BIOLOGY-CHEMISTRY

Chemist Extraordinary

Tiny Bacillus, Visible Only Under the Microscope, Can Perform Feats Impossible to Best Trained Man

By JANE STAFFORD

SUPPOSE you were given some glycerine, water, a few chemical salts, including one from asparagus, and a citrate. What could you make out of them? Not very much, even if you are a trained chemist.

From those same substances, the tuberculosis "germ," the tubercle bacillus to scientists, so small you cannot see it without a microscope, makes dozens of highly complicated substances. Among them is an acid that is absolutely unique and which is largely responsible for the germ's ability to cause disease in man and other animals.

"The tubercle bacillus is a better chemist than I am," Prof. R. J. Anderson of Yale University told me. Prof. Anderson is no mean chemist himself. He has spent nine years learning the secrets of the tb germ's chemical factory.

He showed me 170 tubes of chemicals, most of them different substances which the germ builds up by its skillful chemistry, but he says he and his colleagues have "only scratched the surface."

The tubes he showed me in his laboratory at Yale were exhibited to medical scientists at the Washington meeting of the Federation of American Societies for Experimental Biology.

Some of these chemicals of long names and complicated structure are of utmost importance to you and me. They are the means by which the tubercle bacillus, when it gets into human bodies, causes tuberculosis.

Dangerous Research

That is the reason behind Prof. Anderson's long years of tedious, painstaking and even dangerous research. (Dangerous because Prof. Anderson and assistants have handled many pounds of tb germs that were alive and ready to strike back with disease and death if given the slightest chance.) To go back to the reason for his research: Medical men know they can hold tb in check by hygienic measures—good living and working conditions, food and rest—and by measures that block the spread of the germ from sick to well.

They want more specific, deadly sure weapons against the disease. A good way to get such a weapon is to probe the inmost secret living processes of the germ and find just what poison it uses to spread disease in healthy bodies. A few attempts had been made at this tb germ-probing in the past. They failed to reveal much. Members of the National Tuberculosis Association's research committee, headed by Dr. William Charles White, U. S. Public Health Service, decided to marshal all the forces of medical science in a drive on the tb germ.

The first step was taken in biological laboratories where huge quantities of the germs were grown under exactly similar conditions and on exactly similar media—the glycerine-water-salt mixture from which the germs get the raw materials for their life processes.

Thousands of Quarts

Thousands of more than quart-size flasks of these living germs were sent to the Yale University chemical laboratories. There a systematic chemical analysis was made of the germs. It is the first such systematic chemical examination of the tb germ ever made anywhere in all the long history of man's fight against the white plague.

Taking great care not to injure or destroy the active principles of the germs, the Yale chemists proceeded to extract by simple neutral solvents the three chief chemical groups: proteins, carbohydrates and lipoids or fats contained in the living germs. Prof. Anderson, with the aid of Drs. E. G. Roberts, E. Chargoff, M. L. Burt, M. C. Pangborn, N. Uyei, M. S. Newman, J. A. Crowder and F. H. Stodola, have spent nine years analyzing just the lipoid or fatty fraction part of the germ.

The proteins and carbohydrates of the tb germs were analyzed similarly by another group of chemists headed by Prof. T. B. Johnson of Yale University with the aid of Drs. R. D. Coghill, E. B. Brown and A. G. Renfrew, and by Prof. M. Heidelberger of Columbia University. Very minute amounts of both protein and sugar which the tb germ produces will kill an animal sick with tuberculosis within a few hours, but this discovery is another part of the story.

One reason it has taken so long to make the analyses is that new methods had to be developed.

Working with the fatty part of the germs, Prof. Anderson first split this, chemically, into simpler chemical units. Then he worked at each of these units in turn, splitting or breaking them down into more and more units. Each unit was studied to determine what chemical elements it was made of and how these were put together. In some cases, the chemists took from their shelves the same elements and combined them to produce synthetically the units they were finding in the tb germ.

Important Acid

Most important of all these substances, is phthioic acid. (Pronounced tie-oh-ick.) Prof. Anderson gave it that name because the old name for tuberculosis of the lungs or consumption was the Greek-derived word, phthisis. This acid is characteristic of the tb germ and some of its germ-relatives. Some of the other chemicals Prof. Anderson obtained from the germs are found in other living organisms. Phthioic acid, however, is a special acid found only in the tb germs.

This acid all by itself can produce in the body the nodules of cheesy tissue known as tubercles, characteristic of the disease, tuberculosis. This was discovered in tests conducted by Dr. Florence Sabin at the Rockefeller Institute for Medical Research, New York City. One cannot say, however, that this acid produces the disease, since in the absence of living tb germs, there is no spread of tubercle formation throughout the body. Other chemical fractions of the germ can also cause tubercle formation in the body, but phthioic acid has the greatest activity along this line.

The picture of sickness which we know as tuberculosis is produced by the continuous manufacture by living germs within the human body of these chemical poisons; first, phthioic acid; then the poisonous sugar; finally the poisonous protein. It is in the hope of finding substances to neutralize these

MADE BY A GERM

From the chemical "factory" of the tubercle bacillus, come a poisonous sugar, a poisonous protein, and the unique acid that produces tubercles all by itself. Prof. R. J. Anderson, of Yale University, (right) is showing Dr. William Charles White, of the U. S. Public Health Service's National Institute of Health, the tubes containing the first chemical fractions extracted from the TB germ. Each of these in turn was subjected to further extraction, and each fraction again extracted, until now Prof. Anderson has nearly 200 such tubes.

poisons that the research headed by Prof. Anderson is going on.

Dr. Anderson also looked for the chemical that gives the tb germ its reddish-brown color. He finally extracted this substance in the form of yellow crystals to which he gave the name phthiocol. There is only a tiny amount of this in the germ, but it probably plays a very active part in the germ's breathing process. From pounds of tb germs Dr. Anderson extracted what amounts to a good-sized pinch of the crystals, and this tiny bit represents the world's supply of natural phthiocol, outside of what is in living tb germs.

This phthiocol which has a very long chemical name had never before been found anywhere until Dr. Anderson discovered it in the tb germ's chemical factory. Shortly following the discovery of phthiocol the Yale chemists were able to prepare the substance in the laboratory by two different chemical methods, starting from the coal tar products, methylnaphthalene and naphthalene.

Within a year of the discovery of phthiocol two other methods of synthesizing it were described by other chemists while working on entirely different research programs. A Spanish chemist prepared the substance in the course of his investigation of plumbagin, the active principle of leadwort, and a chemist in Brooklyn, N. Y., prepared it by the careful gradual oxidation of lapachol, a compound found in the wood of the African lapacho tree.

The tb germ also makes a peculiar and characteristic sugar by the name of d-arabinose. Arabinose is universally distributed throughout the plant kingdom, but it is l-arabinose. The letters signify the way the chemical affects polarized light, a complicated matter of interest chiefly to chemists. The tb germ is unique in producing d-arabinose.

This sugar by itself is harmless, but the tb germ combines it in a peculiar way with other harmless sugars to make its own complex sugar that is deadly poison to a tuberculosis-infected animal.

These findings of Dr. Anderson's pertain not only to the germ of human tuberculosis. There are other, related germs that cause tuberculosis in cattle and in birds. A third relative of the tb germ is a harmless organism known as the timothy bacillus. Also related is the leprosy bacillus. Each of these organisms has been analyzed in the same way, and most of the chemicals found in one were found in another, though in varying amounts.

Prof. Anderson is still busy analyzing the tb germs and expects to find more products of its chemical factory. Some may be even more significant.

ARCHAEOLOGY

Jerash Had Traffic Rules And Parking Lot in Forum

IS JERASH mentioned in the Bible? "It is and it isn't," answers Dr. W. F. Stinespring, archaeologist.

Young Dr. Stinespring has been asked that question so many times since he went to dig at ruins of the city of Jerash, or Gerasa, for Yale and the American School of Oriental Research in Jerusalem.

Whether you can find Jerash in the Bible depends on the version you consult, Dr. Stinespring explains. You have to look for the story of Christ healing two men possessed of evil spirits, with the dramatic ending of the spirits entering a herd of swine and running headlong into a lake. In some Bibles it is reported to have happened at Jerash, then called Gerasa. Another version places it 30 miles away at Gadara.

The Jerash of Roman days, about the time of Christ, was a typically Roman planned town—main street lined with columns running one way, and principal cross streets running the other.

There are mysterious ruts in this main street, Dr. Stinespring told the Archaeological Society of Washington, describing the latest finds. In the well-laid Roman paving these deep ruts were worn along the right side of the road—never the left. Traffic rules, whatever they were, evidently were obeyed.

A Parking Lot?

Some of the graceful columns encircling the oval forum of Jerash are still standing. But what the forum was used for, whether a meeting place, market dealings, or official business, is uncertain. One theory has it that merchants, coming over the dusty caravan routes, "parked" their camels in the forum and tidied themselves up before going into town. The stone pavement of the forum is so solid, where it has been uncovered by the archaeologists, that Dr. Stinespring says it would make an excellent parking lot for automobiles.

Jerash had a beautiful and impressive triumphal arch built in honor of the visit of the Emperor Hadrian himself. That visit was a great event. Jerash had a large *circus maximus* like that at Rome, but archaeologists believe this was not finished because of a financial depression.

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