THE DAILY MITOTIC RHYTHMS IN DIFFERENT ORGANS OF WHITE MICE AND RAT EMBRYOS

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Although the daily periodicity of mitosis has been studied in various plant and animal subjects [1-8], the mechanism of this phenomenon is still insufficiently elucidated. Thus, it is important to study the establishment of the daily mitotic rhythm in the process of embryonal development.

In this work, we attempted to demonstrate the regimen of mitotic activity in different organs of white mice and rat embryos.

EXPERIMENTAL METHOD

We undertook two series of experiments. In the first, we investigated the daily rhythm of mitotic activity in various organs of 21-22 day old embryos and adult female white mice and rats; in the second – the daily mitotic rhythms when the pregnant female animals were kept under conditions of reversed daily photoperiodicity. Before the experiment, the female mice and rats were kept separate from males for a period of 23 days.

Then, 2-3 males were added to the groups of females (5-6 in each group). The time of fertilization was established from the presence of spermatozoa in smears of the vaginal contents. Females fertilized on the same day were divided into 8 groups (5 rats or mice in each). Four groups of the animals were maintained under natural illumination conditions, and 4 were kept under conditions of altered daily photoperiodicity for a period of 22 days: light during the night hours (8:00 P.M. to 8:00 A.M.), and darkness during the day (8:00 A.M. to 8:00 P.M.). On the 22nd day of pregnancy, the females were sacrificed over the course of the day, at 8:00 A.M., 2:00 P.M., 8:00 P.M., and 2:00 A. M., using one group for each time period. Two embryos were taken from each female.

The mitotic activity was determined in the epithelium of the cornea, and skin, in the liver and the duodenum of the embryos, and also in the epithelium of the cornea and epidermis of the female mice and rats. The magnitude of the mitotic activity was judged from the number of dividing cells in a constant area (for the cornea, skin, and intestine – 1.65 mm^2; for the liver – 4.28 mm^2), and the percent relationship of the individual mitotic phases. The obtained data were treated statistically, according to the method of Fisher-Student.

EXPERIMENTAL RESULTS

The results of the first series of experiments showed that the mitotic activity in the epithelium of the cornea, skin and duodenum, and in the liver, of the white mice embryos that were kept under natural conditions of daily photoperiodicity during the period of pregnancy followed a pattern of regular changes during the course of the day (Table 1).

The daily mitotic fluctuations in these organs followed parallel courses. Curves of the daily rhythms of mitotic activity were monophasic in character (Fig. 1,A). The maximum number of mitoses were observed at 8:00 A.M.; then the number of mitotically dividing cells decreased, reaching its minimum levels at 8:00 P.M. (P ranged within the limits of 0.000-0.021 for the different time periods).

The daily mitotic fluctuations in the corneal and cutaneous epithelium of the female white mice that were kept under conditions of natural day and night changes, coincided with the daily rhythm of mitoses within the different or-

TABLE 1. Daily Changes in the Mitotic Activity of Different Organs from 21 Day Old Embryos, and in the Cornea of Pregnant White Mice, Under Natural Illumination Conditions

Subject of Investigation	Organ	Number of mitoses			
		8:00 A.M.	2:00 P.M.	8:00 P.M.	2:00 A.M.
	Cornea	112,4	64,9	53,9	66,9
White mice embryos	Cutaneous epidermis	36,4	23,4	20,1	20,0
	Intestine	121,8	59,6	46,4	70,0
	Liver	45,0	29,0	11,0	19,7
Females	Cornea	190,2	113,8	62,0	89,0

gans of the embryos. The maximum mitotic activity was noted at 8:00 A.M., and the minimum at 8:00 P.M. (P = 0.001).

Identical results were obtained in the experiments on the white rat embryos that were kept under normal conditions, i.e., natural shifts of day and night (Fig. 1, B). The daily mitotic periodicity was followed in the epithelium of the cornea, skin, and liver. Cell multiplication in these organs reached a maximum at 8:00 A.M., and then fell to a minimum at 8:00 P. M. (P within the range of 0.000-0.076). The daily mitotic regimen in the corneal epithelium of the female rats was synchronous with the daily fluctuations in mitotic activity within the different organs of the embryos. The curve for the daily mitotic periodicity was monophasic in character, with the maximum number of dividing cells at 8:00 A.M., and the minimum at 8:00 P.M.

The parallel relationship between the daily mitotic rhythms of the embryo and the adult female permit postulating that the mitotic periodicity in embryos is synchronized with the maternal organism, and arises in connection with the action of those factors which cause the daily mitotic rhythm in the adult animal. One of the decisive factors determining the mitotic rhythm of the animals appears to be the photoperiodicity of the days [1, 9, 10].

In connection with this, a series of experiments was carried out in which we studied the mitotic regimen of different organs in the embryo and adult female under conditions where the daily photoperiodicity was reversed. The data of these experiments showed that in the female mice and rats that were maintained under reversed daily photoperiodicity during the period of pregnancy(illumination during the night hours, darkness during the day), the

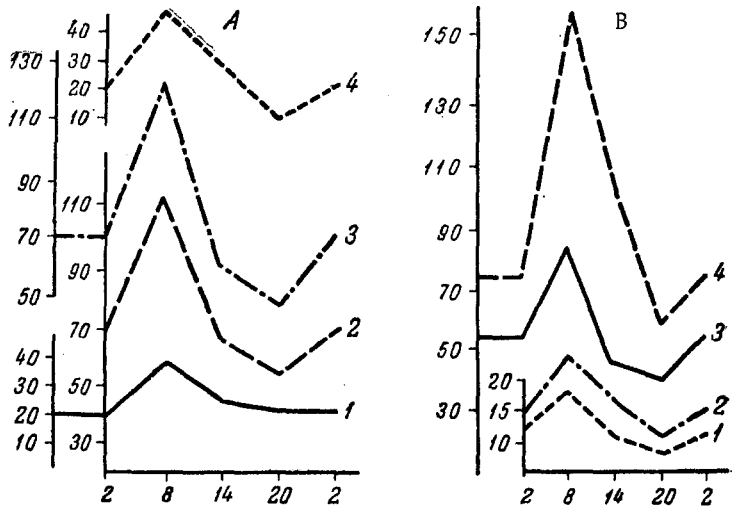

Fig. 1. A) Curves of the daily mitotic rhythm in different organs of white mice embryos, under conditions of natural daily photoperiodicity. On the abscissa – time of day, on the ordinate – mitotic activity. 1) Mitotic activity of the skin; 2) cornea; 3) intestine; 4) liver. B) Curves of the daily mitotic rhythm in different organs of embryos, and in the cornea of adult female white rats, under conditions of natural daily photoperiodicity. 1) Mitotic activity of the skin; 2) liver; 3) cornea of the embryos; 4) cornea of the adult females.

TABLE 2. Daily Changes in the Mitotic Activity of Different Organs in 21-22 Day Old Embryos, and in the Cornea of Adult Female White Mice, Maintained Under Conditions of Reversed Daily Photoperiodicity During the Period of Pregnancy

Subject of Investigation	Organ	Number of mitoses			
		8:00 A.M.	2:00 P.M.	8:00 P.M.	2:00 A.M.
White mice embryos	Cornea	93,3	53,6	40,1	58,9
	Cutaneous epidermis	33,8	21,7	19,1	22,5
	Intestine	152,1	84,9	70,7	97,4
	Liver	38,9	23,2	16,7	25,5
Females	Cornea	83,0	92,6	186,8	137,6

the daily mitotic regimen was completely reversed (Table 2).

Maximum figures for the mitotic activity were noted in the evening hours (8:00 P.M.), and the minimum – in the morning (8:00 A.M.); P = 0.000, and for the other time periods P = 0.001 and 0.166. In the embryos of these animals, the daily fluctuations in the epithelium of the cornea, skin, duodenum, and in the liver did not undergo any changes at all (Figs. 2 and 3). The maximum mitotic activity was observed in the morning hours (8:00 A.M.), and the minimum – in the evening hours (8:00 P.M.). P ranged from 0.000 to 0.001. In other words, the daily mitotic rhythm in the different organs of the mouse and rat embryos that were maintained under natural conditions of day and night shifts, and of those that were kept under reversed daily photoperiodicity, were the same type.

The impression is created that the daily mitotic rhythm in embryos is stable, and inborn in character, and is not only arranged under the influence of the conditions in the external environment, exerting their effect via the maternal organism. Inheritance of a resistant daily mitotic rhythm in the embryo probably can gradually be altered, in the process of ontogenesis, in connection with exposure of the organism to various external factors.

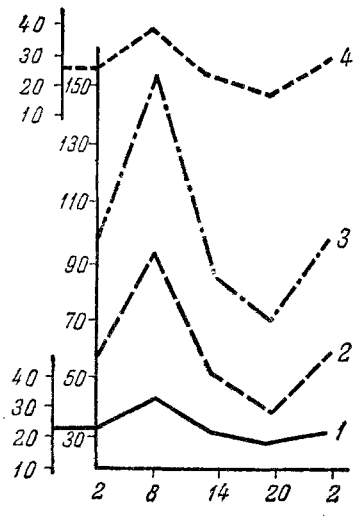

Fig. 2.

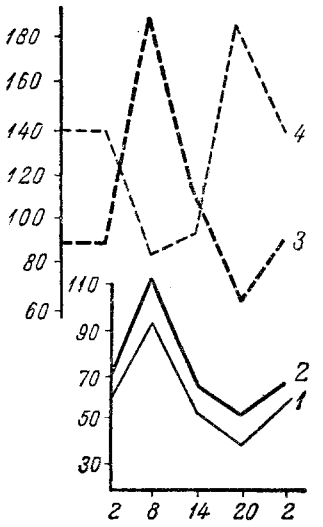

Fig. 3.

Fig. 2. Curves of the daily mitotic rhythm in different organs of mouse embryos, under conditions of reversed daily photoperiodicity. On the abscissa – time of day, on the ordinate – mitotic activity. 1) Mitotic activity of the skin; 2) cornea; 3) intestine; 4) liver.

Fig. 3. Daily mitotic rhythm in the cornea of embryos and adult female white mice, under conditions of natural and reversed daily photoperiodicity. 1) Mitotic activity of the cornea in embryos, with natural daily photoperiodicity; 2) with reversed daily photoperiodicity; 3) mitotic activity of the cornea in adult females, under conditions of natural daily photoperiodicity; 4) under conditions of reversed daily photoperiodicity.

SUMMARY

The present work deals with the 24-hour mitoses in various organs of 21-22 day embryos and females of albino mice and rats, kept during pregnancy in conditions of natural and inverted 24-hour photoperiodicity. Mitotic activity in the epithelium of the corneum skin, duodenum and liver of mice embryos and rats during natural alterations of day and night exhibited 24-hour changes. There was a maximum number of mitoses at 8:00 A.M. and minimum – at 8:00 P.M. The 24-hour variations in mitoses of the corneal and cutaneous epithelium in females kept during pregnancy in conditions of natural 24-hour photoperiodicity coincided with the 24-hour mitotic rhythm in various embryonic organs. In female mice and rats kept during pregnancy in conditions of inverted 24-hour photoperiodicity, the 24-hour mitotic rhythm showed a complete inversion. No changes were seen in the embryos of these animals.

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