Cheating is easy -- for the social amoeba

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Cheating is easy and seemingly without cost for the social amoeba known as Dictyostelium discoideum, said a team of researchers from Baylor College of Medicine and Rice University in Houston who conducted the first genome-scale search for social genes and found more than 100 mutant genes that allow cheating. A report of their work appears in the current issue of the journal *Nature*.

Cheating has special meaning in the world of Dictyostelium. In normal times, the organism exists as a single cell. However, when food gets scarce, the social amoebas aggregate into a multicellular organism that consists of thousands of individual cells. In doing so, one-fifth of the cells “sacrifice” themselves to become non-reproductive stalk cells that support the fruiting body of spores that can then be transported to more auspicious areas where they can begin the life cycle once more as single cells.

Previous studies had shown that even when the social amoebas come into contact with others who have a different genetic blueprint, they form mixed multicellular structures that produce roughly fair proportions of spores, said Dr. Gad Shaulsky, associate professor of molecular and human genetics at BCM. For example, if the aggregate is 90 percent from a group with one genetic fingerprint and 10 percent from another group, the organism’s allocation of stalk to spore will be the same. Ninety percent of the stalk cells will be from one type and 10 percent from another. The same for the spores.

However, his colleagues, Drs. Joan Strassmann and David Queller, evolutionary biologists at Rice, noticed that there are Dictyostelium strains in nature that if mixed under lab conditions “cheat.”

“They make more than their fair share of spores, sometimes to the exclusion of others. They can completely dominate the population,” said Shaulsky.

To understand this better, Shaulsky and Dr. Adam Kuspa, professor and chair
of biochemistry and molecular biology at BCM, and their Rice colleagues undertook a genome-wide study of the 10,000 genes in the organism to find those mutants that permit cheating.

“Is there a genetic basis for cheating?” Shaulsky said. “Is it easy to cheat or not?”

In a previous study, he and his colleagues showed that there is sometimes a cost to cheating. They identified a mutation that made it easier for a cell to become “pre-spore” but then the cells did not produce spores very well.

The phenomenon is called pleiotropy, Shaulsky said. One evolutionary theory holds that a lot of genes have dual function. One is social but the other is metabolic or structural – something that contributes to the cell’s survival. A social gene is one that reduces a cell’s “fitness” to survive singly but increases the survival chances of the whole organism.

In this study done on a genome-wide basis, he and his colleagues saturated the genome with mutations and grew strains that each had a mutation. Over 20 generations, they mixed the strains and forced them to develop chimeras – multi-cellular organisms that have are a mixture of cells with different genetic blueprints.

“Under these circumstances, cells that have a higher propensity to become spores become enriched,” said Shaulsky. “In the end, we found more than 100 mutants that can cheat.”

When they mixed mutant strains with their normal counterparts in a 50-50 concentration, they found that the “cheaters” gave rise to more than their fair share of spores.

However, when they tested the “cheaters” ability to develop and form spores on their own, they were surprised to find that most of them did not have a “cost.” In other words, they did not lose fitness in order to cheat.

“The fact that these mutations do not have an overt cost says things are a lot more complicated in nature than we thought,” said Shaulsky, “but it is possible that the way we calculate ‘cost’ in the laboratory is not the way it’s calculated in nature.”

He and his colleagues theorize that there may be a constant battle between “cheaters” and non-cheaters and that the resulting adaptations have much to do with evolution.

“Now we are looking for counter-cheaters – mutants that can resist cheating,” he said.

Source: Baylor College of Medicine