

SCIENCE AT WORK

- FOCUS
- LAB WATCH
- INNOVATION

Darwinian Medicine

Taking Another Look at Health

Biology. Like most species, humans have adapted to their environment to maximize reproduction. Looking at diseases in light of the theory of evolution opens new research avenues.

BY LAURE CAILLOCE

One of the world's top antibiotics consumers, France recently went as far as launching a public awareness campaign advising patients not to misuse the drugs. Antibiotics are intended to eradicate bacterial infections, but are widely prescribed for viral infections among others. This has caused the most resistant bacterial strains to be selected, a real-case example of the Darwinian theory of evolution applied to human health.

Darwinian medicine postulates that like other species, humans have been shaped by the environment in which they have evolved, and that better understanding of adaptation sheds new light on the health problems we face today, as first hypothesized in the 1990s by American biologists Nesse and Williams. "For thousands of years, humans have co-evolved with many parasites, such as bacterial intestinal flora, against which they have developed a number of defense mechanisms," explains Luc Perino, physician and professor at the faculty of medicine in Lyon. "At the same time, these parasites have undergone their own adaptation to maximize their reproduction at our expense."

Immunity on alert

Fever is the best-known example of adaptation: by raising its temperature, the body makes the parasite

1. Maladies infectieuses et vecteurs: écologie, génétique, évolution et contrôle (CNRS / IRD / Université Montpellier-I). 2. Institut des sciences de l'évolution de Montpellier (CNRS / IRD / Université Montpellier-II).



michel.raymond@univ-montp2.fr
frederic.thomas2@ird.fr
lucperino@wanadoo.fr

uncomfortable. Prescribing a drug to remove the fever means suppressing the body's capacity to fight the infection. "Before treating a symptom, it is wise to find out what category it falls into," notes Perino.

Sudden environmental changes have consequences, including individuals having difficulty to adapt to their new environment. This is one of the explanations provided by Darwinian medicine for the current upsurge in autoimmune diseases and allergies. "Having evolved in environments rich in parasites, we have developed a powerful immune system," explains Frédéric Thomas, research scientist in evolutionary biology at the MIVEGEC laboratory¹ in Montpellier (southern France), specialized in infectious diseases. "But since the advent of vaccination and antibiotics, combined with better hygiene and other factors, our immune system is much less solicited." When underemployed, it tends to bring out the heavy artillery for minor events, such as pollen grains, or even fight against the body that it is meant to protect. Understanding this mechanism has led to the development of a groundbreaking treatment for Crohn's disease, a chronic intestinal inflammatory condition. Patients ingested worm eggs found in pig intestines. These eggs do not develop in human intestines, but they focus the immune system's attention. This seemingly simple idea has led to long-lasting remission in clinical trial patients.

Foods tolerated differently around the world

Some digestive disorders can also be explained by environmental changes. Milk is an example: we do not all tolerate it in the same way. "Barely 2% of Chinese adults tolerate cows' milk, versus 98% of Dutch subjects," says Perino. This difference can be explained by the selection of a genetic mutation that occurred more than six thousand years ago, when breeding first began. Because of this mutation, some individuals in northern Europe were able to continue to produce lactase—the enzyme that degrades lactose—after weaning, thus increasing their chances of survival during food shortages. This phenomenon is not innocuous in the present era of globalization. Soy, for example, a plant commonly consumed in Asia for millennia, contains phytoestrogens, substances that have hormonal effects in mammals and whose impact on Westerners not used to consuming it is little known. "There is always a risk when people eat plants they didn't evolve with," bemoans Michel Raymond, a research scientist at the ISEM.²

The Darwinian approach also seems very valuable with regard to age-related conditions. "During evolution, mechanisms for maximizing reproduction have been favored systematically, even if they have harmful effects in the longer term," states Perino. "Calcium strengthens bones and makes people more resistant, therefore more likely to reproduce. But it is also deposited in arteries, which becomes a problem with age."

Cancer research could also benefit from this evolutionary approach. "Due to natural selection, our defenses against cancer are globally efficient as long as we can reproduce," observes Thomas. "This is why the most common cancers (prostate, breast, colorectal) are most often triggered in the post-reproduction phase of life." Some mechanisms favorable to reproduction may then turn against the individual: for instance, men who produce much testosterone have a reproductive advantage, but a higher risk of developing prostate cancer.

Shedding light on cancer

The disease itself, characterized by uncontrolled tumor cell growth, presents a typically Darwinian function. Cancer cells prove to be selfish, reproducing to the detriment of their neighbors—a dysfunction that may date back to the appearance of multicellularity, half a million years ago. "Initially, life was unicellular, so each cell was responsible for its own reproduction," explains Thomas. "When multicellular beings appeared, specialized cells—called gametes—became responsible for reproduction. In theory, cells now only renew themselves. Yet in case of deregulation, they can regain the old reflexes of unicellular organisms." These observations prove that our health problems are well worth considering in the light of Darwinian thought. ■

*"Barely
 2%
 of Chinese adults
 tolerate cows' milk,
 versus 98% of Dutch
 subjects"*

Darwin's Theory of Evolution

Because of infinitesimal genetic mutations, every individual in a species differs slightly from the others. Mutations that improve an individual's chance of survival, and therefore of reproducing, are transmitted to the subsequent generations and eventually spread within the species. This mechanism of natural selection was described by Charles Darwin in the mid-19th century.