DEVELOPMENT OF THE SERUM ANTIGENIC SPECTRUM OF LOWER MONKEYS IN ONTOGENESIS

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The dynamics of appearance of antigens of the adult organism in fetuses of lower monkeys is similar to that in the human fetus. Albumin appears before the other proteins. γ-Globulin in first found in the 18-week fetus. Most adult antigens appear between the 18th and 23rd weeks of intrauterine life. The antigenic spectrum in newborn monkeys, and even in monkeys aged 5 months, is less representative than in adult animals, especially in the zone of α_2- and β-globulins.

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The development of the blood antigenic spectrum in ontogenesis is of great interest and has been studied by several workers [3, 4, 6, 10]. The published data suggest that the blood serum proteins of man and other animals characteristic of the adult organism appear gradually in the blood stream of the fetus. Some proteins (haptoglobins, for example) are not formed until after birth. Albumin, followed by transferrin, are found in embryonic blood before other proteins. γ-Globulin may also be found fairly early, and until recently it was mainly held that fetal γ-globulins are maternal in origin. More recently, following the investigations of the Gm-factor, their synthesis in tissues of the human fetus has been conclusively proved [12].

Stage-specific proteins (α- and β-fetuins [1, 2, 5]) may also be found in embryonic and fetal blood of man and the lower monkeys, but their function is not yet clear. It is interesting that adult human and monkey proteins and the fetuins of their fetuses are immunologically very close [2, 13].

The order of development of the serum antigenic spectrum of human blood has been well described in Yablokova's dissertation [7]. Similar data for the proteins of lower monkeys could not be found in the literature. The only relevant papers were those demonstrating the possibility that fetal and maternal proteins of Macaca rhesus can both pass through the placenta [8, 9]. The structure of the placenta is the same in the lower monkeys and man, being hemochorial in type [11].

Blood serum antigens of lower monkeys at different periods of development were studied in the present investigation.

EXPERIMENTAL METHOD

Under sterile conditons blood was taken from the heart of monkey fetuses obtained after absortion or from dying pregnant females at autopsy and serum obtained from it in the usual manner. In the case of living full-term and premature monkeys, blood was taken from an incision in the auricular vein into capillary tubes, which were then sealed with plasticine and centrifuged. A mark was made with a file at the boundary between serum and clot, the capillary tube was broken, and the part containing serum was kept at −30° until required for use. The embryo was washed with cold physiological saline to remove traces of maternal blood, homogenized, and the proteins extracted with physiological saline. All samples were subject to immunoelectrophoretic analysis (1% Difco agar gel, barbiturate buffer, pH 8.2, duration of electrophoresis 2.5 h at 5 V/cm). Development was carried out with rabbit antisera against serum proteins of adult baboons (Papio hemadryas) and rhesus monkeys. Altogether material was investigated from 27 fetuses and adult monkeys and, for comparison, from three human subjects.

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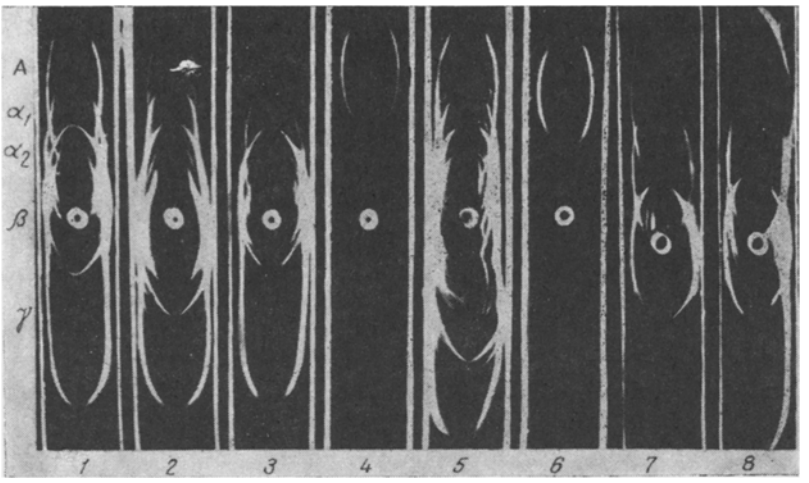

Fig. 1. Immunoelectrophoretic analysis of blood serum proteins of fetal and adult monkeys and man. Development in all cases by antiserum against blood proteins of adult baboon. Antigens: P. hamadryas: 1) adult, 2) young animal aged 2 days, 3) 5-month fetus; 4) 5-week embryo; M. rhesus: 5) adult, 6) 5-week embryo; Man: 7) adult, 8) newborn; A) zone of albumins; α_1, α_2, β, γ (zones of globulins).

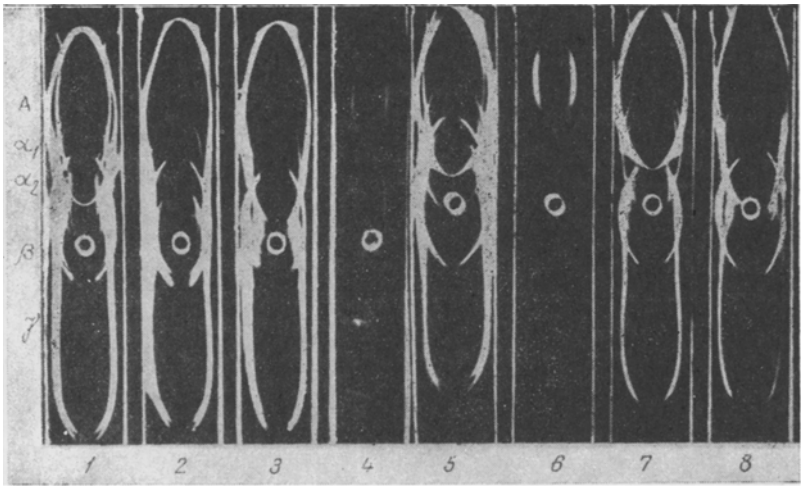

Fig. 2. Immunoelectrophoretic analysis of blood serum proteins of fetal and adult monkeys and man. Development in all cases by antiserum against protein of adult rhesus monkey. Legend as in Fig. 1.

EXPERIMENTAL RESULTS

The results are summarized below in Table 1, analogous to the table given by Yablokova [6, 7] for human blood antigens. Unfortunately, the antiserum used by Yablokova was too weak and the number of antigens which she determined was much smaller than that found in the present analyses. It is clear from Table 1 and Figs. 1 and 2 that albumins appeared first in the monkey embryos. This is the only protein of the adult animal which could be detected in the blood of 5-week baboon and rhesus monkey embryos. At the 19th week (pregnancy in the baboon lasts 27 weeks), the fetuses had only 6 proteins compared with 27 detected by the same antiserum in adult monkeys. It is interesting to note that at this time the γ-globulin fraction had already appeared. At 21 weeks, the blood contained prealbumins, α_1- and β-lipoproteins, and several other proteins. The serum protein spectrum of the newborn baboon differed from that of the adult animal by being poorer in α_1-, α_2- and, in particular, β-globulins.

TABLE 1. Number of Antigens Detected in Fetal and Adult Monkeys and Man by Immunoelectrophoresis (Development with Rabbit Antiserum Against Adult Proteins of P. hamadryas)

Species and age of mammal		Number of observations	Total number of fractions	Zones of serum proteins					
				prealbumins	albumins	globulins			
						α_1	α_2	β	γ
Baboon	5-week embryo	1	1	—	1	—	—	—	—
	Fetus 18 weeks	2	6	—	1	1	1	2	1
	20 weeks	2	12-15	1	1	2-4	2-3	5	1
	23 weeks	2	16-19	1	1	3-5	4-5	6	1
	Newborn	3	16-19	1	1	3-5	3-4	7	1
	Young animal aged 2 days	3	18-21	1	1	5-6	3-4	7-8	1
	Young animal aged 5 months	2	21-22	1	1	6	4	8-9	1
	Adult	5	27	1	1	6	5	11-13	1
Rhesus monkey	5-week embryo	1	1	—	1	—	—	—	—
	Adult	5	21	1	1	5	5	8	1
Man	Newborn	1	10	1	1	3	—	4	1
	Adult	2	22	1	1	5	5	9	1

Comparison of the immunoelectrophoretic spectra of embryonic and adult rhesus monkeys led to the same results as in the case of baboons (Table 1). The number of arcs revealed by human anti-baboon antiserum in the rhesus monkeys was smaller than in baboon serum. Evidently this was due not only to differences in the concentration of some proteins, leading to absence of equivalence in the amounts of these antigens and of the corresponding antibodies and, consequently, to the absence of their arcs, but also to the presence of a certain number of species-specific antigens. The process of development of protein spectra in man and P. hamadryas in ontogenesis is generally similar, albumins appearing first, followed by proteins in the zones of α- and β-globulins. A protein which is formed early is transferrin. In cattle also this protein starts to be synthesized by the end of the 4th-5th week of intrauterine life [14]. The appearance of "adult" antigens in the blood of monkeys takes place particularly intensively between the 18th and 23rd weeks of pregnancy. The spectrum of newborn monkeys is poorer in protein than that of adult animals, in α- and, in particular, β-globulins. Even in young baboons aged 5 months, appreciably fewer arcs were found in these zones than in adults. Possibly some proteins were present in the blood of the young animals, but in very low concentrations. Few data are available for rhesus monkeys, but it can be considered that the difference in this respect between closely related species of lower monkeys can hardly be substantial. Bearing in mind the antigenic similarity between the blood proteins, the identical structure of the placenta, and the similarity between the formation of the protein spectrum, it can be considered that monkey fetuses constitute a very valuable model for various experiments to study either normal embryogenesis or the influence of different factors on the fetus and on its proteins.

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