

PHOSPHATASES OF THE HUMAN PLACENTA

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Published data regarding the phosphatases of the human placenta are conflicting; they have been based either on an insufficient number of placentas, or have not sufficiently taken into account differences in gestation times. Busse [7] determined the alkaline phosphatase content of placentas from the 3rd, 5th, and 10th months of pregnancy, and found that phosphatase activity was 3 times as great in 10-month as in 3-month placentas. Dempsey and Wislocki [8] concluded from histochemical investigations that the alkaline phosphatase activity of the placenta rose as gestation progressed towards term. Thomsen [13], however, considered that alkaline phosphatase activity rose to a maximum in the 30th week of pregnancy, falling thereafter. In early pregnancy inconsiderable acid phosphatase activity was located in the stroma of the villi, while in late pregnancy it was found in the trophoblast [9]. At term, the enzymatic activity of the trophoblast was quite high [6]. Wislocki and Dempsey [15] found various levels of acid phosphatase activity in 6 placentas from 8-16 weeks of pregnancy, and they concluded that activity was not related to duration of pregnancy. According to Thomsen [14] the acid phosphatase activity of the human placenta is at a maximum during the third month of pregnancy, after which it falls, and is absent at term. T. B. Yatsenko [6] examined 12 placentas from the 24th, 32nd, and 40th weeks of pregnancy, and concluded that acid phosphatase activity is located in the nuclei of the chorionic syncytium, and to a much smaller extent in the cytoplasm, whereas alkaline phosphatase is present as larger and more clearly defined granules in the syncytial cytoplasm.

EXPERIMENTAL METHOD

We examined 123 choria and placentas obtained from women in the 4th to the 40th weeks of pregnancy. The material was fixed within 2 h of abortion or of premature or full-term birth. Pieces were cut out of the maternal and fetal surfaces of the placentas, and were fixed in acetone and 80% alcohol. Acid and alkaline phosphatases were assayed according to Gomori. Deparaffined sections, 6 and 8 μ in thickness, were incubated with substrate for 2 and 21 h, respectively. The sites of alkaline phosphatase activity in the sections showed a black stain under these conditions, and of acid phosphatase a brown one. Phosphatase activity of different tissues of the placenta was assessed from the intensity and distribution of discoloration, giving four arbitrary grades of activity, according to the following convention. Presence of a precipitate in the nucleolus only was indicative of trace activity, in the nucleus only of low activity, in the nucleus and cytoplasm of the cells of high activity, and, where the intensity of blackening of the "active sites" was so great as to obscure the details of cell structure, of very high activity [4].

Storage of the tissue fragments embedded in paraffin led to loss of phosphatase activity [10]. V. V. Portugalov [2] considers that phosphatase activity cannot be detected in paraffin sections after 1½-2 months of storage, and that sections attached to microscope slides show no activity after a week. According, however, to Thomsen [14] material embedded in paraffin did not lose any of its activity after 1½ years of storage. We found that paraffin sections which had been attached to microscope slides 7 years ago, and stored under laboratory conditions, were still fully active, and this finding is in accordance with those of other authors [11].

EXPERIMENTAL RESULTS

Alkaline phosphatase. It is known that the human chorion of the 4-5th week of pregnancy possesses secondary villi covered with an epithelium consisting of an internal cellular and an external syncytial layer. About a third of the villi seen in a section were found to show phosphatase activity (Fig. 1, a). High enzymatic activity was detected in the trophoblast syncytium, particularly in its extensions. Very high alkaline phosphatase activity was evident in the

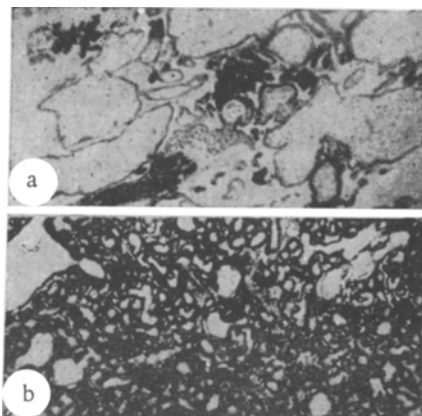


Fig. 1. Alkaline phosphatase in human placentas at the 4-5th week (a) and the 40th week of pregnancy (b).

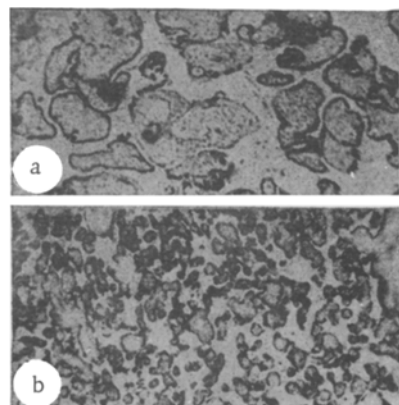


Fig. 2. Acid phosphatase in human placentas at the 5-6th week (a) and the 40th week of pregnancy (b).

showed low activity, and the leucocytes of the maternal blood high activity. Phosphatase activity was not detected in the mesenchyma of the placental amnion and chorion.

Acid phosphatase. In placentas from the 4-5th week of pregnancy acid phosphatase was detected in trace or small amount in the Langhans and syncytial layers of most of the villi, in the ramifications of the syncytium (Fig. 2, a), in the stroma of the smaller villi, in fetal blood cells, in leucocytes of maternal blood, in decidua cells, in flattened maternal epithelium cells, in connective tissue cells, and in the endothelium and walls of blood vessels of the compact and spongy zones of the uterine mucosa. The enzyme was present exclusively in the nuclei, in granules scattered throughout the nuclear sap. The greatest density of such stained granules was found in the nuclei of the syncytium and its ramifications, as well as in the nuclei of the cells of the maternal epithelium and of the fetal blood, while the lowest density was in the nuclei of cells of unmodified connective tissue of the uterine mucosa, in the villous stroma, and in the decidual tissue and the Langhans layer.

Placentas of the 12th week of pregnancy showed low acid phosphatase activity, located, as before, in the nuclei of the syncytium and its ramifications. The syncytium of some of the villi showed high activity, and the stained granules were visible not only in the nuclei but also in the cytoplasm. In such cases, the nuclei of the Langhans cells showed only sporadic granules. The stroma of the villi exhibited only trace or low enzymatic activity.

Practically all of the villi present in sections taken from placentas of the 16th and 20th weeks of pregnancy showed acid phosphatase activity. The activity was higher than in the 12th week, and was found in the same components of the placenta, as well as in the cellular nodes and leucocytes of the fetal blood.

endothelium of the capillaries, precapillaries, and other larger blood vessels of the compact and spongy layers of the uterine mucosa. Trace or low activity was encountered in isolated cases in the uterine epithelium, in that of the uterine glands, and in connective tissue cells showing decidua changes, chiefly those of the spongy layer in the immediate vicinity of blood vessels. Alkaline phosphatase could not be detected at any stage of pregnancy in the unchanged connective tissue of the compact layer of the uterine mucosa, in the stroma of the villi, in the Langhans layer of the trophoblast, in the cellular islets, in the fetal vascular endothelium, and in the fetal blood.

The decidua basalis attains the height of its development during the 12th week of pregnancy, the villi become more branched, and the cellular layer of the chorionic epithelium becomes somewhat attenuated. The proportion of villi exhibiting alkaline phosphatase activity was increased. High or very high activity was, as before, found in the trophoblastic syncytium and its ramifications. Alkaline phosphatase could not be detected in the decidual tissues throughout gestation.

Alkaline phosphatase activity was still on the increase in the 16th week of pregnancy, being found in half of the villi seen in the sections, mostly in the smaller ones. Its activity ranged from trace to very high in the trophoblastic syncytium and its ramifications. Alkaline phosphatase was absent from the umbilical cord, the fibrinoid masses, and the "white infarcts" throughout pregnancy.

By the 20th week of pregnancy alkaline phosphatase activity was found in the trophoblastic epithelium of the majority of the villi seen in sections. Some villi exhibited very high activity, but most of them showed either trace or high activity. In the latter case the syncytial nuclei were well defined, and there was a zone of blackening around the external surface, in direct contact with maternal blood, of the villi. The leucocytes of the maternal blood showed low activity. The enzyme could not be detected in the Kashchenko-Hofbauer cells

At the 40th week of pregnancy all the villi seen in the sections showed very high alkaline phosphatase activity (Fig. 1, b). As before, the enzyme was present only in the trophoblastic syncytium. The chorionic epithelium

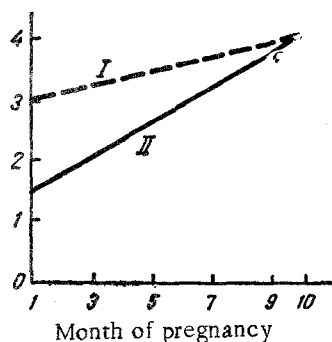


Fig. 3 Alkaline (I) and acid (II) phosphatase activity as shown by the distribution of granules in the trophoblast of the human placenta of the 1st to the 10th month of pregnancy. Ordinates axis: 0) phosphatase absent; 1) traces; 2) low activity; 3) high activity; 4) very high phosphatase activity.

Acid phosphatase was not found in the placental amnion and chorionic membrane of the 40th week of pregnancy. All the villi showed high, and sometimes very high, activity of the syncytium and its ramifications (Fig. 2, b). The bulk of the granules were seen in the nuclei of the syncytium, the structure of which was in many cases obliterated; the syncytial cytoplasm either contained very few granules, or none at all. The cells of Langhans and the leucocytes of the maternal and fetal blood also showed low activity. The stroma of the larger villi and of the stem villi did not show more than traces, if any, of acid phosphatase activity in the nuclei of the connective tissue cells, most often of those directly surrounding the fetal blood vessels, the walls of which displayed only low activity. The acid phosphatase content of the stroma of the smaller villi was high, in some cases very high, and the colored granules were evident both in the nucleus and the cytoplasm of the cells. The endothelium of the fetal blood vessels showed low or high activity. No acid phosphatase activity could be discerned in the fibrinoid masses.

It is concluded that acid and alkaline phosphatases are present in the human placenta over the entire period of gestation. In early pregnancy only trace or small amounts of acid phosphatase were detectable in most of the villi, while alkaline phosphatase activity could be seen in only a minority of the villi. With the progress of pregnancy the number of villi showing stained granules rose gradually, together with acid and alkaline phosphatase activity, to a maximum at the 40th week of pregnancy (Fig. 3). Alkaline phosphatase activity was localized in the nuclei, and to a higher degree in the cytoplasm of the trophoblast, but was absent from the cells of Langhans. Acid phosphatase, on the contrary, was concentrated more in the nuclei; it was more widely distributed among placental tissues than was alkaline phosphatase. In general, it was present in those sites of the placenta in which deposition of glycogen took place [3-5, 12].

The human placenta possesses high acid and alkaline phosphatase activity, which is evidence of its high metabolic activity. The highest activities of the phosphatases was found in the trophoblast, which is responsible for exchange of metabolites between maternal and fetal blood [1].

Our findings are thus in conflict with those of Thomsen [13, 14], but are in agreement with those of other authors [7, 8, 16].

SUMMARY

Acid and alkaline phosphatase activity has been examined in chorionic and placental tissues of 123 women in the 4-5th to the 40th week of pregnancy, by the method of Gomori. Both enzymes could be detected over the whole duration of pregnancy. Most of the villi of preparations from early pregnancy showed trace or low acid phosphatase activity, and the proportion of such villi increased as pregnancy progressed. At the same time, there was a gradual rise in the acid and alkaline phosphatase activity of the structures, to a maximum at term. Alkaline phosphatase was present in the nuclei, but more abundantly in the cytoplasm of the syncytium; it was absent from the Langhans cells. Acid phosphatase was concentrated mainly in the nuclei, and was more widely distributed among the placental tissues than was alkaline phosphatase. The trophoblast showed the highest acid and alkaline phosphatase activities. The results reported are not in agreement with those of Thomsen.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
