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THE LITTLEST LIFE

By Dr. Edwin E. Slosson.

"How many angels can stand on the point of a pin?" was debated by the wise men of the Dark Ages. It was a good question for debate of the sort they delighted in because they never could find out, and if they could it would have made no difference to anybody.

"How many microbes can stand on the point of a pin"? is the question that interests the wise men of modern times, not for the fun of discussion, but because they can find out and because our lives depend upon their finding out.

For a single microbe may be more than a match for a man in single combat in spite of their disparity in size. Compared with this, the duel between David and Goliath was a fair fight on equal footing. The man, let us say, is five feet, ten inches tall. Against him we will put a microbe of moderate size, say a bacillus measuring only a micron in height. A micron is a millionth of a meter, or, if you prefer, a twenty-five thousandth of an inch. Such a microbe is not afraid to tackle a man, who is 1,750,000 times as tall and 5,000,000,000,000,000,000 times his fighting weight. Yet the microbe often succeeds in knocking him out.

For although the microbe has such odds against him on the start, they do not stay so. For the microbe grows faster than the man and is quicker at multiplication. The Asiatic cholera germ, for instance, doubles every fifteen minutes. If unlimited in space and food, its progeny would equal the mass of a man in the course of some fifteen hours. That is to say, a microbe that gets a lodgment in a man might eat him up in less than a day if the man were entirely edible and provided adequate accommodations.

To return to the point. I have just tried to measure the diameter of the point of a pin, but my desk rule is not fine enough, so I measured the head of it. It is not one of these new fashioned round-head pins, but the common metal kind, and its head is two millimeters across, that is, two thousand microns. Now the bacillus of typhoid fever is two microns long and one wide. So that a thousand of them could be end to end across the pinhead or two thousand lying side by side.

But these are big ones compared with some. It was formerly supposed that

water could be made germ-free by forcing it through a filter of unglazed earthenware, but it is now known that fifty distinct diseases are caused by germs so small that they will pass through the pores of porcelain. Among these are such well-known human diseases as influenza, small pox, hydrophobia and measles, and a long list of plant diseases, especially those recognizable by mosaic discoloration of the leaves.

Most bacteria measure about a micron but the one that carries the flu infection, and is known as pneumosintes, may be only a tenth of that length. The chicken plague and the mosaic diseases of tobacco are carried by something still smaller, say a fortieth of a micron.

Now when the biologist gets down as fine as this he comes into conflict with the chemist. For a single molecule of hemaglobin, the red coloring matter of the blood, is bigger than one of these creatures - if they are creatures. If they are not, how is it that they can grow and multiply and carry their specific characteristics over from one animal or plant to another? But if they are living organisms they must be largely composed of protein and the protein molecule is so large that the chemist can only allow the biologist a few hundred or at most a few thousand molecules out of which to construct the necessarily somewhat complicated machinery of these virulent bodies.

But in spite of the criticism of the chemist the biologist continues to discover minuter bodies which possess some of the functions of life. Bacteria are found to be devoured by something that d'Herelle of the Pasteur Institute calls "bacteria eaters", or if you insist upon the Greek of it, "bacteriophages". These also are filter-passers and must be much smaller than the bacteria on which they prey, but whether they belong to the realm of chemistry or biology is still in dispute. Possibly the question may be settled in the end by finding that there is no definite dividing line between the two realms.

READING REFERENCE - Kendall, Arthur I. Civilization and the Microbe. Boston and New York, Houghton Mifflin Company, 1923.

NON-BOILING STEAM GENERATOR DOUBLES EFFICIENCY

A new steam generator, revolutionizing former conceptions of steam engineering, has been given a successful trial at Rugby, England. It is capable of producing power from coal at an overall efficiency of something like 28 to 30 per cent. This approaches the efficiency of the Diesel oil-burning engine, which is about 35 per cent., and is in contrast to 17 to 18 per cent. efficiency for the most modern superpower station at 350 pounds pressure and 700 degrees Fahrenheit superheat. Its efficiency rivals that of the new mercury vapor boiler recently developed in America.

The generator is the invention of M. Benson of the Benson Engineering Company of London. Its principle is the production of steam at a pressure of 3200 lbs. per square inch, and at the "critical temperature" of water, 706 degrees Fahrenheit. This is by far the highest pressure ever used in steam production.

The "critical temperature" of any liquid is the temperature above which

it no longer can exist as a liquid, no matter how high the pressure. Above that point the whole of the liquid changes suddenly and completely into a gas without alteration of volume. The phenomenon can be observed in a laboratory using liquid carbon dioxide, from which soda water is made, sealed in a thick glass tube and heating it slowly to 89 degrees Fahrenheit, when the whole of the liquid suddenly changes into gas. The application of this principle to water is the basis of the Benson generator, which is described by "Chemistry and Industry" here as follows:

"In the 'Benson' generator water is converted into steam at the critical temperature of 706 degrees Fahrenheit, that is, the whole mass of the water in the coils is bodily changed into steam at the same volume without the absorption of any latent heat, since the volume remains the same. It will be obvious that as no latent heat is absorbed, there is no ebullition or 'boiling', that is, the sudden conversion of small particles of water into comparatively large bubbles of steam, the energy required for this increase in volume constituting the latent, or lost heat.

"It is on these highly ingenious lines that the essential trouble of the small-bore coil steam-generator has been overcome, the fact that because of the absorption of latent heat and consequent boiling the water will not remain in contact with the sides of the tube, and the generation of steam is spasmodic and apt to be explosive. The generation of steam at the critical temperature has, of course, completely eliminated this difficulty so that narrow-bore steel coils can be used which will withstand almost any pressure; in fact, the present installation is said to have been tested hydraulically to 6400 lb. pressure.

"The actual installation at Rugby, which is only one of a number of different arrangements possible, consists of generator coils of $\frac{3}{4}$ in. steel tube, $\frac{1}{4}$ in. thick, placed to a height of 8 ft. round an inner vertical cylinder of fire-brick. This is surrounded by an outer casing and a superheater, consisting of similar coils, is placed on the top. Distilled water is passed in continuously at the bottom of the coil by means of a motor-driven hydraulic force pump working at 3200 lb. pressure, the evaporation on the trials being about 8000 lb. per hour, although 10,000 lb. is the normal figure and is easily obtained. The installation is heated from the bottom by means of an oil blast flame with heated air. Pulverised fuel or gas would do equally well.

"The water as it travels upwards through the coil is gradually raised to a higher and higher temperature, until when 90 per cent. of the total length has been traversed the critical temperature of steam, 706 degrees Fahrenheit, is attained, the pressure being, of course, all the time 3200 lb. At this point the whole mass of the water in the coil, three times the volume when at 60 degrees is bodily and quietly converted into steam at the same volume without the absorption of latent heat and without boiling.

"For the remainder of the travel in the coil the steam is then very slightly superheated to 720 degrees and subsequently passed through a reducing valve, during which the temperature is lowered to 620 degrees and into the superheater, being finally discharged from the latter at 1500 lb. pressure, and 850 degrees Fahrenheit. It will then be used in a small high-pressure turbine, running at 20,000 to 25,000 revolutions per minute, exhausting at 200 lb., generating 350 kilowatts in the process, into an ordinary condensing turbine, giving a further 900 kilowatts down to a 29 inch vacuum.

"The enormous economy to be obtained by working at 1500 pounds and 850 degrees will be apparent. Further details will be awaited with interest as the work unquestionably represents a complete revolution in steam practice.

MYSTERY OF AURORA BOREALIS SOLVED

The shimmering glow of the aurora borealis, which has mystified scientists for many years, is now declared to be due to the action of electric radiations on crystals of solid nitrogen floating in the upper atmosphere. The statement is made by the Norwegian scientist, Prof. Lars Vegard of the University of Christiana, as the result of experiments made in the cryogenic laboratory of Dr. Kamerlingh Onnes at Leyden.

Earlier theories about the aurora attributed it to electric radiations from the sun. Professor Vegard extended these theories and concluded that the aurora was due to the action of these radiations on nitrogen "snow" which he assumed to exist at an altitude of more than 50 miles above the earth.

To test the theory he froze nitrogen onto a copper plate by chilling the plate to the temperature of liquid hydrogen, much as the moisture of a warm room is frozen onto refrigeration pipes in cold storage plants. The rest of the nitrogen was mostly exhausted, resulting in greatly reduced pressure above the deposit of solid nitrogen. These crystals were then bombarded by cathode rays.

Using potentials of from 250 to 750 volts, Vegard was able to make the nitrogen crystals emit light of a greenish color, which when examined in the spectroscope, proved to be identical with the mysterious strong green line in spectrum of the aurora that has always been a puzzle to investigators. Vegard also found that the crystalline nitrogen kept on emitting this greenish light several minutes after the bombardment of cathode rays had ceased.

He also explains the wonderful changes of color in the aurora, for he found that under the electric excitation the solid nitrogen partly evaporates and then begins to emit light of the reddish color so characteristic of nitrogen gas.

STORM SLEUTH COMPLETES FIRST BALLOON JOURNEY

Dr. C. L. Meisinger, storm-riding meteorologist of the U.S. Weather Bureau, has successfully completed the first of his fifteen projected balloon journeys, undertaken to learn more about storms and how they behave. He landed late in the afternoon of April 2 at Walterboro, S.C., after a flight of 22 hours and 20 minutes from Scott Field, Ill.

The flight was terminated because of the simultaneous approach of night and of the Atlantic Ocean which is about 40 miles from Walterboro in the direction which the balloon was travelling. Walterboro is about 40 miles west of Charleston. The air line distance from Scott Field is about 650 miles. Scott Field is at Belleville, Ill., about a dozen miles east of St. Louis, and the course of the flight was across Illinois, Kentucky, Tennessee, and North and

South Carolina.

The Balloon was piloted by Lieut. L. A. Lawson of the U.S. Army Air Service which is cooperating with the Weather Bureau in the arrangements for these flights. Most of the journey was made at an altitude of from 7,000 to 8,000 feet.

The next flight will be started as soon as the balloon can be taken back to Scott Field and re-inflated. This flight was made in the wake of the storm which brought a record April snowfall along the Atlantic Coast. Others will be started on the front, or near the centers of storms, the purpose of the flights being to study the motion across the country of the great masses of air involved in these disturbances, and to get a "close up" of the storms themselves from the air.

READING REFERENCE - Talman, C. F. Meteorology, The Science of the Atmosphere. New York, P.F. Collier Sons' Co., 1922.

EFFICIENT AND LIGHTER CURTAIN TO PREVENT THEATER FIRES

A theater curtain of asbestos and metal, weighing only one-fifth as much as a rigid steel curtain of the same size, and capable of holding back a hot fire for at least 15 minutes, has just been given a thorough test at the U.S. Bureau of Standards, Washington. The new curtain is composed of two sheets of asbestos cloth, separated by a metal framework that connects with guides, trolleys, and track in such a way as to maintain the curtain in place and enable it to operate under considerable pressure as from wind or drafts produced by a fire.

The test was made by placing the curtain so as to form one side of a furnace fired by fuel oil burners. The result is described as fairly satisfactory since little smoke and almost no glow showed on the exposed side during the 15 minute test. A temperature of 1700 degrees Fahrenheit, corresponding to bright red heat, was attained in the furance. Any well designed theater could be emptied in about five minutes so that if a fire occurred on the stage and got out of control, such a curtain would protect the audience until ample time for escape had been given.

Curtains made of asbestos cloth in one thickness were found not so satisfactory. The cloth lost strength readily when exposed to the fire, permitting smoke and glow to show on the auditorium side. Similar faults were shown by a curtain in which the asbestos was woven with wires of nickel, chromium-nickel alloy, or monel metal. The most efficient fire stop was shown to be a rigid steel curtain having a sheet metal face on the auditorium side and an asbestos board covering on the steel side with structural steel framing between them. This held back fire, smoke, and glow for half an hour; but such curtains are so heavy that some buildings cannot carry them. The new curtain is designed to remedy this defect.

Quartz glass is capable of absorbing oxygen, which imparts to it a phosphorescent glow.

ARTIFICIAL CELL CULTURE LEADING TOWARD CAUSE OF CANCER

By growing cells outside the body for many years in his research laboratories at Washington University School of Medicine and the Bernard Free Skin and Cancer Hospital, St. Louis, Mo., Dr. Montrose T.Burrows is gaining new light on the cancer problem. His apparatus makes it possible to keep cells alive, active or growing for an indefinite number of years, and it was devised as a means of finding out why some cells continue their normal existence and why others suddenly change their nature and grow, forming cancers.

He has found that cells normally form a substance, if present in sufficient amounts, which will cause them to grow or migrate. If the circulation is too fast, this substance is removed before the cells have undergone its effect; but if the circulation is slowed up, growth or migration occurs. This explains why a well-exercised muscle gets hard and larger, because the contractions of the muscle cause momentary interference with the circulating blood and retains the substance long enough to cause the muscle to grow in size.

Louis H. Jorstad, who has been assisting in this work, found that coal tar has the power to attract cells away from their normal blood supply sufficiently to cause them to grow and multiply. These cell clumps thus formed enlarge and soon are perceptible as tumors of a cancerous nature, and can be transplanted into other animals for an indefinite number of generations. It is only when there is a clump of cells so affected by impaired circulation that the growth-producing substance can act.

In the medical world old age is noted for its defective circulation and cancers. Dr. Burrows has demonstrated that if an extract of a cancerous tumor is injected into skin which has its circulation impeded in a manner similar to that of old age, a cancer forms. Cancers frequently occur in pigmented warts or moles when their already deficient circulation is interfered with by natural changes of old age. Their exposed location predisposes them to irritation and injury which may be sufficient stimulation to cause a rapidly spreading cancer. Medical science has been groping for the cause of cancer for hundreds of years, and has been unsuccessful in adequately coping with it because the cause was unknown. Since this discovery that cancer may be produced by anything which causes a re-arrangement of cells in the presence of a defective circulation, it is possible that medical science will soon find methods of administering its most effective treatment and prevention.

RUSSIANS SHRUNK INCHES DURING RECENT FAMINE

What long-continued famine does to human beings is vividly shown in the form of a coldly scientific article on the effects of the recent famine in Russia recently published as a translation from the work of a Russian scientist, Prof. Alexis Ivanovsky of the University of Kharkov. Not only loss of weight, but a shrinking of several inches in stature and a general drying up of the whole bodily frame similar to that experienced in advanced old age was experienced by Russians suffering from a three-year shortage of wholesome food.

When it became evident that a period of famine was approaching in Russia, and that it threatened to be of long duration, Professor Ivanovsky enlisted his colleagues in an investigation of the physical effects of starvation. The ob-

servations were made on 2,114 individuals, male and female, in all parts of Russia, and were continued for three years, each individual who survived being measured six successive times at intervals of six months.

The most universal and obvious effect of the famine was loss of weight. Not one individual was found whose weight had not deminished, while in a great number of cases the loss was as much as thirty per cent. of the normal weight. Fat was the first to be sacrificed and by the end of the famine had almost completely disappeared in all the subjects measured. After that was usedup, the muscles wasted away, then some of the internal organs such as the liver or pancreas were affected, while the essential organs such as the heart and the central nervous system were little affected.

Bodily stature declined in nearly all cases, the average loss being from 1.5 to 2.6 inches in men, and from 1.4 to 1.9 inches in women. The loss was greater among young persons, but was made up by them more rapidly when food again became adequate.

The shape of the head changed. In the average famine sufferer it became relatively broader, the front and back diameter shrinking more than the transverse. The length of the face decreased less than its breadth, resulting in a typically lean, narrow visage. Similarly the nose became narrower and thinner.

"In very emaciated people," Prof. Ivanovsky states, "the hair grew more slowly, fell out prematurely, and tended rapidly to become gray. The eyes became like those of old people, the skin lost its elasticity and became wrinkled, the gait became weak and uncertain, the body bent. The sexual instinct became very weak or even disappeared entirely. The number of births decreased enormously, while the number of children born prematurely or still-born increased, as did those born with various deformities."

Because of the irregular diet of indigestible food, ulcer of the stomach became a common complaint. The body largely lost its power of resistance, simple boils easily became carbuncles, and abscesses of the hands were common as the result of ordinary infections. Finally, Professor Ivanovsky considers the psychological factors of depression and apathy to have been of great influence, even to the extent of causing changes in the body structure.

READING REFERENCE - Morgulis, Sergius. Fasting and Undernutrition; A Biological And Sociological Study of Inanition. New York, E.P. Dutton and Company, 1923.

RATS FAIL TO BENEFIT BY PARENTS' EDUCATION

Descendants of educated rats are just as dumb as their parents were before going to school. At least, that is what results of experiments on 247 animals by E. M. Vicari of the Zoological Laboratory of Columbia University to be published in "Science" seem to indicate. He found that rats of the fourth generation did not learn how to find food in a labyrinth any quicker than had their ancestors of the first generation.

NITROGEN FED LAND NEEDS LIME TO PREVENT ACIDITY

Lime is needed by soils fed too rich a nitrogen diet, says a report to the American Chemical Society recently made by the New Jersey Agricultural Experiment Station. If the nitrogen is administered as sulphate of ammonia over a long period of years, the soil becomes so acid as practically to prevent growth. This may be corrected if lime is added at intervals of five years.

Heavy applications of manure tend to correct the unfavorable conditions brought about by the continued use of sulphate of ammonia without lime, the report states. Manure also was found to increase the fertility of the soil more when used in combination with nitrate of soda than when the same quantity of nitrogen was added to the soil solely through the use of manure or nitrate of soda.

EXHAUSTED SOIL NEEDED TO PRODUCE BIG CROPS

Lack of necessary plant food in the soil is necessary to produce big crops. The same processes which exhaust the land lead to bumper yields. These apparently paradoxical conclusions have been reached by Prof. W. F. Gericke of the Division of Plant Nutrition of the University of California from experiments which will be described in the next issue of "Science".

During the most active period of their growth many plants take some of the necessary foods out of the soil faster than these foods are returned to the soil. Prof. Gericke arranged his experiments in order to determine whether this temporary depletion of itself increased the crop-producing power of the soil.

A large number of wheat seedlings were started in a solution containing potassium, calcium, magnesium, iron, sulphur, nitrogen, and phosphorus, all the seven elements required by plants and supplied by the soil. Seven other solutions, each lacking one of the required elements, were also prepared. Wheat plants were set in each of these partially complete solutions.

At intervals of a month, some of the plants from the solution containing all the food elements were transferred to each of the partially complete solutions. Changes were made with different sets at four different periods of growth. Other plants were grown in the different solutions, but were not changed.

Prof. Gericke found that the plants which grew one month in the complete solution and were then put in the solution lacking potassium were, after six weeks, more vigorous, more mature, and twice as big as those which were kept in the complete solution. Very little growth was made by plants started in the solution lacking potassium.

These results are in accord with what actually happens in soils growing field crops, Prof. Gericke says that while the removal of salt elements from the soil is a process which leads to infertility, that is, if the rate of removal exceeds that of replenishment over a long enough period of time, such

removal also plays a beneficial role in crop production. This temporary depletion of certain available food elements in the soil by plants is one of nature's most important conditions essential to large crop production, he says.

HARDEST SUBSTANCE TO MELT IS MELTED AT LAST

The most refractory substance has been melted. Thorium oxide has been fused by the scientists at the U. S. Bureau of Standards. The work was done by C. O. Fairchild and M. F. Peters in the course of a research which involved the melting of platinum, and the thorium oxide was melted to enable crucibles to be made of it to hold the molten platinum.

The oxide is used commercially in incandescent gas mantles. It does not melt at the temperature attained in the gas flame, which heats it white hot. As ordinarily prepared, it is a fluffy white powder which upon heating to high temperatures gradually shrinks in volume.

But no matter how high it is heated there is still some shrinkage left. So it occurred to the investigators to take all the shrinkage out of it by melting it, something that had never been done before.

The exact details of the method have not yet been made public, beyond the fact that it was melted in a hollow formed in a heap of the powdered substance. Nothing else could be used, for it melts at a temperature only found in the electric arc, hot enough to melt or vaporize any other container. Platinum melts at a temperature of about 3,200 degrees Fahrenheit, while the melting point of thorium oxide is probably almost twice as high.

The peculiar value of crucibles made of this substance is that molten platinum may rest in them for some time without absorbing enough of the thorium oxide to be detected in a spectroscope, so permitting the metal to be purified.

SULPHUR BATHS MAKE SANDSTONE STRONGER

Sandstone may soon become the competitor of granite for the distinction of being one of the strongest of building materials. Tests made at the U.S. Bureau of Standards show that by the simple device of soaking sandstone for several hours in melted sulphur and then cooling it the strength of the stone is increased from 200 to 300 per cent.

The crushing strength of ordinary sandstone is about 8,000 to 9,000 pounds per square inch. But if it be subjected to the sulphur bath the crushing strength is raised to 30,000 pounds, or equal to that of the best granite.

Sandstone is porous, and if it be immersed in melted sulphur, the sulphur soaks in through the pores of the rock. A treatment of several hours is sufficient to impregnate sandstone blocks of the usual building sizes and make them as strong as granite blocks. Sulphur melts at about 240 degrees Fahrenheit. Further heating thickens it, so the sandstone is immersed in the liquid while it is still cool enough to be quite fluid.

Experiments are continuing at the Bureau of Standards to determine the

weathering qualities of the sulphurized sandstone, upon which its use as building material will largely depend. Investigation has also shown that sulphur also has the property of greatly increasing the strength of cement which is soaked in it, and experiments along those lines are being made.

Some of the more important public buildings of Washington, such as the White House and the Treasury are built of sandstone, which is a favorite material for such work. Its relatively low crushing strength has, however, prevented it from being extensively used in engineering works of a massive character. The investigation so far indicates that if treated with sulphur it may be regarded as the equal of granite for these purposes so far as strength is concerned.

CUT FLOWERS KEPT FRESH BY ASPIRIN

Cut flowers may be prevented from fading by giving them an aspirin tablet. Norman D. Keefer, pharmacist at the State Sanitarium at Mont Alto, Pa., states that by this method he has not only preserved flowers several days beyond the time when they would ordinarily fade, but has revived them when wilted.

The experiments were conducted with chrysanthemums. Some of them were put into water to which an aspirin tablet had been added; the others were put into plain water. Kept under conditions otherwise the same, the drugged blooms outlasted the others by three days. In another case, flowers which had stood in a hot room over night and were badly wilted, were given fresh water to which an aspirin tablet had been added. They revived in two hours, looking as fresh as they did when picked the day before. The leaves, however, remained wilted.

The explanation of the action of the aspirin is that it acts as an antiseptic, interfering with the enzyme, which normally causes the clogging of the vessels of the stem at its cut surface.

POISONED THROUGH THE SKIN

Most of us are inclined to think that the skin is a great protection against absorption of poisonous substances. Surgeons for example often scrub their hands with bichloride of mercury solutions and put on rubber gloves without bothering to dry the hands. Bichloride poisoning might be acquired in this way. Other poisons are sometimes absorbed through the skin. For instance, a Philadelphia painter spilled a large quantity of wood alcohol over his clothing by accident, and became blind. The doctors say the wood alcohol went through the skin into the blood, and was carried to the optic nerve, and so did the damage.

BEER FROM POTATOES

New uses for potatoes are being sought by German scientists who have found that by the utilization of dried potatoes a strong, palatable beer may be obtained. The potato taste and odor completely vanish if the wort is cooked. From the carbonized rotten and spoiled potatoes a useful bleaching substance has been made, and this black bleaching powder, if mixed with turpentine, makes a good shoe polish.
