DYNAMICS OF THE CONTENT AND SYNTHESIS OF NUCLEIC ACIDS AND PROTEINS IN THE LUNGS DURING ADAPTATION TO HYPOXIA

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The relative weight of the lungs and the synthesis of nucleic acids and protein in the lungs of rats adapted to hypoxia were studied. Adaptation was carried out for 6 h a day in a pressure chamber at an "altitude" of 7000 m for 40 days. An increase in the relative weight of the lungs, in the relative (per 100 mg lung tissue) and total RNA content, and in the intensity of protein synthesis was found. The relative DNA content (per 100 mg) in the lung tissue was unchanged.

Key words: hypoxia; lungs; synthesis of nucleic acids and protein.

During adaptation to high-altitude hypoxia marked activation of the synthesis of nucleic acids and proteins is observed in the hematopoietic system, the heart, brain, and other organs. This adaptation is the basis of the polycythemia, cardiac hypertrophy, and the increase in power of the mitochondrial system in different tissues [6]. Activation of the synthesis of nucleic acids and proteins thus plays a decisive role in the development of the adaptation itself. In hypoxia arising after removal of one lung, intensification of respiration and hypertrophy of the residual lung are observed [2]. However, the dynamics of the nucleic acid content and protein synthesis in the lungs during adaptation to hypoxia has not yet been studied.

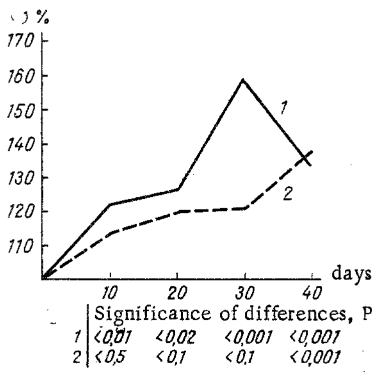

Fig. 1

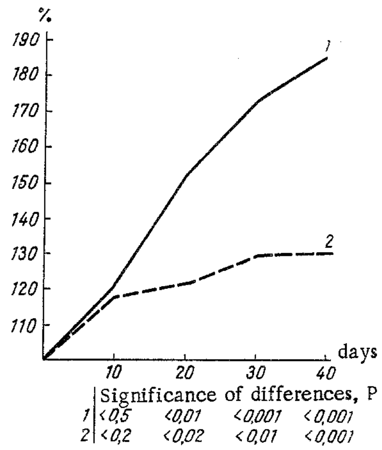

Fig. 2

Fig. 1. Dynamics of intensity of protein synthesis in lungs (1) and relative weight of lungs (2) as a percentage of control values during adaptation of rats to interrupted high-altitude hypoxia.

Fig. 2. Dynamics of total (1) and relative (per 100 mg tissue) (2) RNA content in lungs as a percentage of control values during adaptation of rats to interrupted high-altitude hypoxia.

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This was the object of the present investigation.

EXPERIMENTAL METHOD

Experiments were carried out on 106 female Wistar albino rats weighing 140-180 g. Adaptation to hypoxia was carried out in a pressure chamber for 40 days, for 6 h each day. On the first day the atmospheric pressure in the chamber corresponded to an altitude of 2000 m and the exposure lasted 1 h. The "altitude" was then increased daily by 1000 m and the exposure by 1 h. By the 6th day the "altitude" was 7000 m and the exposure 6 h [1]. These levels were maintained thereafter. The animals were decapitated 18 h after the last "ascent." Tests were carried out before and on the 10th, 20th, 30th, and 40th days of the experiment. RNA and DNA in the lung tissue were determined by the method of Schmidt and Thannhauser [5] with subsequent spectrophotometry (by Spirin's method [4]) on the SF-4A spectrophotometer at wavelengths of 270 and 290 μ. The results were expressed in micrograms phosphorus of the corresponding acids/100 mg wet weight of lung tissue. The rate of protein synthesis in the lung tissue was determined from the incorporation of methionine-S^{35} into protein and expressed as counts/min/g protein. The rate of incorporation of methionine in the experimental rats was calculated as a percentage of that in the controls. The lungs were weighed with an accuracy of 10 mg.

EXPERIMENTAL RESULTS

The dynamics of changes in the relative weight of the lungs during adaptation to hypoxia is illustrated in Fig. 1. On the 10th day of adaptation the relative weight of the lungs was 13% higher than in the control, 19% on the 20th day, 21% on the 30th day, and 37% higher on the 40th day. This was evidently the result of activation of nucleic acid and protein synthesis in the cells of the lung tissue. Protein synthesis in the lung tissue increased during adaptation mainly proportionally to the increase in the relative (per 100 mg tissue) RNA content.

The curves in Fig. 2 illustrate the dynamics of the relative and total RNA content in the lungs during adaptation to high-altitude hypoxia. Clearly on the 10th day of adaptation the relative RNA content was increased by 17%, on the 20th day by 22%, and on the 30th and 40th days by 30% compared with initially.

On account of the increase in mass of the lungs their total RNA content was increased more substantially.

The relative (per 100 mg tissue) DNA content in the lungs did not change significantly during adaptation, but the total content was increased by the same degree as the relative weight of the lungs.

The change in the ratio between the RNA/DNA concentrations is particularly interesting. This ratio, normally 0.5, rose to 0.63 during the development of adaptation to high-altitude hypoxia and presumed hypertrophy of the lungs. This was evidently caused by an increase in RNA synthesis on the existing DNA templates.

On the whole, the activation of synthesis of nucleic acids and protein and the increase in the relative weight of the lungs discovered during adaptation to hypoxia must evidently be regarded as a response of the genetic apparatus of the lung tissue cells to the hyperventilation and the increased lung function developing during adaptation.

The significance of the hypertrophy of the lungs developing on the basis of activation of nucleic acid and protein synthesis during adaptation to hypoxia is evidently that it leads to an increase in the alveolar surface through which oxygen diffusion takes place.

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