How Darwin can help us with cancer and coronavirus

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Credit: AI-generated image (disclaimer)

Some 160 years after Darwin, we understand how natural selection works. But why don't all organisms have the same ability to evolve?

This is the topic that professors Christophe Pélabon and Thomas F. Hansen are researching—Pélabon at NTNU and Hansen at the

University of Oslo.

They are now leading a project at the Centre for Advanced Study at the Norwegian Academy of Science and Letters (CAS). There, they have put together their scientific dream team to spend a year researching so-called "evolvability".

Evolvability is the ability of an animal, plant or microbe to evolve so that the next generation is a little different.

Darwin and variations

The answers they find can help improve our understanding of everything from cancer to the coronavirus. Pélabon and Hansen don't expect to find the cures, but they hope to find out why and how both the diseases and the patients evolve.

Ever since Charles Darwin, scientists have studied why some organisms reproduce and evolve, while others die.

"Natural selection requires variations in order to work, so that some specimens are better at surviving than others. We know that the individuals in a population are different from each other," Hansen says.

Using people as an example, he says, "Some of us are tall, some are short, some are fat, some are thin, some have dark hair, and some have light hair. These variations are similar for populations of all kinds of organisms."

"He points out that if any of these traits give us an advantage in surviving or finding a partner, then selection will lead to changes in the population over time.

"They can find out why and how both the diseases and the patients evolve."

Where does the variation come from?

So far, we're on familiar ground. But in the 1990s, the concept of "evolvability" emerged.

"The question is where the variation comes from and why there's so much variation," says Hansen.

He talks about "selection pressure"—how much difference there is between individuals—in what biologists call "fitness," referring to their ability to survive and reproduce.

"If selection pressure is a given, then how fast can the population change?" he asks.

He emphasizes that this is about genes that can be passed on to the next generation. If some individuals are bigger simply because they have been given more food, their offspring won't turn out bigger for that reason.

"All traits show genetic variation, but some of them can evolve much faster than others. We're trying to understand why some traits and some populations evolve faster than others," says Pélabon.

It is not only a question of how fast the characteristics evolve, but also whether the access to genetic variation helps determine the tempo.

Biology and philosophy in collaboration

Hansen and Pélabon are biologists, but this year they're also collaborating with experts in other fields, including philosophers and historians. Together, they are reflecting on the research that has been done over the past 30 years.

"What have we really learned and what can we do to understand more?" They would rather not say so themselves, but this kind of systemization and review hasn't really been undertaken since the research on evolvability began.

"Some researchers have investigated this question at the molecular level. We're not looking at individual genes, but at traits like height. We're looking at small changes in a short time period—10 to 20 generations. At another level, we're looking at the potential for evolution over geological time," says Pélabon, "in other words, millions of years."

So far, he believes the future of this kind of research will involve a new type of study that attempts to link molecules, genes and traits.

"These links seem to be necessary to improve our understanding of evolvability," he says.

Or to use his own words, the research strives "to link the molecular level with the phenotypic level."

Relationship between genes and traits

"A lot of the key lies in understanding the relationship between genotypes and phenotypes," Hansen says.

That would be the relationship between the hereditary material (genotype) and the characteristics that can be observed in each individual (phenotype).

"Selection looks at the phenotypes, while heredity depends on the underlying genotypes and their traits. We have to go back and forth between them, and some of the research is about understanding how to do that," Hansen said.

Cod and bacteria

Then there's the question of how the different characteristics are linked.

"Let's say you want longer arms, so you'd select for genes that give you longer arms. But if those genes simultaneously affect the length of the legs, then the arms aren't very evolvable. We have to try to understand how much variation is in the arms that isn't locked up in other organs," says Hansen.

Whatever this project comes up with will be important for further research in both biology and medicine.

Changes can happen fast. In only a few years or decades, for example, cod have become smaller and bacteria more resistant. Many of the researchers working on the topic now have found new collaborative projects that they can continue with.

Corona collaborating crinks

There's a certain irony in the fact that a project that can provide new knowledge about how viruses mutate and evolve, has a spanner in thrown the works of the usual CAS way of collaborating by—what else—this coronavirus.

Usually, researchers have the time and resources to put other things aside, meet in Oslo and find new answers together. This spring they have had to meet digitally instead.

"We miss sitting together and discussing things face to face, or standing at the whiteboard to do our drawings and calculations. Sure, it's possible to sit and discuss or have a presentation or seminar digitally, but the dynamics of everyone having offices in the same place is dead," says Pélabon.

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