

MEDICINE

# Discovery of the Tubercle Bacillus

## "A Classic of Science"

**March 24 Is the Fiftieth Anniversary of This Event  
The First Part of Koch's Paper Is Translated Here**

*DIE AETIOLOGIE DER TUBERCULOSE (The Etiology of Tuberculosis) von Dr. Robert Koch. In Berliner Klinische Wochenschrift, neunzehnter Jahrgang, No. 15. Berlin, 10 April, 1882. Translated for the SCIENCE NEWS LETTER by Helen M. Davis.*

**T**HE discovery of Villemin that the tuberculosis of animals is contagious has, as is well known, met multiple confirmation, yet also apparently well founded opposition, so that the question whether tuberculosis is an infectious disease or not had to remain undecided for several years. Since then inoculations into the anterior chamber of the eye, performed first by Cohnheim and Salomonson, later by Baumgarten, and further the inhalation experiments of Tappeiner and others safely established the contagiousness of tuberculosis beyond all doubt, and it must in the future be assigned a place under infectious diseases.

If the number of victims which a disease takes can be taken as a measure of its importance, then all illnesses, and even the most dreaded infectious diseases, pest, cholera, etc., must be placed far behind tuberculosis. Statistics teach that one-seventh of all persons die of tuberculosis and that, if only the middle productive age class is taken into consideration, tuberculosis carries off a third of them and often more. Public health work thus has reason enough to devote its attention to so murderous a disease, without taking into consideration other circumstances, among which only the relation of tuberculosis to bovine tuberculosis need be mentioned, in which public health work has an interest.

Since, from the standpoint of care for the public health, it is now among the duties of the health officer to make infectious diseases the object of investigation, particularly with respect to their etiology, it seems an urgent duty to put inauguration of research on tuberculosis before everything else.

Determination of the nature of tuber-

culosis has been attempted repeatedly, but until now without result. The methods of staining which have so often proved valuable in the study of other pathogenic micro-organisms have failed us in this disease and attempts at isolation and culture of the tubercle virus hitherto have not been successful, so that Cohnheim, in the latest edition of his work on general pathology, just issued, has had to point out that a "direct proof of the tuberculous virus is a still unsolved problem."

### Abandoned Usual Methods

In my researches on tuberculosis I in the beginning employed the usual methods, without getting any enlightenment upon the nature of the disease. But through some chance observations I was led to abandon these methods and to try another way which finally led to positive results.

The aim of the investigation must be directed first to the discovery of any parasitical organisms foreign to the body, which might serve as the source of disease. It was also part of this investigation to find hitherto unknown bacteria in all organs characteristically altered by tuberculosis, with the aid of a distinctive staining reaction. It would lead too far to describe the way in which I arrived at this new method and I will therefore proceed to the description of it.

The material for investigation is prepared in the well known manner usual in investigation for pathogenic bacteria, either spread out on a cover-glass, dried and heated, or, after hardening in alcohol, cut in sections. The cover-glass or section is put into a staining solution of the following composition. 200 cc distilled water is mixed with 1 cc of a concentrated alcoholic solution of methylene blue, shaken and to it is added with repeated shaking 0.2 cc of a 10% solution of potassium hydroxide. This mixture should give no precipitate upon standing for a day. The object to be stained remains in this for 20 to 24 hours. By warming the staining solution

to 40° C. on the water bath this time can be reduced to 1/2 or 1 hour. After this the cover-glass is rinsed with a concentrated water-solution of *Vesuvium* (Bismarck Brown), which must be filtered each time before using, and after one or two minutes washed with distilled water. When the cover-glass comes out of the methylene blue it appears to have a dark blue layer sticking to it and it is strongly overdyed, through the treatment with *Vesuvium* the blue color is lost and it is changed to a weak brown. Under the microscope all constituents of the animal tissue, namely the cell nuclei and their disintegration products, now appear brown, the tubercle bacteria on the other hand are dyed a beautiful blue. All other bacteria which I have so far studied, with the exception of the lepra bacillus, by this method of staining change to a brown color. The color contrast between the brown stained tissues and the blue tubercle bacteria is so striking that the latter, which are often present only in very small numbers, can nevertheless be detected with the greatest accuracy and recognized as such.

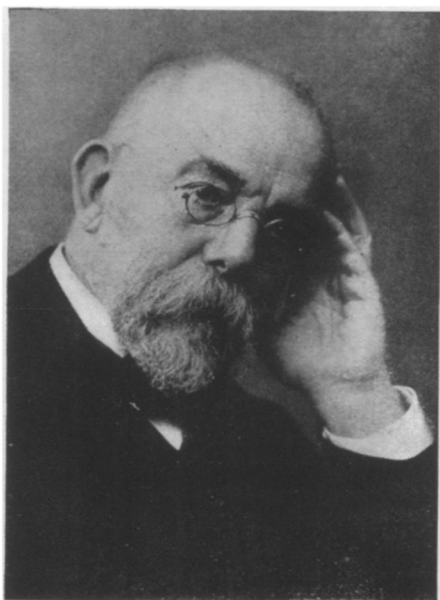
The sections are handled quite similarly. They are taken out of the methylene blue solution into the filtered *Vesuvium* solution, left in it for 15 or 20 minutes, and then washed in distilled water till the blue color is washed away and a more or less strong brown tint is left. Afterward they are washed with alcohol, cleared with oil of cloves, and can then be examined microscopically in the same fluid or finally mounted in Canada balsam. In this preparation also the constituents of the tissues appear

A process in the direct line of descent to

### MODERN PHOTOGRAPHY

was discovered 130 years ago by T. Wedgwood who announced that it needed only a fixing agent to "render the process as useful as it is elegant." The fixing agent was discovered a generation later by Sir John Herschel who added the idea of photographic prints on paper. These accounts form the next

CLASSIC OF SCIENCE



**ROBERT KOCH (1843-1910)**  
German Bacteriologist, discoverer of the  
tubercle bacillus.

brown and the tubercle bacteria are stained a sprightly blue.

Although the bacteria are not indeed dyed exclusively by methylene blue, but take up other aniline dyes, with the exception of brown dyestuffs, under the simultaneous action of alkalis, yet the color with the others is not so beautifully developed as with methylene blue. Moreover the caustic potash may be replaced by caustic soda or ammonia, from which it appears that the potassium does not play an essential role, but only the strongly alkaline nature of the solution is necessary. Therefore it might be said that with a still stronger alkaline content some bacteria might be colored which in a weaker solution would not appear. But the tissues of the section would shrink and change so much under the influence of a stronger caustic solution that the latter would only occasionally be of advantage.

The bacteria made visible by this procedure show a peculiar behavior in many respects. They have a rod-like shape and so belong to the group of bacilli. They are very thin and from one-fourth to one-half as long as the diameter of a red blood corpuscle, occasionally they may reach a greater length, up to the full diameter of a blood corpuscle. In shape and size they show a striking resemblance to the lepra bacilli. But they may be distinguished from the latter because they are a little more slender and pointed on the ends. Also the lepra bacilli take up the coloring if you use Weigert's nuclear

staining, while tubercle bacilli do not. In all places where the tuberculous process is found in fresh onset and in rapid development, the bacilli are found in great numbers; they then usually appear grouped closely together and often tied together in little bundles which many times lie in the interior of cells and here and there present a picture like that of lepra bacilli heaped up in the cells. Nearby also occur many free bacilli. Especially at the edge of great cheesy masses are found only numbers of bacilli which are not enclosed in cells.

#### Fewer After Crisis

As soon as the climax of the tuberculous eruption is past, the bacilli become fewer, are found only in little groups or entirely isolated around the edge of the tubercular lesion near weakly colored and here and there scarcely recognizable bacilli which probably are in the act of dying or are already dead. Finally they can disappear entirely, yet they are seldom completely missing and then only in places where the tuberculous process has come to a standstill.

If giant cells appear in the tubercular tissue, the bacilli lie chiefly in the interior of these structures. In tubercular

infections progressing very slowly the interior of the giant cells is usually the only place where the bacilli may be found. In this case most of the giant cells enclose one or a few bacilli and it makes a surprising impression to keep finding in widely separated thin sections always new groups of giant cells, in which almost every one holds, in the large enclosed space around brown-stained nuclei, one or two tiny blue rods floating almost in the center of the giant cell. Often the bacilli are to be found only in small groups of giant cells, often only in single specimens, while at the same time many other giant cells are free from them. In that case those containing bacilli are the younger giant cells, as may be known from their size and position, while the bacilli-free are older, and it may be assumed that the latter also originally contained bacilli but that they are dead or have gone over into the dormant condition soon to be described. By analogy with the formation of giant cells around foreign bodies, such as vegetable fibers and *Strongylus* eggs, discovered by Weiss, Friedlaender and Laulamié, one may imagine the relation of the giant cells to the bacilli such that here too the bacilli are taken up by the giant cells (Please turn page)

EVOLUTION

## Ice Water Possible Cause Of Evolutionary Speeding

**I**CE WATER in large doses, following the melting of the great continental glaciers, may have been an indirect cause of the speeding up of evolutionary changes that seem to have followed each of the earth's great ice ages. This is one of the suggestions arising out of the researches of T. Cunliffe Barnes of Yale University.

To this might be added the speculation that a like effect may be operative more or less constantly in frosty northern lands, where evolution seems to be more rapid than in the languid, conservative tropics. Each winter, a miniature ice age, may give a little push to evolution, just as a glacial epoch may have given a big push.

The research on which these suggestions are based was conducted with *Spirogyra*, a microscopic green plant common in sluggish fresh waters. Growths of equal size were started in each of three kinds of water. One was

water in which most of the molecules of  $H_2O$  are free and unattached—a state most nearly fully attained in steam. The second kind was "common" water, in which most of the  $H_2O$  groups are bound together in paired molecules. The third was "trihydrol" water, with its  $H_2O$  groups predominantly three in a bunch. Ice is richest in trihydrol, but water from recently melted ice also contains large numbers of trihydrol molecules. Mr. Barnes found that by far the most vigorous growth of his *Spirogyra* cultures took place in trihydrol water.

Whether trihydrol consumed by human beings in the form of ice water will make them grow faster, or have any other effect on their health, is not stated.

Mr. Barnes is at present working on the effect of trihydrol on some of the simpler animal forms, and expects to report in a future publication.

Science News Letter, March 19, 1932

as foreign bodies and therefore, if the giant cells are found empty, the hypothesis is justified that all the other circumstances in the tubercular process mean that earlier they lodged one or more bacilli and this cause gave rise to them.

The bacilli may also be observed unstained in an unprepared condition. For this it is necessary to examine a little material from a place which contains considerable numbers of bacilli, e. g., a little gray tubercular nodule from the lung of a guinea pig which has died from inoculated tuberculosis,—with the addition of distilled water, or better, blood serum, which happens to be most suitable for avoiding currents in the liquid on the stage of the high power microscope. The bacilli then appear as very fine rods, which show only molecular motion, but do not possess the slightest motion of their own.

Under certain conditions to be described later the bacilli form spores in animal bodies and in fact the individual bacilli form several, usually two to four spores, oval in shape, which are distributed at symmetrical distances along the length of the bacillus. . . .

*Science News Letter, March 19, 1932*

## Hans Christian Oersted

When Oersted in 1820 wanted to inform the world that he had discovered the relation between the old force of magnetism and the new force of electricity, he wrote the account in the universal language of Latin and circulated it among scientists of all countries. To his account he signed his name in the Latinized form "Johan." In England the editor of *Annals of Philosophy* translated it into English, and gave his name the English form of "John Christian Oersted." This translation, made in the year of the discovery, was used as a Classic of Science in the SCIENCE NEWS LETTER, February 20, 1932. The possibility that this century-old mistranslation may mislead modern students has been called to our attention by Niels C. Ortvad, President of the Detroit Motorbus Company, who presented to the Museum of Science and Industry, in Chicago, the bronze tablet, executed by the sculptor A. J. Bundgaard, from which the illustration accompanying the Classic was taken.

*Science News Letter, March 19, 1932*

The slow process of erosion has changed the surface of the earth more than all the earthquakes, volcanoes, tidal waves, tornadoes, and excavations in history.

### GEOPHYSICS

# Wobble of Compass Needle Reveals Inner Earth Secrets

## Study of Terrestrial Magnetism Also Helps Explain Conditions of Upper Atmosphere and Activity on the Sun

A BETTER understanding of events deep within the earth has been made possible during the past few years through research by scientists who know how to read the language of the subterranean happenings as written in the varying of the compass needle from true north, John A. Fleming, acting director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, has revealed.

Mr. Fleming presented conclusions reached after careful study of all data collected during past centuries including information taken in recent years from more than 10,000 stations established in different parts of the world by the Carnegie Institution. Thus the most complete picture possible of the long period or secular variation of the earth's magnetism is obtained.

"The relation of large and rapidly changing rates of change of the intensity and direction of the magnetic field to the surface structure of the earth can scarcely be accidental," Mr. Fleming declared. "It is natural to expect that there is a causal relationship existing between crustal and subcrustal movements and these magnetic manifestations. Perhaps there are changing mechanical stresses, or possibly a changing distribution of internal heat, which in turn affects the direction or magnitude of subterranean electric currents.

"Thus secular variation changes within the earth's crust indicate an interior more mobile than the exterior layers, not only as a whole but regionally."

The great secular variations, which over the period of actual observation of several hundred years, caused the compass needle to change its direction by as much as 15 to 20 degrees at some places on the earth, are now better understood, following detailed mathematical analyses of data for periods centering around 1842, 1882 and 1922 by scientists of the Department of Terrestrial Magnetism. Thus it is known that the main cause of the secular variation arises from a system of forces embedded in the earth, Mr. Fleming said. This variation

is caused not only by a change in the direction of magnetization but also by a change in its intensity.

Magnetic force has been decreasing more rapidly in the southern, or water hemisphere, than in the northern, or land hemisphere, he continued. The average equivalent intensity of magnetization over land areas is somewhat larger than that over ocean areas.

*Science News Letter, March 19, 1932*

### ARCHAEOLOGY

## Portrait of Seneferu Discovered in Egypt

A PORTRAIT of the Pharaoh Seneferu, builder of the Great Pyramid at Meydum, has been discovered on a limestone slab, says a report just received from Alan Rowe, field director of the University of Pennsylvania Museum expedition at Meydum, Egypt.

The portrait shows Seneferu wearing a close-fitting cap above which are the horns of a ram supporting two curved plumes. The king wears a long false beard and carries a scepter in his hand.

"Importance of the portrait head," says Mr. Rowe's report, "lies in the fact that, so far as is known, it is the only contemporary portrait of King Seneferu ever found in Egypt. Other pictures of the King have been found in Sinai, but only one of them can be called a portrait."

*Science News Letter, March 19, 1932*

### PLANT PHYSIOLOGY

## Frozen-Pack Pineapple Retains Digestive Power

JUICE of pineapple preserved by the frozen-pack method keeps its power to digest proteins. This is one of the results of a series of experiments conducted at the new frozen-pack laboratory of the Bureau of Plant Industry, U. S. Department of Agriculture, under the direction of H. C. Diehl.

It has been long known that the juice