and since modified by Roughton [Brown and Hill, 1923].

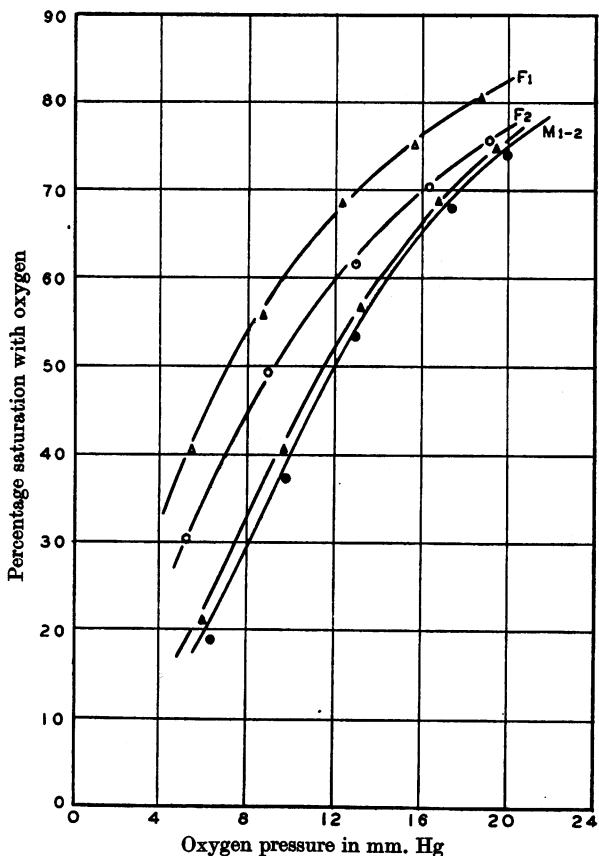


Fig. 2. Oxygen dissociation curves of foetal and maternal hæmoglobin from rabbits, in phosphate buffer at pH 7.4. Δ , from foetuses; \blacktriangle , from mother. 23 days' gestation. \circ , from foetuses; \bullet , from mother. 23 days' gestation.

RESULTS.

Results obtained by spectroscopic comparison of hæmoglobin from maternal and foetal goats are shown in Fig. 1. The blood was taken from the foetal and maternal circulation in the 15th and 18th week of gestation. The total gestation period is 21 weeks. There seemed to be very little difference in the two foetal hæmoglobin curves and the experimental

points are therefore plotted on a single curve. The oxygen dissociation of maternal hæmoglobin varied very little. Unfortunately the spectroscopic analysis did not begin early enough to include determination from

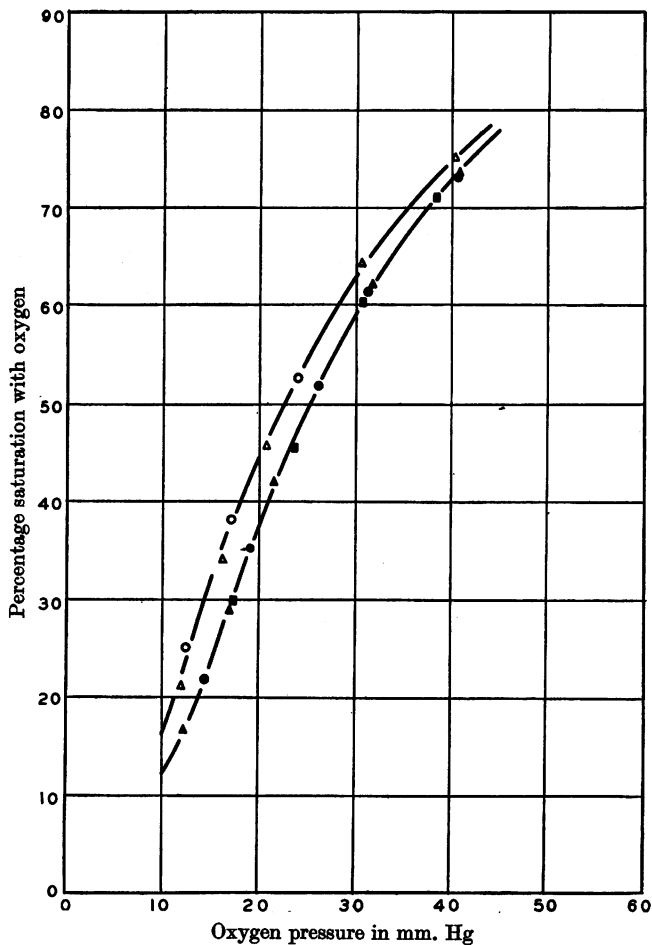


Fig. 3. Oxygen dissociation curves of fetal and maternal hæmoglobin from rabbits, in phosphate buffer at pH 6.8. Δ , from fetuses; \blacktriangle , from mother. 23 days' gestation. \circ , from fetuses; \bullet , from mother. 23 days' gestation. \blacksquare , represents points obtained from a non-pregnant female rabbit.

any more of the goats used in Prof. Barcroft's experiments. It seems quite evident that the oxygen dissociation curve of the fetal blood was decidedly to the left of that of the maternal blood.

Fœtal blood was obtained from rabbits on the 23rd day of gestation. Oxygen dissociation curves were made on the fœtal and maternal hæmoglobin in phosphate buffer solutions (1/15 *M*) at pH 6·8 and 7·4.

The results are shown in Figs. 2 and 3. The oxygen dissociation curve of the fœtal hæmoglobin is definitely on the left of that of the maternal but not so pronouncedly so as in the case of the goat. It was also more decidedly on the left at pH 7·4 than at 6·8.

CONCLUSIONS.

Spectroscopic analysis of the oxygen dissociation of fœtal and maternal hæmoglobin in the goat and rabbit showed that fœtal hæmoglobin had a greater affinity for oxygen than had maternal hæmoglobin. It would seem, therefore, that the greater affinity of fœtal blood for oxygen is partly due to a specific difference in their hæmoglobin.

This work was suggested by Prof. Barcroft as a part of a study of the conditions of fœtal respiration. I wish to thank both Prof. Barcroft and Mr G. S. Adair for their very generous assistance.

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