

# BIOMETRIC ANALYSIS OF STRUCTURES OF THE PLACENTAL BARRIER IN EARLY HUMAN ONTOGENESIS

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Biometric investigation of the villi of the 7-week chorion (measurement of the thickness of the syncytio- and cytotrophoblast, the shortest distance from the subcytotrophoblastic membrane to the outer wall of the blood vessels and the thickness of the vascular wall of the chorionic villi) provided a basis for the author to construct a model of the human placental barrier, faithfully reflecting the quantitative relationships between its elements.

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The biometric analysis of individual elements of the chorionic villi, and especially the dimensions of the nucleus, has been the subject of few investigations [2, 4, 5, 10, 11]. Yet the need for a quantitative study of these structures is evident because their morphological and physiological properties are related to changes in their size.

Using results of previous systematic morphological and histochemical investigations [3] as the starting point, in the present investigation we selected for biometric analysis the chorionic villi, whose level of development is that of typical vascular villi of the first third of normal pregnancy.

## EXPERIMENTAL METHOD AND RESULTS

The structures of the human placental barrier were measured by means of B. P. Khvatov's drawing apparatus [7] on specimens of the 7-week chorion stained with iron-hematoxylin. Altogether 114 villi were studied and 3451 measurements made. The thickness of the syncytium, the cytotrophoblast, the epithelial lining of the villi, the shortest distance from the subcytotrophoblastic membrane to the outer wall of the blood vessels, and the thickness of the vascular wall of the chorionic villi were measured.

The results of statistical analysis of the material by the methods normally used in biometry [6] are given in Table 1.

A scheme of the human placental carrier was compiled from the arithmetic mean values (Fig. 1). Statistically significant quantitative relationships between its elements are reflected along the axis MN. As a measure of the degree of variation in size of the structures of the placental barrier, a coefficient of variation (CV) was calculated for each element in each villus, and their mean values were then determined by the methods of variance analysis (Table 1).

Statistical analysis of the results revealed a number of general principles governing the relationships between the structures of the human placental barrier. A point worth noting (these results

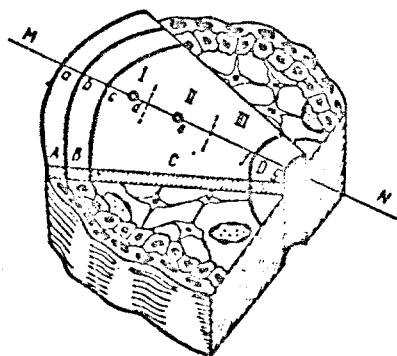


Fig. 1. Biometric scheme of human placental barrier at the 7th week of pregnancy. A) Syncytiotrophoblast; B) cytotrophoblast; C) connective-tissue part of villus; D) blood vessel wall. I-III) Zones of distribution of blood vessels. Remainder of explanation given in Table 1 and text.

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TABLE 1. Results of Biometric Analysis of Structures of the Placental Barrier in Early Human Ontogenesis

Object measured	Size (in conventional units)			Coefficient of variation (in %)		
	M±m	σ	V <sub>min</sub> - V <sub>max</sub>	M±m	σ	V <sub>min</sub> - V <sub>max</sub>
Thickness of syncytium (ab)	14.2±0.80	±5.63	4.1-36.8	23.6±1.41	±10.00	8.7 - 66.6
Thickness of cytotrophoblast (bc)	17.5±0.80	±5.65	6.1 - 36.0	28.9±1.71	±11.85	7.3 - 62.9
Thickness of epithelial lining of villus (ac)	30.0±1.00	±7.05	10.2 - 62.2	15.6±1.08	±7.55	2.0 - 29.6
Distance from subepithelial membrane to outer wall of blood vessels in zone I (cd)	20.5±1.68	±3.65	16.9 - 24.3	34.6±10.15	±20.30	16.8 - 59.0
Distance from subepithelial membrane to outer wall of blood vessels in zone II (ce)	55.6±4.10	±14.75	31.0 - 78.0	15.3±2.65	±9.15	5.3 - 36.5
Distance from subepithelial membrane to outer wall of blood vessels in zone III (cf)	114.9±8.81	±27.90	90.7 - 162.4	8.2±1.30	±4.11	3.3 - 14.3
Thickness of vessel wall (fg)	23.0±1.43	±8.00	11.3 - 47.5	20.5±1.97	±11.00	5.6 - 47.6

are not given in the table) was that in 44% of cases the thickness of the cytotrophoblast on the average was 7.2 conventional units greater than the thickness of the syncytium ( $m = \pm 0.88$ ,  $\sigma = \pm 4.15$ ,  $CV = 57.6\%$ ), in 26% of cases there was no significant difference between their size, and in 30% of cases the syncytium was 8 conventional units ( $m = \pm 0.70$ ,  $\sigma = 2.73$ ,  $CV = 34.2\%$ ) thicker than the cytotrophoblast. The height of the cytotrophoblast varied considerably in different parts of the villi, and in 62% of cases its variability was greater than that of the height of the syncytium (in 6% of cases these values were indistinguishable). These results evidently reflect the morphological and physiological properties distinguishing the cytotrophoblast, notably the fact of conversion of cytotrophoblast into syncytium revealed by various morphological methods [9].

By measuring the shortest distances from the subcytotrophoblastic membrane to the outer wall of the blood vessels, 3 zones of the most typical arrangement of the blood vessels in the chorionic villus could be distinguished: I) subcytotrophoblastic vessels lying not more than 30 conventional units away from the chorionic epithelium; II) vessels of the middle zone lying from 30-80 conventional units away; III) vessels of the middle part of the villus lying more than 80 conventional units away from the epithelium. According to our findings, 48% of vessels at the stage under investigation were in zone II and 37% in zone III.

The size of cells is known to be related to their functional state. This was confirmed by the present investigation, as the coefficients of variation in size of the elements studied show (Table 1). Compared with all other structures of the human placental barrier, considerable variations in size are found in the syncytio- and cytotrophoblast, despite the fact that, according to morphological and histochemical evidence, normally functioning villi were analyzed. For the syncytium the ratio  $V_{min} : V_{max}$  is approximately 9, for the cytotrophoblast 6, and for the other structures from 1.5 to 4. The results of histochemical investigations show that the epithelium of the villi, especially the syncytium, is extremely active functionally [1, 8].

The results described above are of general biological interest and may serve as the basis for quantitative assessment of changes taking place in the structures of the human placental barrier during normal and pathological pregnancy.

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\*  $V_{min}$  denotes the smallest variant,  $V_{max}$  the greatest variant.

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