MICROBIOLOGY AND IMMUNOLOGY

THE INFLUENCE OF THE PLASMA AND BLOOD SERUM OF ANIMALS OF DIFFERENT SPECIES-RESISTANCE ON THE ASSIMILATION OF OXYGEN AND PHOSPHORUS BY Mycobacterium tuberculosis

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Mycobacterium tuberculosis enters the blood vessels very easily, but in the majority (70%) of patients suffering from chronic disseminated tuberculosis they fail to multiply in the blood and are soon eliminated. This is not the case in patients suffering from localized lung lesions [6]. The property of the serum to prevent the multiplication of M. tuberculosis is explained [7] by the presence of an inhibitory factor. Some authors [3] believe that the active serum factor in a certain group of patients as well as of animals suffering from tuberculosis or sensitized to tuberculin represents a substance of globulin character; others [5] ascribe this role to the enzyme lysozyme or to a closely related substance. The latter authors emphasize that the sera of immunized rabbits and of a small group of normal persons (10%) also have a bacteriostatic effect upon M. tuberculosis.

It seems that not only lysozyme but also many other blood enzymes are capable of affecting M. tuberculosis. It is known, for example, that serum lipase affects this organism: in patients in whom the clinical course of the tuberculotic process is more favorable the lipase activity is higher than in persons suffering from progressive tuberculosis. Similarly, the aminopeptidase is twice as active in the serum of rabbits infected with tuberculosis as in the serum of non-infected rabbits [2]. Schultz and Weiss [9] found that some sera exerted an increased proteolytic activity, a feature which they regarded as a sign that the person in question was resistant to tuberculosis.

The studies of authors who made attempts to discover antibodies in the serum of patients and animals suffering from tuberculosis are of particular interest. These authors were able to establish the presence of antibodies in the serum of rabbits infected with tuberculosis. These antibodies were frequently present in so small quantities that the serum had to be concentrated before the antibodies could be found. Among 40 patients suffering from tuberculosis investigated, antibodies were found in only five; in a similar group of healthy persons they were found to be absent without exception [1, 8]. Other authors [4] found hemagglutinating antibodies after treating the serum of some patients suffering from tuberculosis with cold ethyl alcohol. Treatment of the serum of healthy persons did not reveal the presence of antibodies.

Notwithstanding the considerable interest of these findings, it can hardly be assumed that antibodies which can be found with such difficulty and in so rare cases can play an appreciable role in the immunity to tuberculosis.

We failed to find reports in the literature directly concerning the role of humoral factors in the natural species-resistance of animals to tuberculosis. In the opinion of Pagel and co-workers [7] the bacteriostatic properties of the serum are not connected with individual or species-specific features of the serum and characterize only certain groups of patients or animals suffering from tuberculosis. At the same time, however, it could be
established in the Laboratory of Microbiology and Morbid Anatomy of our Institute that after intravenous injection of M. tuberculosis the organisms rapidly disappear from the blood of white mice, and these findings, as well as the absence of the organisms from the blood of the animals mentioned above after other methods of infection, warrant the assumption that a certain factor exists which prevents the continued survival of the organism in the blood.

Fig. 1. The influence of mouse plasma upon the absorption of oxygen and phosphorus by M. tuberculosis (a); the effect of mouse plasma (1) and rabbit plasma (2) upon the same processes (b); the influence of mouse serum (1) and rabbit serum (2) upon the respiration and phosphorus assimilation by M. tuberculosis (c).

Fig. 2. The effect of serum of immunized (1) and normal guinea pigs upon the respiration and phosphorus assimilation of M. tuberculosis.

It was the aim of the present paper to establish some of the biochemical foundations for the influence of the plasma and blood serum of animals possessing a species-resistance of different degree to M. tuberculosis. It is well known that all living cells, and in particular bacteria, require for the performance of their vital functions, for the normal course of their plastic metabolism, multiplication, toxin formation, and many other functions, phosphate groups as well as energy; the latter is stored in the high-energy phosphorus compounds which accumulate in aerobic bacteria in the course of oxidative phosphorylation. In view of this fact we thought it worthwhile to establish above all the changes (if any) occurring in the intensity of respiration and assimilation of inorganic phosphate in M. tuberculosis in the presence of plasma and serum from different animals.

METHOD AND RESULTS

The plasma and the serum of 542 mice, 23 rabbits, and 125 guinea pigs were used for the study. It is well known that mice are relatively resistant to infection with tuberculosis, whereas rabbits and in particular guinea pigs are highly sensitive. The experiments were carried out with several strains of M. tuberculosis of the bovine type (strain No. 23 of the Leningrad Institute of Tuberculosis, Vallee strain and BCG strain) and one strain of the human type (strain No. 97 of the Leningrad Institute).

The respiration of the bacteria was studied manometrically in a Warburg apparatus. The bacterial suspension in Soton's medium was placed into the containers and the plasma or serum in question was added in volume corresponding to one quarter of the total volume of the mixture. In the control samples a corresponding volume of normal saline was added instead of the serum. The assimilation of phosphorus was judged by the decrease of inorganic phosphate in the medium after incubation in the Warburg apparatus at 37°C for 20 min.

In approximately 73% of cases we were able to observe a marked suppression and sometimes also a complete