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SPECTROPHOTOMETER INVESTIGATION INTO THE DIFFERENCES BETWEEN FŒTAL AND MATERNAL HÆMOGLOBIN IN MAN

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It has been shown that in different animals fœtal hæmoglobin has a higher affinity for oxygen than has that of the mother [Barcroft, 1934]. When the dissociation curves are compared the fœtal curve is found to lie to the left of that of the mother. The difference might be explained either by assuming that the maternal differs from the fœtal hæmoglobin or that in the same blood there is more than one sort of hæmoglobin, the proportions of the two forms being different in the fœtal and maternal bloods. Von Krueger & Bischoff [1925] and Brinkman [1934] have shown that the resistance towards alkaline denaturation differs in maternal and fœtal hæmoglobin.

The few dissociation curves which have been recorded on men at high altitudes also seem to be shifted to the left [Barcroft, 1934], and it was suggested that oxygen want tends to displace the adult dissociation curve to its pre-natal position. As this would be a very interesting fact if true, I looked for a simple physical method of demonstrating the difference between these kinds of hæmoglobin for later use in altitude experiments.

For this purpose I attempted to demonstrate the difference between maternal and fœtal hæmoglobin by direct examination of their respective spectra in the ultra-violet. Five experiments were performed and, so far as can be judged by photometric examination of the records, there was no material difference between the maternal and fœtal hæmoglobin. Although the result was negative I feel that it may be of interest to other workers on this subject. An example of the method used is given in the following protocol.

Exp. No. 5. 9 *December* 1934. Human blood obtained from the mother by puncture of the cubital vein some hours before parturition. Fœtal blood obtained from the umbilical cord during birth. A weak solution of hæmoglobin was made up, first washing the corpuscles repeatedly with saline and then hæmolysing them with distilled water. The solutions were saturated with oxygen from the air and distilled water was added until both were of exactly the same depth of colour. A Hilger all-metal quartz spectrograph with hydrogen source was used. The time of exposure was 1 min. The thickness of the absorbing layer of hæmoglobin was varied by a Baly tube.

A series of spectra from the maternal hæmoglobin solution was first taken, followed on the same plate by corresponding spectra from the fœtal solution. The absorptions seem to be the same in both cases (Fig. 1), but for finer analysis I measured the records with a Kipp photometer by two methods. The records obtained by the first method are shown in Fig. 2, where the upper curve refers to the maternal hæmoglobin and the lower curve to the fœtal hæmoglobin. It will be seen that the two curves are almost identical. In the second method the blackening of the plate at a wave-length of 3850 A. was measured by the optical density. The density of each strip for both kinds of hæmoglobin is indicated on the graph. It will be seen that there is no difference between the densities of the corresponding strips (1–5, Fig. 3).

In one experiment I used the bloods of twins, both of which were found to be identical with the maternal blood by the methods used in this paper.

Discussion

Haurowitz [1935] has shown that a solution of hæmoglobin from a newborn child has less affinity for oxygen than a similar solution obtained from the mother. A suspension of fœtal corpuscles, on the other hand, has a greater affinity for oxygen than one of the maternal corpuscles. This reversal of the positions of the dissociation curves does not exist in the experiments which Barcroft has made on different animals. The special property of human hæmoglobins which has been shown to exist by Haurowitz does not affect the point of my experiments, since I was attempting to find out whether the *difference* in affinity for oxygen gives in addition a difference in the short-wave spectrogram.

Purer solutions of hæmoglobin than those used would have been preferable. It is also possible that hæmoglobin from a younger fœtus would have been different from the maternal hæmoglobin. Nevertheless one would have expected to find some slight difference in these experiments if the difference with a younger fœtus was considerable. I am

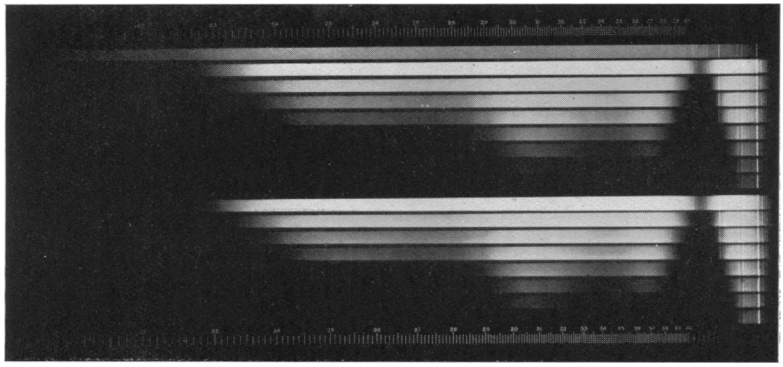

Fig. 1.

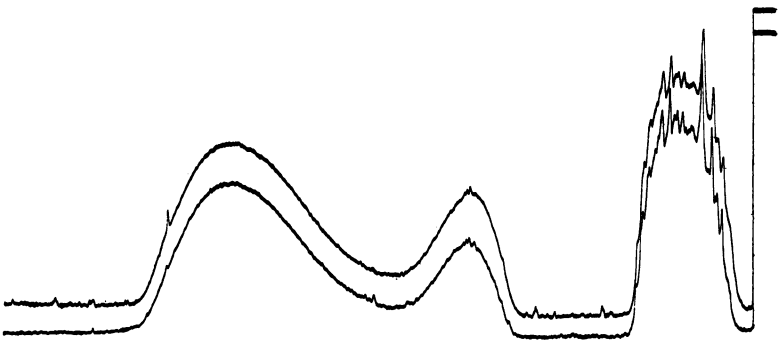

Fig. 2.

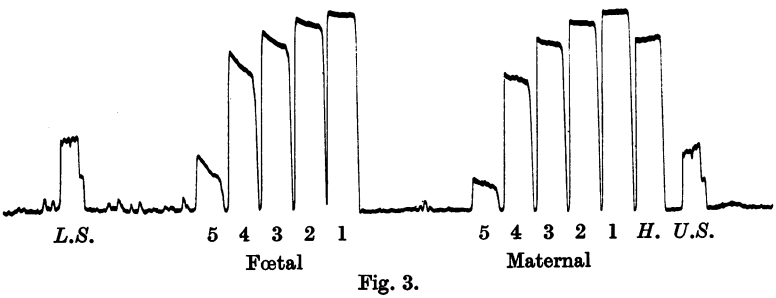

Fig. 3.

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inclined to conclude that the difference in the affinity for oxygen of maternal and fœtal hæmoglobin in man is not correlated with a demonstrable difference in absorption in the ultra-violet.

SUMMARY

Absorption curves in the ultra-violet were obtained from fœtal and maternal hæmoglobin in man. Although the oxygen affinities of the two kinds of hæmoglobin are different from one another, there is no demonstrable difference in their absorption curves.

I am greatly indebted to Sir Joseph Barcroft who was kind enough to read the manuscript and to give me valuable advice. I am also indebted to Prof. A. K. M. Noyons, the Director of the laboratory in which the work was carried out.

The Editorial Board regrets that owing to an oversight there has been delay in the publication of the above paper.

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EXPLANATION OF PLATE I

Fig. 1. Uppermost: hydrogen-spectrum. Next, eight spectra of maternal hæmoglobin, thickness of the layer respectively 5, 10, 15, 20, 30, 40, 50 and 60 × 0·85 mm. Lowermost: eight spectra of fœtal hæmoglobin with same thickness of layer.

Fig. 2. Photometrical analysis of the sixth spectrum of Fig. 1 from maternal (upper curve) and fœtal (lower curve) hæmoglobin.

Fig. 3. Transverse photometrical analysis of Fig. 1 at a wave-length of 3850 A. (i.e. midway between 38 and 39 on the scale). *L.S.* lower scale (to be neglected). Fœtal 5–1: first five spectra fœtal hæmoglobin. Maternal 5–1: first five spectra maternal hæmoglobin. *H.* hydrogen spectrum; *U.S.* upper scale (to be neglected).

Mean height of galvanometer deflexion on original graph:

Spectrum	Fœtal mm.	Maternal mm.
5	12	9
4	45	42·5
3	54	54
2	60	60
1	63	63·5