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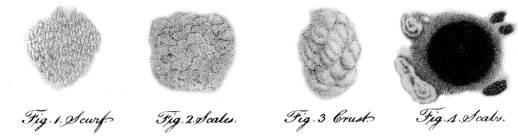
Subject: **Air is replete with infinite multitudes of living creatures**

Dear Doctor Franklin:

Do you remember corresponding with your British friend Dr. John Pringle (in 1777, shortly after arriving in Paris) about your boils? You wrote in the third person—as though speaking of someone else—and didn't mention that you were at the Continental Congress when your rash first appeared.

You told Sir J.P. that "Towards the end of winter 1776, he set out on a journey of 500 Miles, of which great part was performed in a small open boat, where he was kept sitting without exercise for many days."

Do you recollect that failed effort soliciting Canadians to join America's rebellion? While heading up the Hudson River and across Lake Champlain, you said you were "afflicted with a succession of boils, sometimes two or three together, each when healed leaving round about it spots of the same scurff, which obstinately continued, being renewed after every removal."



Skin lesions from an 18th-century medical textbook

Your next assignment sent you to France to raise money for the Revolutionary War. Again, you said nothing to J.P. about the trip's purpose: "In November 1776 he made a long sea voyage, in which the disorder sensibly increased, and the boils became more frequent. Part of each arm, and of each side, the small of his back, and parts of his thighs and legs, became covered with the scurff, which became very troublesome, itching sometimes extremely, and when rubbed or scratched off, would spot his linen with blood."

We now know that boils, empyema, and suppuration are different manifestations of the same thing, all caused by the "kind of vermin" you mentioned in your MICROSCOPE article.

For millennia before your time, *spontaneous generation* explained the appearance of numerous kinds of creatures in rotting trees, muddy swamps, and all manner of decay. Overthrowing that doctrine proved essential to establish a relationship between the microscopic vermin and disease.

In 1668, the Italian scientist Francesco Redi (whose book you owned), placed two identical pieces of meat in separate jars, leaving one open and while covering the other with a snug-fitting cloth. Maggots appeared only in the uncovered jar.

You obviously knew of Redi's work. Recall telling *Almanack's* readers that no microscopic animals appear in fluids if they remain covered, "but when

open to the access of the air, their numbers are beyond reckoning...” You even explained how this happened: “Air is replete with infinite multitudes of living creatures too small for sight...which fall upon places fitted for them...”

For the next hundred years after your MICROSCOPE piece, occasional publications described microorganisms in diseased tissues. Today, however, we credit the experimental work of French chemist Louis Pasteur and of German physician Robert Koch for our modern understanding of infectious diseases.

Pasteur first studied wine spoilage. He suspected that microscopic animalcules caused the problem, so he conducted experiments that buried forever the notion of spontaneous generation. He proved that the tiny organisms arrived at the wine’s surface by settling out of the air.

Pasteur quickly realized that he could prevent spoilage by keeping airborne microbes away from wine and other beverages after he first heat-killed bacteria already there. *Pasteurization* with heat has since become mandatory in the beverage industry.

Asked to investigate anthrax (splenic fever of sheep and cattle), Pasteur determined that a microbe caused the disease, but more significantly, found he could stimulate permanent immunity by inoculating sheep with *killed* anthrax bacteria. He soon applied the same principle to rabies, even though he never found a bacterium that caused the illness. Without knowing about existence of even smaller microscopic beings called *viruses*, Pasteur heated an extract from a rabid dog’s brain to inactivate the infectious organisms, creating an inoculation that prevented rabies.

Robert Koch also started his scientific career studying anthrax: he advanced the techniques used today to isolate and identify bacteria; he discovered the tuberculosis bacillus (1882) and the bacterial cause of cholera (1885). He made contributions to our present understanding of malaria, typhus, and other diseases I’ll tell you about in a couple of days. Most significantly, Koch established the idea that each microbiological species causes its own distinct disease.

Based on your selection of material for the *Almanack*, it appears that you accepted—or at least considered—the notion that microscopic creatures could cause infectious contagions in persons so predisposed. Today, thanks to countless researchers, we suffer less from invasion by “minute animalcules” than from our own excesses—at the dinner table, on the barstool, in the armchair.

Understanding the cause of an illness and achieving a cure are, of course, two different things. With respect to diseases produced by bacteria, a fortuitous accident in a British laboratory led to the discovery of *antibiotics*—medicines that kill microbes without harming the patient. I’ll tell you more about them after I review some “infectious distempers” from your era.