of the skin and nerve sheaths and the lepra bacillus in human leprosy, and so on, through other examples in different species of animals and different strains of acid-fast bacilli.

What the chemical factor is, has, up to now, eluded the investigator, possibly because of the difficulties surrounding the study of the internal chemistry of the monocyte, which does not thrive away from its natural environment in association with the other cells of the body.

Much progress, however, has been made in the study of the chemical processes involved in the life history of the various strains of acid-fast bacilli. The study of the chemical composition of the different strains of bacilli has yielded substances common to the whole family in the three gross divisions of their living tissues, that is, the proteins, the carbohydrates and the fats. This progress has been facilitated by our ability to grow many of the strains of acid-fast bacilli on a simple inorganic food stuff out of which each strain can make, by virtue of its own peculiar living characteristics, its own peculiar tissues. This study of the chemical processes has served to prove that the family is bound together by other bonds than acid-fastness and monocyte-bacterial relationship. And it has also served to isolate some of the distinctive qualities that make the strains what they are, *viz.*, human, bovine, or avian tubercle bacilli, timothy grass bacilli, Johne's bacilli, or leprosy bacilli.

From the same study have been found fractions responsible for the changes the bacilli themselves produce in disease, for instance, the fever, the skin reaction, the stimulation to multiplication and change in the character of the monocyte. The same studies have developed further knowledge on the difficult problem of virulence or the quality that certain strains of bacteria have for certain species of animals to produce severe or not very severe disease. It has been found, for example, that a single strain can be made more virulent at will by modifying the medium on which it grows, a phenomenon probably best exhibited with some of the avian tubercle bacillus strains, which can be made more or less fatal for the rabbit.

It is, however, in the later phases of the various diseases caused by these acid-fast bacteria that the contrasts between them become most marked in spite of their common early picture. The massive skin and nerve deformities of leprosy, the destructive cavity formations of tuberculosis, the stripped gut mucous membrane of Johne's disease, are as widely different pictures as possible, and yet with the microscope one finds the constant association of the acid-fast bacteria and the monocyte cell in all the diseases, even in these later phases.

In the blood serum of bodies infected by the different strains there is found also in immunological studies cross precipitation which binds the group together, but exhibits differences showing specificity as well. In the same way the skin reactions resulting from introducing proteins from the different strains into animals infected with one strain are similar and different mainly in the severity of reactions they cause.

This is of necessity but a short introduction to the substance of the papers which follow in this symposium. With the many similarities that have been pointed out, thought has been given to some word which will attempt to comprehend the diseases here described under a single term. Because the bacteria in the group are in scientific literature called *Mycobacteria,* Dr. Esmond R. Long has suggested the term "Mycobacteriosis," which serves the purpose admirably.

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METHEMOGLOBIN REDUCTION BY GLUTATHIONE OR CYSTEINE

GLUTATHIONE or cysteine is efficient, within the physiological pH range, in reducing methemoglobin to hemoglobin, which is able to combine reversibly with oxygen and carbon monoxide. The reduction has been accomplished *in vacuo,* in air, in hydrogen and in carbon monoxide. For example, in the presence of carbon monoxide and using cysteine as the reductant 1.0 millimole of added cysteine had effected the reduction of 0.6 millimole of methemoglobin (on a heme basis) in 24 hours at room temperature. The initial concentrations in this example were 0.14 millimole of methemoglobin and 0.16 millimole of cysteine per liter. Under identical conditions except for the reductant used, 1.0 millimole of added glutathione effects the reduction of 0.7 millimole of methemoglobin. When considerably larger relative concentrations of cysteine or glutathione are used reduction is complete and almost instantaneous whether in the presence of carbon monoxide, hydrogen or *in vacuo.* In air, reduction is not as complete, presumably because of partial oxidation of the reductant by the atmospheric oxygen.

The glutathione content of the human red cell is relatively high (about 40 mg per 100 cc. of whole blood) and is present almost entirely in the reduced form.[1] The ratio of oxidation-reduction equivalents of glutathione to total pigment in the normal red cell is therefore 1 to 5. It is also well known that when hemoglobin is liberated from the cell it is transformed

[1] S. R. Benedict and G. Gottschall, *Jour. Biol. Chem.,* 99: 729, 1933.

into methemoglobin and thus is no longer active as a physiological oxygen carrier. In view of these considerations we suggest that glutathione is one part of the mechanism which prevents the accumulation of methemoglobin in the intact erythrocyte.

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THE CRYSTALLINE CHARACTER OF LIVING MATERIAL

THE notice in SCIENCE for August 13, 1937, Supplement, page 6, outlining Dr. George A. Baitsell's conclusions concerning the crystalline character of living material is interesting. Dr. Baitsell's work is specially significant from two angles. Firstly, because his conclusions are based upon x-ray investigations; and secondly, because his conclusions can be correlated with similar findings by several workers in the past who used data mostly obtained by microscopic methods. The very close relationship between crystallinity and living structures was realized and extensively advocated by the German scientists, Otto Lehmann, Ernst Haeckel and Friedrich Rinne. The main contention of Rinne's work, "Grenzfragen des Lebens" (1931), is upon the fundamental similarity of crystalline material and organic structure. Rinne in his book also insisted upon the continuity of the organic with the inorganic world.

The writer, in a paper entitled "Iron as the Original Basis of Protoplasm" (1935), shows that the iron bacterium *Leptothrix ochracea* is crystalline. He also summarizes observations on the double refraction of plant cell-wall material, the geometric outline of plant cells and the double refraction of certain chromosomes as general indications of the crystalline character of cellular material. The writer concludes that there are four fundamental factors in the generation of life, and one of these is the aggregation and crystallization of an iron compound, ferrous hydroxide.

On a general basis, all these relationships between crystalline and morphological phenomena can be reduced to the conceptions of modern atomic physics. R. Fuerth, of Prague, especially, has applied physical conceptions to structures and functions of organisms (*Die Naturwissenschaften,* 16: 777, 1928). On this basis, not only organic structures but organic functions are reduced to electromagnetic fields.

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POLLEN AND HAY-FEVER

WHILE the recognition of pollen as the cause of hay-fever is general, apparently the behavior of the inhaled pollen does not seem to be clearly understood. At any rate, when I asked for information on this subject from medical men, who I took for granted could give me the desired data, I was rather taken aback when I was told they could give me no references bearing on this subject. Further questioning brought out the admission that they had never thought of the pollen grain as a living thing, comparable to bacteria or other pathogenic organisms.

When it was first shown that pollen was responsible for the symptoms of hay-fever, it at once seemed to me that the inhaled pollen spores might very probably find the moist mucous membranes a favorable medium for germination. The rapid germination, accompanied by the excretion of enzymes associated with the penetration of the tissue of the host by the pollen tube, would presumably immediately set up the characteristic irritation of the mucous membrane, and through the pollen tube the proteins of the pollen spore would be discharged into the tissue of the host.

The germination of pollen is a routine experiment in the botanical laboratory, where in an ordinary sugar solution of about ten per cent. many species will germinate promptly, the protrusion of the pollen tube sometimes occurring within a few minutes.

Assuming that the above theory is correct, it may be inferred that the pollen grains falling on the moist mucous membrane of the nasal passages might in a few minutes send out the pollen tube, exactly as a fungus spore germinates, and quickly initiate the characteristic symptoms of the disease.

The demonstration of the presence or absence of germinating pollen should not be a difficult matter and, if germination does occur, it certainly should offer a wide field for experiment.

It seems hardly possible that experiments along these lines have not been made, and I should very much appreciate any information on the subject.

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QUOTATIONS

SCIENCE'S MAGNA CHARTA

IT took the British Association for the Advancement of Science a decade to realize that a biologist, a physicist or chemist is not an anchorite of the laboratory but a responsible member of society. The realization bore fruit at the historic Blackpool meeting of 1936. There English men of science awakened socially. Possibly the present Indianapolis meeting of the American Association may be equally significant. A symposium on "Science and Society" will give our