Abstractions

LAST AUTHOR

Cooperation is a key driver in the evolution of multicellular organisms as well as societies. Molecular biologist Gad Shaulsky at Baylor College of Medicine in Houston, Texas, teamed up with evolutionary biologists to find 'cheater' mutations — those that enable some strains to benefit from the cooperation of others — in the social amoeba *Dictyostelium discoideum*, an organism that alternates between a unicellular and a multicellular form (see page 1107). They found cheater mutations in more than 100 genes. Shaulsky tells *Nature* that even cooperative species sometimes cheat to survive.

Your early work was on cancer — how did you get into the social dynamics of amoeba?
While working on the tumour-suppressor gene *p53* as a student, I became interested in communication between cells. I was curious to know why some cells risk foregoing their own survival to become part of a multicellular structure. To answer this question, I needed a social organism that can form chimaeras — organisms that combine DNA from two or more genetically distinct individuals. In conditions of starvation, multicellular chimaeras of the normally unicellular *Dictyostelium* form, in which spores (live cells) and stalk cells (dead) arise from genetically equitable mixtures of two or more strains.

How did the work on cheating come about?
In 2000, before we collaborated, two of our co-authors at Rice University discovered that one *Dictyostelium* strain makes more than its fair share of spores within chimaeras — in other words, it cheats. Rice is only across the street from Baylor, but we didn't team up until later that year, when we were all at a meeting in Scotland. We decided to search for cheater mutations and, to our surprise, found more than 100 genes involved in cheating — which suggests frequent opportunities for cheating in natural populations.

Is this subterfuge unique to amoebae?
No. The large number of genes we discovered indicates a long evolutionary history of social competition.

Can *Dictyostelium* shed more light on sociality?
Yes. Of the organisms whose genomes have been sequenced, there are no other social eukaryotes that are also amenable to genetic modification. Evolutionary biology is a field with many robust theories, and we want to test them at the molecular level. The molecular details of these mechanisms almost certainly differ between species, but the concepts will probably be the same. We think *Dictyostelium* will become the *E. coli* of social evolution for the coming decade. ■

MAKING THE PAPER

Douglas Hofmann

Large, branched crystals make metallic glasses less brittle.

Despite what parents may tell their children, watching television is not always a waste of time. For Douglas Hofmann, it led to a graduate project helping to produce a new class of metal alloys that are more resistant than other types to fracture under stress.

In 2003, Hofmann saw William Johnson, a professor of materials science at the California Institute of Technology (Caltech) in Pasadena, on a televised history programme. Johnson talked about his invention of bulk metallic glasses — an unusual group of metal alloys. Typically, these are about twice the strength of similar metals as a result of their amorphous microstructure; traditional metal alloys consist of crystalline matrices of atoms.

Intrigued by the topic, Hofmann, who had been searching for a materials engineering programme, enrolled as a graduate student at Caltech, with Johnson as his adviser. There, he learned that metallic glasses do have a weakness: when overloaded, they fracture without warning. Unlike their crystalline counterparts, metallic glasses don't show any signs of breaking under stress — a property known as ductility. "Ductility is important for structural things, such as bridges," says Hofmann. "You want to see signs that they will buckle or break."

On the basis of previous research by several groups, Hofmann and his colleagues knew that to make metallic glass ductile they would need to add 'dendrites' — branched crystalline particles that form in a liquid. Through a series of metal 'bending' experiments, they discovered that, to make the metallic glass less brittle, the crystalline particles had to be softer than the metallic glass — like adding bits of rubber to plastic — and of a fairly large size. "Once we figured these two things out, actually making the composite was the next step," says Hofmann.

This took the researchers into uncharted territory. "We had no idea how to make the particles sufficiently large for ductility," says Hofmann. But, as it turned out, their first attempt was successful. "I took a shot in the dark and it worked," Hofmann says.

He admits that fortune smiled on their efforts. He decided to use an induction coil — an instrument that heats over a lower range of temperatures and provides better temperature control than other instruments typically used to melt metals in alloy production.

In a subsequent analysis of the technique, Hofmann learned that when the metal–glass composites are heated in the temperature range above the melting point of glass and below that of the dendrites, two phases form. The metallic glass becomes a liquid with little crystalline particles floating in it. When this 'slush' is cooled, the crystalline particles grow larger. "It was a lucky choice," says Hofmann, "but now that we look at the thermodynamics, it seems so obvious" (see page 1085).

The technique, which Hofmann has dubbed "slushy processing", resulted in a final glassy composite with large coarsened dendrites, providing the microstructure needed for ductility.

Now that the researchers understand the process needed to impart ductility to metallic glass, they want to refine it further. Eventually, Hofmann would like to create bulk metallic glass composites that are both lighter and cheaper — made using iron, for example, rather than titanium or zirconium. And, if he succeeds, perhaps he'll find himself on television. ■

FROM THE BLOGOSPHERE

One of *Nature Medicine*'s peer reviewers recently told the editors that it is unreasonable of the journal to seek advice from more than three reviewers for a paper, because it places an undue burden on authors.

Juan-Carlos Lopez, the journal's chief editor, explains on the blog 'Spoonful of medicine' (http://blogs.nature.com/nm/spoonful/2008/02/strength_in_numbers.html) that this practice, which is not undertaken lightly, is often necessary. One reason for this is that one of the referees may be someone who has not reviewed for the journal before, who may turn out to be either too tough or the opposite — what editors call "wet".

Second, many submissions to *Nature Medicine* are multidisciplinary studies. In some cases, the editor will need one reviewer with expertise on animal experiments, another to advise on potential relevance to human disease, and others who are knowledgeable in the various disciplines and technologies involved.

Third, editors don't ask authors to address every point each referee raises. So, as Lopez says, "two referees times two does not necessarily equal four sets of comments"! ■

Visit Nautilus for regular news relevant to *Nature* authors ➧ http://blogs.nature.com/nautilus and see Peer-to-Peer for news for peer reviewers and about peer review ➧ http://blogs.nature.com/peer-to-peer.