

Survival vs. Cooperation

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Survival and cooperation are the twin tracks of evolution. The survival track is easy to see: adaptations that help the person live longer—at least until he or she can reproduce—are rapidly spread through the population. The second was harder to figure out. Darwin saw and wrote about it, but its pathway was not readily apparent. The cooperation that becomes apparent as people play games gives us big hints, but that is applying social evolution to the much larger area of genetic evolution. The rules are the same as we point out, but it's still comparing apples and oranges.

Bacteria provide plentiful examples of genetic cooperation, but for them it is most often a matter of survival. In the bacterial world there are lots of threats. They need water and food just like we do and their hosts—the plant or animal they are clinging to—is often using some of its own defensive tricks to get rid of it. Paul Ewald talks about this survival game in his book, *The Evolution of Infectious Disease*. He points out that individual bacteria are like pioneers looking for a place to hang out and that they are very vulnerable and easily killed. But if they can find a place to live and grow into a colony they are safer. If the colony can evade the threat from the locals and their environmental threats long enough they can build houses and forts and walls to protect themselves. In the bacterial world there is a lot of cooperation and self sacrifice in doing this. When a single bacteria senses a threat it screams about it by releasing a particular chemical called a signaling molecule. When more bacteria sense the threat the voice of this signal gets increasingly louder. It's exactly like tweeting in our world—it's the massive retweets that get the attention. In the bacterial world its called quorum sensing. When the threat gets loud enough the colony shifts as many of the bacteria give up their lives to become homes for the others. They form a matrix that encloses the colony in what is called a biofilm. If an established biofilm is threatened, like with an antibiotic, a part—not all, that would be suicidal—of the bacteria will begin to sacrifice themselves by rapidly mutating as they attempt to find a way to cope with the antibiotic. With billions of them participating they are usually successful. Then the successful mutation is spread both vertically as the successful mutant divides and multiplies, and, exemplifying the cooperation we are talking about, sharing the mutation horizontally by lateral transfer using plasmids containing the genetic information that are available to any other bacteria—even different types of bacteria.

Biofilms are all over the place. Bill Costerton was one of the pioneers who showed the place of biofilms in our bodies. He started off by looking at streams in his native northwest. The streams were clean and safe to drink, but if you went deep enough to the rocks on the bottom they were all slimy with a coating of bacterial biofilm. The plaque on our teeth is a biofilm and we talk elsewhere about the role that some bacteria living in this plaque have in causing tooth decay and how xylitol was found to help. Biofilms are often a problem in medicine. Sometimes bacteria get to places in our bodies where they don't belong and if they can form a biofilm it protects them from the antibiotics we use to kill them. Foreign objects like catheters and IV lines that are inserted into the body are almost always homes for biofilms. Artificial joints are also a common site and the dose of antibiotic needed to penetrate the biofilm and kill the bacteria is often toxic for the patient. But many biofilms in the body are actually helpful. The biofilm in the stomach and intestines protects it from invaders at the same time it is making many of the vitamins and materials we need to live, as well as helping to shape our own immune systems. The acidic nature of the biofilm in the female vagina provides a similar defense. One of Costerton's first campaigns was the successful one that recognized the defensive nature of this biofilm and

stopped the medical recommendation of vaginal douching because it washed out this defense. The key to whether a biofilm is friendly or hostile takes us back to Ewald.

Ewald looked at cholera epidemics and found that if the bacteria that cause this illness were prevented from getting around easily it shifted–adapted–to a less virulent form. Clean water and proper disposal of waste are key elements in coping with these epidemics. He found the same thing when he looked at HIV in Japan. Most often the strain is the virulent form found in south-east Asia, but the most common form of birth control used in Japan is the condom and Ewald found that HIV in Japan rapidly becomes less virulent. He concludes something like: **bacteria want to survive and if they cannot escape to infect someone else they will shift–adapt–to keep you alive.**

That is a very nice concept. It set me to thinking about our warfare with microbes, that we really cannot win, and how we need to shift our thinking and essentially start negotiating and about how xylitol helps. I wrote about this in the medical journal *Medical Hypotheses*. Preventive measures like hand washing, chlorination of our water supplies, gowns, gloves, and masks when dealing with potentially infectious situations make sense. They stop the bugs from getting around and push them in a friendly direction. Xylitol works at the next stage and is equally effective; it stops them from attaching to us so they are just washed out and applies the same push toward commensalism–living together in some form of harmony.

And these ideas led us back to the issue of survival vs. cooperation. Survival is important for all of us, but if you are trying to find some way to measure the health of a system looking at its diversity is a far better measure. We do have pockets around the world where people tend to live much longer, but they are hardly examples of diversity. More likely they are places where the elderly are respected and honored and continue to play a meaningful part in the lives of their families and friends. A comment from a colleague working at Creighton Medical School in Nebraska comes to mind: “people tend to live long in Nebraska because dying is redundant.” And it led us to looking at how these genetic concepts can be applied to our outside worlds. Survival seems most associated with an adequate profit margin and with the financialization of the US economy we see an increase that direction at the expense of any pressure toward cooperation and its seeming partner innovation. The primary innovations seen lately being those in the financial world that appear to increase ones profits by ripping off someone else.

As a physician I often feel somewhat out of place commenting on our world and its political, economic, and social aspects. But then I realize that the human body, where I am more at home, is what we call a complex adaptive system in *The Boids and the Bees* just as are these social creations–**and they follow the same rules.**

That is to say: we can guide them into a better cooperative pathway, just as Ewald shows us how to guide bacteria. If you create a threatening environment you will get defensive responses aimed at surviving. If the environment is threatening and yet friendly–like over-controlling parents or states–you will promote ‘gaming the system’ behaviors, like passive aggression, or the ‘smartest guys in the room’ at Enron who gamed the power grid for their own profit. If you want to support cooperation and diversity you need to provide a space for the players (like the stuck in place pathogens), an environment that is rich in elements to play with, and a direction like making that environment better. As Jerry points out these playful elements and goals of making life better are best seen in children; they are a part of who we all are, they are natural, they are a manifestation of the gods that live in us all.