# DO BACTERIA OR THEIR GERMS EXIST IN THE ORGANS OF HEALTHY LIVING ANIMALS? By JOHN CHIENE, *Surgeon to the Royal Infirmary, Edinburgh;* and J. COSSAR EWART, M.B., *University College, London.*

IN the sixtieth volume of Virchow's *Archiv* (p. 453), Dr Tiegel publishes the results of a series of investigations carried on in Professor Kühne's laboratory in order to discover if bacteria or their germs existed in the organs of living animals.

The experiments of Dr Tiegel were repeated by Dr Burdon-Sanderson in 1874, and again in a modified form in 1877. From his experiments Dr Tiegel concluded that numerous living organisms existed in the salivary and lymphatic glands, but especially in the liver, pancreas, and spleen during life.

The method employed may be best stated in the words of Dr Sanderson[1]:—"It consists in killing a healthy animal (a rabbit), and rapidly opening the abdominal cavity, cutting out the liver and kidneys with perfectly pure instruments, and allowing each organ to drop without a moment's delay into a basin previously prepared, containing fused paraffin at the temperature of 110° C. (230° Fahr.). As soon as the mass has solidified its surface is covered with Venice turpentine, in order to provide against the possibility of contamination by the cracking which is apt to occur in cooling. In some instances the experiment was varied by substituting oil at the same temperature for the paraffin. Whichever of these plans is adopted, the organ, let it be liver, kidney, or heart, by its greater specific gravity sinks to the bottom. If, after a day or two, it be removed and cut into, it is found that its internal surface is firm and opaque, in consequence of the action upon it of hot paraffin or oil, but that the interior still retains its red colour, a proof that notwithstanding the very high temperature of the paraffin, that of the central kernel of the immersed organ can never have much exceeded the coagulation point of albumin. The results of all the experiments, whether with liver or kidneys, was the same. The soft

[1] *British Medical Journal*, Jan. 26, 1878.

red kernel of uncooked tissue at the middle of the organ always contained bacteria, the vigorous development of which was indicated by their large size, countless numbers, and active movements." Dr Sanderson, from the above experiments, concluded that in each of the organs experimented upon germs were present during life.

Since 1874 we are not aware that any other investigator has repeated Dr Tiegel's very important experiments.

*Importance of the Question.*—That the question is an extremely important one is at once apparent. If bacteria or their germs exist in the organs of a living animal, then why endeavour by antiseptic precautions to prevent the infection of the wound from without? If the wound is liable to contamination from within, Lister's system of treatment is comparatively useless.

If bacteria or their germs exist in the abdominal organs, lymphatic and salivary glands, it is evident that they must reach these organs from the exterior. Bacteria might, if in the bladder, find their way to the kidneys by the ureters; if in the mouth, they might reach the salivary glands through their ducts; if in the alimentary canal, the pancreas, and liver, through their ducts; and the abdominal lymphatics might be reached through the lymphatic radicles from the alimentary canal, but before reaching the spleen, heart, and lymphatic glands generally, they must first enter the general blood stream. Further, if they can reach the spleen, heart, and other organs, there is no reason why they should not find their way to any part of the animal organism, so that whenever the tissues or fluids of any part, or of any organ, undergo degeneration, we should expect to find bacteria growing and developing in the suitable habitat thus provided for them.

*Are Bacteria present in the Alimentary Canal?*—Of this there can be no doubt, but that in health they can pass through the mucous membrane, and enter directly the blood stream by the veins, or indirectly by the lymphatics, we have no evidence. When chemical or mechanical irritation is applied to the intestinal tract, or when, as the result of disease, the epithelial and other tissues are partially or completely destroyed, bacteria may pass through the mucous membrane. When ulcers exist in the mucous membrane lining the alimentary canal, or when by

injecting irritating fluids into the abdominal cavity the intestinal walls are inflamed, it is possible that bacteria may find their way into the liver through the portal vein, and into the peritoneal fluid through the inflamed walls of the intestine.

The liver, however, may be looked upon as a sieve capable of retarding the passage of bacteria unless present in overpowering numbers, just as it, according to Schiff, eliminates and retains poisons from the blood entering by the portal vein. If this is so, bacteria, if they reach the general circulation at all, must do so by traversing the lymphatics.

*How do Bacteria reach the Alimentary Canal?*—There can be no doubt that they enter with the food. In the stomachs of herbivorous animals they exist in great numbers and in all possible forms. On examination of a drop of the fluid contents of the stomach of a newly-killed rabbit, torula, penicillium, micrococci, bacilli, spores, and even spore-bearing filaments may be found. We have no positive evidence at present that any of these forms are capable of penetrating the healthy mucous membrane, neither do we know what influence the gastric secretions of different animals have on the different organisms they come in contact with; but seeing that they do exist in the alimentary canal, it is possible that they may, under conditions favourable for their existence, reach the interior of organs or even the general circulation by three different channels—(1) directly into the liver and pancreas by the bile and pancreatic ducts, the salivary glands through the salivary ducts; (2) directly by the venous radicles into the portal system; (3) indirectly into the general circulation by the lymphatics.

But further, it may be held that they may reach the general circulation by entering the kidney from the bladder. Bacteria exist in great numbers in diseased human bladders (one form of cystitis is due to their presence), but there is evidence that even into these they are at first introduced by an impure catheter. In order to discover if they were present in rabbits, we under the spray passed an antiseptic ligature round the neck of several bladders filled with urine, cut them out, and suspended them in beakers, which had been previously carefully purified. In order to protect them from the ordinary atmosphere several layers of gauze were tied over each beaker.

Three days after, and again six days after, on careful examination, not a single bacterium was found, whereas every drop of a large quantity of urine which had not been treated in this way was absolutely teeming with the characteristic rods of *bacterium termo*. Klebs has given an elaborate description of how the spores of bacteria find their way from the bladder along the ureters and urinary tubules into the cortical substance of the kidney, but if they do not exist in healthy bladders they cannot reach the kidney by the ureter.

Having eliminated the most natural channel through which bacteria could enter the kidney, the only one left is, as far as we know, the renal artery; but, as with the spleen, before bacteria can enter the renal artery they must be first in the general circulation.

We know that healthy blood can be kept any length of time without undergoing putrefaction and without showing any signs of containing living organisms; this, we need not say, would be impossible if bacteria or their germs existed in the blood stream during life.

Having arrived at the above conclusions, and encouraged by Mr Lister's milk experiments,[1] we thought that, after all, the most likely channels, viz., the ducts of the several glands, might be so constructed that bacteria could not enter them, or that their contents might by some unknown colytic influence render bacteria inactive. All are aware that Mr Lister, by squirting milk direct from the udder of the cow into calcined jars, was able to keep it absolutely sweet and free from organisms. This implies that when it came from the cow it contained no organisms, and that on its passage into the jar it was not infected with organisms.

Now, if organisms do not enter the mammary gland of the cow by orifices of ducts which are ever exposed to the air, and often in contact with straw, hay, and other material loaded with bacteria or their spores (we cannot suppose that such a bland fluid as milk could destroy bacteria), need we be considered rash in supposing that, after all, bacteria may not enter the ducts of glands containing fluids, which fluid, in the case of the liver at least, has an antiseptic action. It was therefore thought right to repeat Dr Tiegel's experiments with antiseptic precautions.

[1] *Microscopical Journal*, April 1878.

*The Apparatus and Material required, and the Method of Experimenting.*—The following were provided:—A spray producer; 1-20 solution of carbolic acid; antiseptic gauze and unprepared gauze; M'Intosh cloth; calcined flasks; a syringe, containing a small quantity of fluid teeming with bacteria.

With the above at hand a rabbit was killed, and under the spray the abdominal cavity was opened, and the liver, spleen kidneys, and pancreas removed. The liver was divided into several portions, and still under the spray some of these were wrapt in antiseptic gauze, others in unprepared gauze, and others were placed in calcined jars, which were either protected by wool, gauze, or glass caps. The kidneys, spleen, and other glands were either wrapt in antiseptic gauze, or placed in calcined flasks. One kidney was kept in the ordinary air, and another, after having a solution containing bacteria injected into its substance through the renal artery, was wrapt in antiseptic gauze. The above experiments were repeated several times.

*Results.*—Three days after performing the experiments, small portions were removed under the spray, with a pair of fine dressing forceps, from the surface and the centre of each organ.

In the portions from the unprotected organ numerous characteristic active rods, resembling in every way those of bacterium termo, were found, and besides rods numerous micrococci.

In the portions from the liver wrapt in unprepared gauze only a few short active rods were found, but a considerable number of fine active-jointed bacilli were present.

In the kidney into which bacteria were injected putrefaction had set in, the centre was soft and dark coloured, and when a small portion was examined large active bacteria were found in great numbers. It contrasted strongly with the kidney placed in the calcined flask, which, when cut into and examined, showed no indication of putrefactive changes, or of the organisms which lead to them.

In all the other portions examined no evidence whatever of organisms was obtained. Isolated moving granules were numerous enough, but the movement was simply of a Brownian nature; they were not dumb-bell shaped, as if in process of division, and there were neither zooglœa of rods, spores, nor micrococci; in fact, not a single bacterium, either in rest or in motion, was

visible in any of the preparations. Three days later the examination was repeated with the same results.

If, then, in the organs of healthy rabbits, removed immediately after death with antiseptic precautions, no indication of bacteria are found, we cannot but conclude that neither bacteria nor their germs exist in the healthy organs of these animals during life.

*Relation to Germ Theory.*—If it be true, then, that after all bacteria do not exist in the viscera of healthy living rabbits, we may infer that they are less likely to exist in the healthy organs of higher forms, that they are not likely to exist in healthy human organs; and this being the case, the greatest possible argument against the germ theory is at once and for ever removed; for if in healthy blood, milk, and other secretions, neither bacteria nor their germs exist,—if in the healthy liver, spleen, kidneys, pancreas, lymphatic, and other glands (when protected from atmospheric contamination) no indication of bacteria several days after death is found,—there is no possible channel left through which bacteria can reach a wound from within, so that in order to prevent putrefaction and the evils which follow it, it is only necessary to adopt an antiseptic method which will prevent living bacteria or their germs from entering the wound from without.