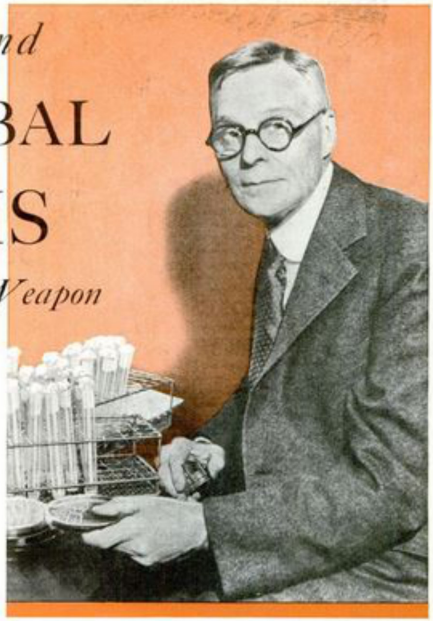
POPULAR SCIENCE
MONTHLY
October 1931 Vol. 119, No. 4
RAYMOND J. BROWN, Editor

New Found CANNIBAL GERMS

Hailed as Mighty Weapon in WAR on Disease

By CLAYTON R. SLAWTER



DR. ARTHUR I. KENDALL, professor of research bacteriology in the Northwestern University Medical School at Chicago. For the first time in history, he has succeeded in making invisible disease germs visible and has thus been able to see what some of man's worst enemies look like His work indicates that bacteriophage are the invisible form of the germs upon which they feed and now may be produced at will in laboratories.

UNKNOWN to the vast majority of his countrymen, an American scientist, working quietly with test tubes, germ cultures, and microscopes in a mid-Western laboratory, has made a series of astounding discoveries that may give the medical profession control over a number of deadly diseases.

He is Dr. Arthur I. Kendall, professor of research bacteriology in the Northwestern University Medical School at Chicago. Made public a few weeks ago, his findings have been hailed the world over as the greatest forward step in medical bacteriology since the days of the immortal Pasteur.

Kendall's discoveries may be said to fall into two closely connected groups. First of all, he has succeeded in growing at will, from the blood of patients suffering from these diseases, the germs that cause influenza, measles, arthritis or inflammation of the joints, common colds, and endocarditis or inflammation of the heart lining. Hitherto all efforts of scientists to identify the germs of these familiar, often fatal maladies, and to grow them in the laboratory, had ended in failure.

This achievement obviously is of the greatest importance to the future study of these diseases and eventually may lead to means of checking them. The reason other scientists were unable to isolate the germs was that the bacteria were invisible, even with the aid of the most powerful microscopes. For the first time in medical history, Kendall has made them visible.

Even more sensational and far-reaching is his discovery, growing out of these experiments, of a method, reminiscent of the magic wishing ring in the fairy tale, by which he arbitrarily can change the germs of many diseases from their invisible to their visible form and back again. This he has done with the germs of influenza, typhoid fever, infantile paralysis, yellow fever, pneumonia, scarlet fever, and the bacteria that are responsible for boils, abscesses, blood poisoning, and certain skin diseases.

At right, millions of locusts, each like the one seen below, were destroyed by a sickness that led to the discovery of an invisible agent that kills disease germs without hurting human beings.

The fact that there are two kinds of disease germs, visible and invisible, had been suspected by scientists for some years. The first to suggest this possibility was Dr. F. W. Twort, of London, who, nearly twenty years ago, announced that he believed he had discovered invisible germs. These studies were continued by Dr. F. d'Herelle, a French physician in the Egyptian government service at the time, and now of Yale University, and later led to the theory of the "bacteriophage," which created a sensation in medical circles when it was first announced.

According to this hypothesis, there exist minute, invisible germ parasites, or germ-eating germs (called bacteriophage by Dr. d'Herelle), that prey on disease germs as disease germs prey on us without, however, attacking the human system. Fifteen years ago, at the Pasteur Institute in Paris, d'Herelle for the first time applied his theory, curing a case of dysentery by means of "bacteriophagy."

WHILE it was known that there were visible and invisible germs, it was left for Dr. Philip Hadley, of the University of Michigan, to discover, more recently, that there are visible and invisible forms of the same germs. He established this "dual personality" in the case of the germs of dysentery, cholera, typhoid, and diphtheria, which he produced in both visible and invisible form. Outstanding among the results of his researches was the fact that the invisible form of the dysentery germ did not attack rabbits and, more important still, was immune from the bacteriophage.

Now, the tremendous significance of Kendall's contributions lies in these two facts:

First, through his discoveries, the germs change from the visible to the invisible form, and vice-versa, can be watched and controlled. In other words, the tiny, invisible killers now can be brought out into the open, where they may be studied so that methods of combating them may be devised.

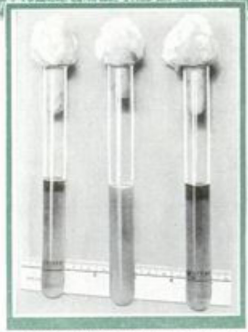
Secondly, his work throws a brilliant new light upon the mysterious nature and activities of the bacteriophage. *Kendall actually succeeded in changing these minute, invisible cannibals into the visible germs which they seem to delight in destroying. As foreshadowed in the experiments of Dr. Hadley, it appears, therefore, that bacteriophage simply are the invisible forms of their own prey.*

THOUGH still in their early stages, the possibilities of Kendall's findings to the study of bacteriology and, through it, to medical science, seem limitless. If germ-destroying bacteriophage can be "made" at will, it would seem that ammunition of unprecedented effectiveness could be brought into play in future wars on epidemics. By leading to the creation of such powerful new weapons in the fight on a long list of diseases that have been among the scourges of humanity for centuries, Kendall's discoveries may completely revolutionize the practice of medicine.

When, a few weeks ago, Dr. Kendall concluded the announcement of the outcome of his researches in a lecture before a distinguished scientific gathering at Northwestern University Medical School, the mild-mannered, fifty-four-year-old professor was greeted by an ovation. The moment the applause and cheering ceased, Dr. Edward C. Rosenow, chief of the bacteriology research division of the Mayo Clinic, at Rochester, Minn., said:

"We have just listened to the revelation of a great discovery." Dr. Irving S. Cutter, dean of the faculty of medicine at Northwestern, declared: "This discovery is as startling to the scientific world as were the discoveries of Louis Pasteur sixty years ago."

As in the case of many of the world's great innovations, the secret of Kendall's discovery, once known, is simple enough.



At right, a tube of agar cultures. A drop of phage, allowed to trickle into the fungus-like growth at top, kills the germs. Above, tube at right contains clear broth of animal hearts into which bacteria taken from patient are placed. In about eight hours, they multiply so culture becomes opaque as seen in center tube. Phage is then added and in a few hours the culture again becomes transparent as seen in left tube, proving that the bacteria have all been destroyed.

How Sick Locusts Led to the Discovery of a New Cure for Fatal Maladies Is Told in This Dramatic Article

At left in drawing, phage is attacking a group of germs. Next, phage breaks through germ shell, fills germ, which bursts and is consumed.

He found that he could make germs visible or invisible by feeding them on human proteins.

Dr. Kendall believed that "faulty germ diet" was responsible for the failure of scientists to grow the bacteria of influenza, measles, and small pox, all of them invisible, outside of human bodies. The bacteriologists fed them such mild concoctions as beef tea and gelatin, which contain the breakdown, or decomposition, products of proteins. When on the war-path, that is, after penetrating the human or animal body, disease-causing germs, however, thrive on stronger stuff. They eat the pure proteins themselves. As a matter of fact, the human and animal system contains scarcely any breakdown products of proteins.

SO KENDALL gave his germs high-protein rations. He made a culture fluid out of pieces of the small intestine of human beings, pigs, dogs or rabbits, which he called "K medium." From this fluid even the faintest traces of breakdown products had been chemically removed. Into the culture he poured blood from human influenza patients, which caused the medium to become cloudy.

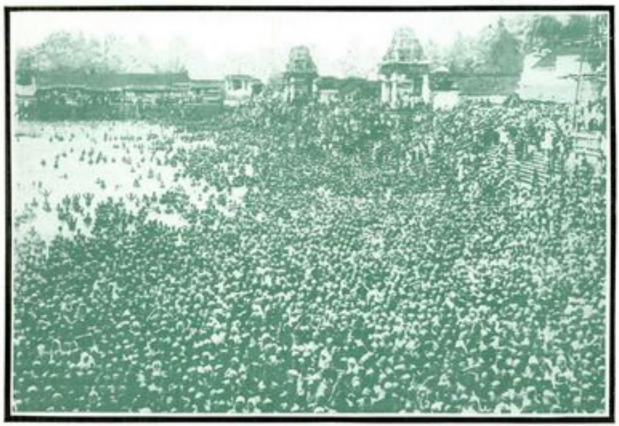
To make sure that the new mixture actually contained influenza germs, he injected a few drops of it into the blood-stream of a rabbit. The animal assumed all the well-known symptoms of the "flu." Then came the essential part of the experiment.

He mixed some of his cloudy fluid, consisting, it will be remembered, of "K medium" and influenza patients' blood, with a quantity of the old-fashioned germ-foods. The result was startling. The germless medium soon was populated by thriving colonies of minute round germs. Here, at last, were influenza germs in their **long-sought**, visible form!

Kendall repeated this experiment with the hitherto invisible germs of several other diseases, and in each case the result was the same. Then he reversed the procedure. Taking germs that, until then, had been known only in their microscopically visible form when grown in the old-fashioned germ-foods, he planted them in his high-protein "K medium." They all became invisible. Now he filtered these invisible germs through the very finest of porcelain filters.

The fluid that came through he mixed again with the old-fashioned germ-foods. As though by magic, the germs once more assumed their visible form. No matter how often he repeated the experiments, each time he got visible germs out of invisible virus *(Continued on page 129)*

Above, the Berkefeld filter and diagram showing how it works. Through the porcelain candle in bottle's neck the phage is filtered to be sure no germs remain in serum.



Natives of India bathing in the sacred Ganges River which a few miles above this point is polluted with drainage from a densely populated country. However, active phage purify the water before it reaches this crowded bathing beach.

CANNIBAL GERMS NOW WAR ON DISEASE

(Continued from page 19)

filterates, and made the visible bacteria change back to their invisible form by planting them in his high-protein medium. Dr. Kendall believes it possible that all disease germs lead this kind of "double life," depending on what sort of diet they feed on.

The experimenter watched the germs as they changed from their visible to their invisible forms. They first lost sharpness of outline and grew blurred and fuzzy under the lens of the microscope. In the end, nothing remained but tiny granules, which passed through the fine filters. These little granules later became full-fledged, visible germs again, either by growing or by reassembling themselves.

In the past, certain puzzling granules have been found in the spinal fluid of patients in the early stages of certain diseases. These, it now appears, may be the half-changed germs in the process of becoming invisible. For use in future experiments, Dr. Kendall has perfected a new, refined form of his "K medium," prepared from highly purified, crystalline proteins.

WHILE Kendall's findings, according to expert medical opinion, probably will work radical changes in the future treatment of a number of diseases, the earlier discovery of bactacphage already has had a far-reaching effect on medical practice. It has freed medical men from the helplessness with which they formerly approached infections. In the light of Kendall's discoveries, there remains little doubt that these tiny cannibals, so destructive to their brothers but harmless so far as man is concerned, will prove the physician's most powerful allies.

In Senegal, French West Africa, phage was given a trial recently against bubonic plague. It was at first administered to patients in advanced stages of this terrible disease. Among these sufferers, we are told, the mortality, by any other methods of treatment, would have been one hundred percent. Yet when bacteriophage was brought into the field, the number of cures effected were in the proportion of fifteen to twenty-one.

Under the direction of the Oswaldo Cruz Institute of the Brazilian government, during the last few years, 10,000 cases of dysentery have been treated by bacteriophagy. Out of all these only two failures have been reported.

BACTERIOPHAGY was tried for the first time in a cholera epidemic in the Punjab, India, the long ago, with striking success. Under all previous methods of treating this Asiatic scourge, the mortality ran from sixty to eighty percent. But when phage was tried, fatalities dropped to as low as eight and one-tenth percent!

The discovery of bacteriophage has solved the ancient riddle of the Ganges River in India. By the Brahman temples at Benares, thousands of natives bathe daily in the sacred stream. Yet a few miles upstream from their bathing *ghats* at the temple steps, the river is unbelievably filthy, since it receives the drainage from a densely populated land that for centuries has known no sewage system but the sluggish streams and rivers.

It would be almost certain death to bathe in many parts of the Ganges. Still, for hundreds of years, millions of natives have washed in it, protected from infection as we now know, not by their own strange gods, but by bacteriophage that devour the disease germs.

Let us watch the phage at work. Since we can't see it by any scientific means, let's suppose ourselves *(Continued on page 130)*

A definite program for getting ahead financially will be found on page four of this issue.

CANNIBAL GERMS NOW WAR ON DISEASE

(Continued from page 129)

equipped with eyes far stronger than the most powerful microscopes, eyes to which a grain of dust seems as large as a baseball. Now let us watch carefully while the phage attacks, say, a *staphylococcus* germ, the kind that makes all the trouble in infected wounds, carbuncles, and boils. This germ, resembling a bunch of grapes, consists of a number of globular germ cells nestled together. The cluster, though, is infinitely smaller than a bunch of grapes; in fact, a grain of dust might be covered with hundreds of them.

Alongside one of these germ globes, the phage, if we could see it, would probably look about as big as a torpedo alongside a battleship, and it is almost as deadly. With our magnified eyesight we see the phage attach itself to a germ and disappear within it. Once inside it begins to eat, making more room within its host. This added space it immediately fills with its offspring, for as the phage eats it multiplies, and it keeps on eating and multiplying, until there is nothing left of the germ but a hollow shell filled with phage corpuscles. Then the germ's shell bursts, liberating thousands of new phage, all ready to carry on their life work against the enemies of man.

THE eating process which you have just watched is not a tearing with teeth and jaws. It is rather an "eating" like that done by some acids when they are brought into contact with certain materials.

Now let us go into a laboratory and see how this powerful new weapon against disease ordinarily is handled by medical men. New methods probably will be developed as a result of Dr. Kendall's work. We see a man partly fill each one of a number of test tubes with an amber colored fluid. Holding his tubes up against the light he shows us that the liquid is transparent, explaining as he does so that it is a culture medium, a broth made of animal hearts. Into each tube, or culture, he puts samples of bacteria taken from a patient on whom bacteriophagy is to be practiced. Then he closes the cultures, telling us that he must let them stand for several hours.

When we return to the laboratory, we find the bacteriologist holding his cultures up to the light, one by one. We see that the culture medium, formerly transparent, is now opaque. In reply to our question, he says:

"When the medium gets cloudy like this, it shows that the germs are active and breeding. We know that they are all thriving and healthy and have settled down to life in their new surrounding."

As we watch him he places several drops of a clear colorless fluid into each culture, taking the new liquid from as many different containers as there are cultures. "This is the phage," he informs us. "We aren't sure yet just which phage will kill germs of the disease on which we're working. So we raised several germ families and now we're going to try a different phage on each of them. In that way we'll know what phage will kill them."

ON OUR next visit, the bacteriologist chuckles as he hands us one culture out of the row on which he has been working. This one, instead of being opaque like the rest, has returned to its former transparent state.

"This is the phage," he tells us, "that will do the trick. When a healthy culture turns transparent, it shows that the germs in it are dead. So this is the phage we'll give our patient; but first we must do some further checking up on it."

Several drops of the sterilized culture are put into each of the other test tubes that contain still active germs. After standing for several hours it is noticed that these also have become sterile. After this the cultures are strained through a Berkefeld filter. This is an odd-looking glass bottle with a narrow neck, into which is fixed a porcelain "candle." The cultures are strained through this into a tube in the bottle.

It is explained that this filtering is a precaution, taken to remove any germ that may have escaped the phage.

A PLAGUE of locusts near Sauterelles, Mexico, in 1909 led to the discovery of bacteriophage. All human methods failed to check the ravenous horde of buzzing insects that were wasting the countryside. At last nature, having sent the dreaded visitation, began herself to destroy it.

People noticed that the insects were beginning to fall dead in great numbers. Evidently some strange disease had killed them; but what was it? Scientists went to work on the dead insects, dissecting and examining them.

Taking samples of the bacteria found in the bodies of the locusts, they bred them in laboratory cultures for study and experiment. Cultures of the disease which had killed the Sauterelles locusts were sent to other regions afflicted with the locust pest. A few of these locusts were caught alive, and into them were injected germs of the new disease. Then the captives were liberated, to fly away and rejoin their comrades.

Soon the Sauterelles conditions repeated themselves. The foreign locusts began to die in great numbers and the plague was shortly a thing of the past.

Not long after this discovery, research work in connection with it took a new turn. If a parasite could be found that would destroy germs of disease in locusts, why couldn't one be found that would do the same thing for man's illnesses? It was this question that d'Herelle finally answered in 1917. The medical world was not slow in realizing the importance of his discovery. Test tubes and microscopes were unlimbered on a world-wide front as a new drive against infection and disease began.

Almost from the first the drive has taken the shape of a hunt for new and different phage. Since the first ones were discovered in bacteria taken from the digestive tracts of sick locusts, it was apparent that the amazing little parasite bred in filth. So highly-fertilized ground, sewers, and polluted streams like the Ganges became the hunting grounds for the new and friendly little organism. The sewers of Paris, incidentally, have been found to supply the best strains of phage found so far. Work of this sort, however, may be superseded by Dr. Kendall's new discoveries.

THE method of extracting these invisible growths from their natural surroundings is similar to the application of them to the cure of human diseases. Samples of sewage are drawn up and strained successively through different filters. The last step in this process is a porcelain candle, from which the sewage sample emerges as a clear colorless fluid. A few drops of this are then put into a germ culture, which is then carefully watched. If it does not become sterile, bacteriologists know they are on the wrong track—there are no phage in the sewage sample they just tried.

When a germ culture finally becomes sterile as the result of application of filtrate from sewage samples, an almost unlimited supply of phage is at hand.