DYNAMICS OF GLYCOGEN CONTENT IN EPITHELIAL ANLAGEN OF ORGANS AT THE SECOND MONTH OF HUMAN EMBRYONIC DEVELOPMENT*

Yu. N. Shapovalov, A. I. Brusilovskii, and B. V. Trotsenko

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In the human embryo at the second month of develpment the glycogen-forming function is performed mainly by the epithelial anlagen of the organs and also by the epithelium lining the chorionic villi. Only a small quantity of glycogen is found in the liver cells.

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Very little information on the principles governing biosynthesis of glycogen in the various tissue and organs can be found in the literature on human embryology. As a result of our earlier investigations using qualitative histochemical methods we obtained data concerning the trophic and plastic role of glycogen in early embryogenesis [6-11]. The need therefore arises for quantitative analysis of the glycogen content in the anlagen of various organs using new methods of inv. stigation. In the present investigation we studied the glycogen content histochemically in the epithelial anlagen of human organs.

EXPERIMENTAL METHOD

The investigation was carried out on 32 human embryos from 6 to 30 mm in length. Glycogen detected by the PAS reaction with an enzyme control in the epithelium of the gut, the outer covering of the embryo, and the bronchi, the cytotrophoblast of the chorionic villi, and the myocardium. For the quantitative analysis cytophotometry was carried out in visible light and its results expressed in conventional units, which were subjected to statistical analysis. Identical methods of fixation and staining of the sections were used and the sections were equal in thickness. For the quantitative estimation of glycogen in the tissues specific absorption of visible light of a particular length by polysaccharides was used [1-5, 12-15]. A thin-beam cytophotometer was used for the measurements. Each test object was measured in two wavelengths, 550 and 575 mμ. The degree of absorption of light was determined by a photoelectric method.

To express the results of cytophotometric analysis pictorially the method of polar diagrams was used, enabling the content of different groups of polysaccharides in cells of embryos of the studied age period to be compared. The content of PAS-positive substances was plotted in conventional units along the radii from the center to each apex of the external polygon on the same scale from the results of cytophotometric investigation, and the content of PAS-positive substances remaining in the cells of the same embryonic anlagen after treatment with amylase was plotted along radii from the center to the apex of the internal polygon. Hence, from the dimensions of the external polygon an idea could be obtained of the content of PAS-positive substances in each embryo, while the dimensions of the internal polygon gave the content of PAS-positive substances remaining after amylase treatment (glycoproteins), and the space lying between the external and internal polygons represented the glycogen content in the same tissue.

EXPERIMENTAL RESULTS

We determined the general principles governing the distribution of glycogen in embryonic tissue during the second month of development. The highest glycogen content was found in the epithelium of the gut and of the outer covering of the embryo, in the bronchi and the cytotrophoblast of the villi.

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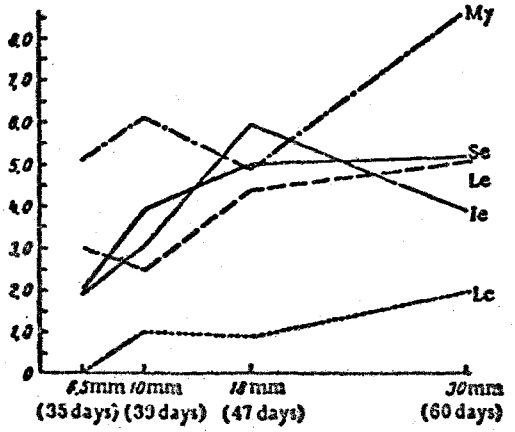

Fig. 1. Dynamics of glycogen content in anlagen of internal organs of human embryos in the second month of development. Ordinate, results of cytophotometric analysis (in conventional units); abscissa, length and age of embryo. My) myocardium; Le) epithelium of lung; Se) epithelium of skin; Ie) epithelium of intestine; Lc) liver cells.

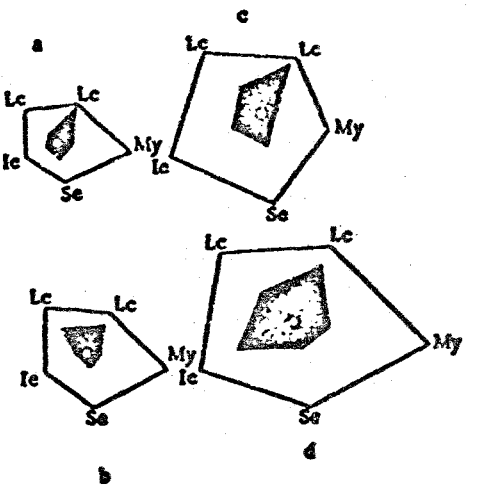

Fig. 2. Polar diagrams reflecting content of PAS-positive substances (total), glycogen, and glycoproteins (separately) in studied anlagen of each embryo. Explanation in text. a) embryo 6.5 mm long (35 days); b) embryo 10 mm long (39 days); c) embryo 18 mm long (47 days); d) embryo 50 mm long (60 days). Remainder of legend as in Fig. 1.

The variance curves (Fig. 1) show the dynamics of changes in the glycogen content in individual anlagen on embryos aged 35-60 days. Analysis of these curves shows that gradual accumulation of glycogen takes place in the cells of the epithelial anlagen of the internal organs until the middle of the second month of development. Later the glycogen content increases more slowly or its intracellular level may actually fall, evidently in connection with changes in the character of metabolism toward the end of the second month of embryogenesis.

It is interesting to compare the intracellular content of glycogen in the epithelial anlagen of the intestine, lung, and skin with its content in the myocardium. At the beginning of the second month of development the myocardium contained 1.5-2.5 times more glycogen than the other anlagen mentioned. By the middle of the second month its content was smaller, and at this period all the areas studied contained about the same amount of glycogen. Toward the end of the second month of pregnancy, in connection with the embryo-physiological state of the heart, the glycogen content in the myocardium fell considerably. Against this background the very low content of glycogen in the liver must be considered. This is evidently associated with the fact that at these stages of embryogenesis the liver has no glycogen-forming function.

Analysis of the polar diagrams (Fig. 2) shows that the content of polysaccharides detectable by the PAS reaction increases with age. This applies both to glycogen and to glycoproteins. The polysaccharide content in the liver also rises, but less so than in the other anlagen. The marked asymmetry of the two first polygons reflecting the polysaccharide content in embryos at the beginning of the second month of ontogenesis is connected with the predominance of PAS-positive substances, including glycogen, in the myocardium of the embryos. By the end of the second month of pregnancy the shape of the diagrams had altered.

As we showed previously, the cytotrophoblast of the chorionic villi begins to accumulate glycogen from the first month of ontogenesis. During the second month intensive formation of acid mucopolysaccharides and other biochemically active substances takes place, and this produces the histochemical and morphological asynchrony of development. Evidently because of this the intracellular glycogen content in the cytotrophoblast is relatively small. However, remembering the considerable area of the cytotrophoblast, and the intensive development of the chorionic villi taking place during the first three months, we consider that the epithelial lining of the chorionic villi is a tissue with a high total glycogen content.

During the second month of embryogenesis glycogen formation is carried out mainly by the epithelial anlagen of the organs and the epithelial covering of the chorionic villi. Because of this, investigations using modern methods must be carried out to examine the functional importance of the liver in the second month of embryogenesis and the dynamics of the glycogen-forming function of the liver cells from the age aspect.

LITERATURE CITED

1. L. S. Agroskin, Biofizika, No. 3, 343 (1958).
2. L. S. Agroskin and N. V. Korolev, Pribory i Tekh. Éksperim., No. 4, 135 (1963).
3. L. S. Agroskin, Biofizika, No. 4, 456 (1964).
4. L. S. Agroskin, Tsitologiya, No. 2, 265 (1965).
5. V. Ya. Brodskii, Nutrition of the Cell [in Russian], Moscow (1966).
6. A. I. Brusilovskii, Development and Structure of the Chorionic Tissues in Early Human Ontogenesis (Morphological, Histochemical, and Karyometric Investigation) [in Russian], Candidate Dissertation, Simferopol' (1963).
7. A. I. Brusilovskii, Akush. i Gin., No. 3, 38 (1964).
8. Yu. N. Shapovalov, Arkh. Anat., Gistol. i Embriol., No. 5, 34 (1961).
9. Yu. N. Shapovalov, Arkh. Anat., Gistol. i Embriol., No. 1, 46 (1962).
10. Yu. N. Shapovalov, Development of the Human Embryo during the First Two Months [in Russian], Doctorate Dissertation, Simferopol (1963).
11. Yu. N. Shapovalov, Arkh. Anat., Gistol. i Embriol., No. 7, 45 (1964).
12. A. I. Sherudilo et al., Optika i Spektroskopiya, 11, No. 2, 266 (1961).
13. A. I. Sherudilo, Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 12, Seriya Biol.-Med. Nauk, No. 3, 145 (1964).
14. T. Caspersson, Cell Growth and Cell Function, New York (1950).
15. T. Caspersson, Acta Histochem. (Jena), Suppl. 6, 21 (1965).