EFFECT OF A LOW-FREQUENCY ELECTRIC FIELD ON CELL DIVISION IN MOUSE TISSUES

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A 50-Hz electric field increases the number of mitoses in the corneal epithelium and liver of mice by 2.5-3.4 times. It is suggested that the low-frequency electric field accelerates passage of the cells through the G_2-period.

Much information regarding the action of electric fields on biological objects has now been obtained [5, 7-9, 11]. However, existing publications deal principally with electric fields of high and very high frequencies. The biological action of low-frequency fields has been described in only a few papers. For example, stimulation of propagation of microorganisms and lengthening of wheat shoots [15], an increase in the ATP content in skeletal muscles [10], changes in muscular effort during forced working [7], and contraction of the muscle in an isolated nerve-muscle preparation [4] have been described in a low-frequency electric field. Morphological changes in the tissues have also been observed after exposure to a 50-Hz electric field. Under these conditions, cell proliferation in the intestinal epithelium, spleen, and liver is stimulated [6]. Other work has shown [2, 3] that exposure to a low-frequency electric field stimulates regenerative processes and shortens the duration of mitosis. Morphological changes in the tissues have also been described as the result of exposure to a steady field, which in its mechanism of action has many features in common with low-frequency fields. Enlargement of the ring endings of nerve fibers and an increase in the size of the cell nuclei and the number of amitoses were found in a culture of the trigeminal ganglion under the action of a steady field [13, 14]. An increase in the number of mitoses in cultures of chick fibroblasts has also been found [12].

The object of the present investigation was to determine whether there is any change in the number of cells undergoing division in animals kept in a low-frequency electric field.

TABLE 1. Mitotic Index (in $^0/_{00}$) for Individual Animals

Corneal epithelium		Liver		Proximal convoluted tubules of nephron	
control	expt.	control	expt.	control	expt.
7,7	18,7	2,3	8,2	1,17	0,60
9,7	19,6	0,6	9,4	0,13	1,28
6,2	5,1	3,9	6,6	0,98	1,14
7,3	12,6	2,6	—	0,70	0,52
8,3	20,3				
3,7	17,8				
Mean mitotic index 7.1	15,7	2,4	8,1	0,74	0,88

EXPERIMENTAL METHOD

Twelve male albino mice weighing 25-30 g were used in the experiments. Six animals acted as the control and the other 6 were kept in the experimental chamber in groups of 2. At the time when they were placed in the chamber (4 P.M.), the experimental mice received an intraperitoneal injection of demecolcine in a dose of 3 mg/kg body weight and the animals were sacrificed at 8 P.M. A capacitive field was produced by application of a voltage of 600 V from a type UTN-1 transformer. The distance between electrodes was 3 cm. The surface of the electrodes was insulated. The animals were sacrificed 4 h after receiving the injection of demecolcine and introduction into the experimental

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chamber, and the eyes, liver, and kidneys were fixed in Carnoy's fluid. Histological sections were made, and the mitotic index determined in promille for 15,000-20,000 nuclei. The numerical results were subjected to statistical analysis by the Fisher–Student method.

EXPERIMENTAL RESULTS

The results are shown in Table 1. The number of mitoses blocked by demecolcine in the corneal epithelium and hepatocytes was 2.2-3.4 times higher in the experimental than in the control animals ($P = 0.008$ and $P = 0.004$ respectively). In the proximal convoluted tubules of the kidney no differences were found between the mitotic indices in the control and experimental animals. This may perhaps be explained by differences in the sensitivity of the tissues to the frequency used.

After exposure to a low-frequency electric field for 4 h, there was thus an appreciable increase in the number of cells starting to divide. The duration of the G_2-period of the mitotic cycle in the corneal epithelium and liver is 3-4 h. It can therefore be assumed that the increase in number of dividing cells in the experimental series took place as the result of a decrease in the time taken by the cells to pass through the G_2-period. It can be concluded from the writers' earlier discovery of the acceleration of mitosis and from the results of the present investigation that low-frequency electric fields affect at least 2 periods of the mitotic cycle.

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