Press Release

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Why flies have sex –
Or, one gene is enough to make things happen.

IMBA's Barry J. Dickson shows that a single gene is sufficient to produce alternatively male or female sexual behaviour in fruit flies. The findings are published as a cover story in "Cell" on June 3rd, 2005.

"We have shown that a single gene in the fruit fly specifies essentially all aspects of the fly's sexual orientation and behaviour", says Barry J. Dickson from the Vienna based IMBA, the Institute of Molecular Biotechnology of the Austrian Academy of Sciences, to summarize his recent discoveries as they get the cover story of the prestigious journal Cell (www.cell.com), in its next issue on June 3rd, 2005).

"Normally, male flies chase after female flies", Dr. Dickson continues. "However, by various manipulations of this gene, we have generated males that court other males, females that court other females, and females that court males."

In fact, these research results are probably groundbreaking as they produce hard evidence that genetically scripted information not only defines how living beings are built, but also, to a certain extent, how they behave.

Dickson and his team focused on the "fruitless" Gene of the fruit fly Drosophila melanogaster which shows distinct differences in males and females. They succeeded in altering this specific gene at will, thus producing males and females who would bear the sex gene of the opposite gender.To everybody's surprise, these flies would instantly start to produce the respective sexual behaviour while all the rest of their body, including the sexual organs, had remained unchanged.

Thus females, who ordinarily wait passively to be courted by males, would actively chase other females, or males, who would normally court females, now ran after other males.
The significance of such amazing behavioural patterns reach far beyond the odd sexual behaviors of these flies Dr. Dickson underlines. So far, it was clear that such a complex process as sexual behaviour must require the action of many different genes, and mutations in any one of these genes could disrupt the behaviour. The surprising finding, however, is that just one of these genes is enough to produce the behaviour in the other sex.
Dr. Dickson's 'sufficiency experiment' clearly shows that in the case of the fruit fly, a single 'switch gene' that sits on the top of a hierarchy is responsible to trigger

complex behaviour. “The ‘fru’ gene creates something”, Dr. Dickson says, and further generalizes the meaning of this discovery: “We learn, in terms of developmental genetics, how animals acquire behaviour.” This is a major step in learning to understand how innate behaviours are specified, a key area for biology that so far is hardly understood.

Technically, the Drosophila underwent a targeted mutation in order to single out a line of flies with a specific splicing of the ‘fru’ gene.

Males and females of the flies generally have dramatically distinct and innate sexual behaviours. These behaviours are essential for their reproductive success, and so strong selective pressure is likely to have favoured the evolution of genes that ‘hardwire’ them into the brain.

Male courtship in Drosophila is an elaborate ritual that involves multiple sensory inputs and complex motor outputs. It is largely a fixed-action pattern, in which the male orients toward and follows the female, taps her with his forelegs, sings a species-specific courtship song by extending and vibrating one wing, licks her genitalia, and finally curls his abdomen for copulation. If the female is sufficiently aroused and has not recently mated, she accepts his advances by slowing down and opening her vaginal plates to accept copulation. An obvious but nonetheless remarkable aspect of this behaviour is that mature males court only females, never other males, whereas females do not court at all.

The concept that a switch gene can specify an entire innate behaviour in no way denies the critical role of complex gene networks, just as, for the physical building plan of an animal, the concept of a morphogenetic switch does not deny the existence of complex regulatory networks among the genes it regulates. These networks add both detail and robustness to the behavioural or morphological pattern initially laid down by the switch gene at the top of the hierarchy.

Given the appropriate genetic tools, behavioural instincts should ultimately succumb to the same kind of molecular genetic analysis that has so successfully revealed the principles of morphological development.

Several noted independent researchers are prepared to comment on this issue (list with names and addresses available on request.

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On IMBA

IMBA, the Institute of Molecular Biotechnology of the Austrian Academy of Sciences, combines basic and applied research in the area of biomedicine. Interdisciplinary research groups work towards understanding the fundamental molecular underpinnings of normal and pathological behaviour. The ultimate aim is to translate this knowledge into novel approaches for diagnosis, prevention and therapy of diseases. IMBA was founded in 1999 and is located at the Campus Vienna Biocenter. It operates in close collaboration with the IMP, Boehringer Ingelheim’s Research Institute of Molecular Pathology. IMBA is financed by the City of Vienna and the Austrian Government.

On Barry Dickson:

Barry Dickson was born in Melbourne, Australia, in 1962. He received his doctorate in Biology from the University of Zurich. After performing postdoctoral research at the University of California, Berkeley, he established his own research group in Zurich. In 1998, Dickson moved to Vienna where he currently holds the position of Senior Scientist at IMBA. Barry Dickson's research focuses on the developing nervous system, using the fruit fly Drosophila as a model organism.