Fruit flies crucial to basic research

30 March 2015, by Marco Gallio

Decreasing funding for fruit-fly research will hurt people, not flies. Credit: John Tann, CC BY

The world around us is full of amazing creatures. My favorite is an animal the size of a pinhead, that can fly and land on the ceiling, that stages an elaborate (if not beautiful) courtship ritual, that can learn and remember… I am talking about the humble fruit fly, *Drosophila melanogaster*. By day, a tiny bug content to live on our food scraps. By night, the superhero that contributes to saving millions of human lives as one of the key model systems of modern biomedical research.

Fruit flies entered the laboratory almost through the back window a little more than 100 years ago. The excitement was still fresh after rediscovery of Gregor Mendel's work on the genetics of peas in 1900. It was an outlandish notion at the time that Mendel's simple laws of inheritance could apply even to animals. To test this revolutionary idea, scientists were looking for an animal they could keep easily in the lab and reproduce in large numbers.

Thomas Hunt Morgan struck gold when he decided to use the fruit fly as a model. He and his students pushed this prolific little animal to great success. They furthered Mendel's work to discover that genes are located on chromosomes, where they are arranged, in Morgan's words, like "beads on a string" – a breakthrough that was recognized with the Nobel prize in 1933. With the success of Morgan's "flyroom," the humble fruit fly was set on its way to becoming one of the leading models in modern biology, contributing vast amounts of knowledge to many areas – including genetics, embryology, cell biology, neuroscience. Additional fly Nobel prizes were awarded in 1946, 1995, 2006 and 2011.

A tiny fly stands in for us in basic research

If you ask a geneticist, humans are brothers to mice and just first cousins to flies, sharing 99% and 60% of protein-coding genes, respectively. Our anatomy and physiology are also related, so that we can use these laboratory animals to design powerful experiments, hoping what we find will be of significance to animals and humans alike. It's undeniable that the research on animal models – such as nematodes, flies, fish and mice – has contributed immensely to what we know about our own body and as a result is helping us tackle the diseases that plague us. On this front, the services of the fruit fly will certainly be required for some time to come.

Studying fly brains to understand our own

Here I am, ready to answer many of your biological questions. Credit: Alfredo Peralta García, CC BY-NC-SA

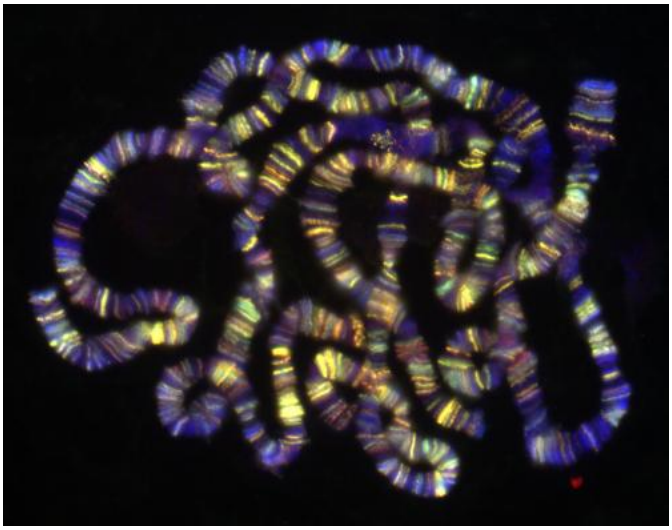
A recent renaissance in neuroscience is also bringing the fly to the forefront of our efforts to understand the brain. One of the things we least understand is how our own brain produces our emotions and behavior. Scientists are naturally attracted by the unknown, making this one of the most exciting open frontiers in biology. Perhaps, our brain, the ultimate Narcissus, cannot resist the temptation to study itself. Can the humble fly really contribute to our understanding of how our own brain works?

The fruit fly brain is a miracle of miniaturization. It deals with an incredible flow of sensory information: an obstacle approaching, the enticing smell of overripe banana, a hot windowsill to stay away from, a sexy potential mate. And it does this literally on-the-fly, as the little marvel is computing suitable trajectories around the room. Yet the fly brain is composed of only about 100,000 neurons (compared with nearly 100 billion for human beings) and can fit easily through the eye of the finest needle.

The relatively small number of cells is a key advantage for brain mapping, and large efforts are under way to label, trace and catalog every single neuron in the fly brain. Combine this with the unique wealth of information on the genetics of this little animal, and you will see how we are now able to design incredibly powerful experiments in which we alter the "software" (that is, introduce specific changes in the genome) to create animals with unique and predictable changes in the "hardware" (the brain circuits) to ask questions about brain function.

Following this playbook are recent experiments demonstrating, for example:

how sleep enhances memory formation (yes, even in flies!)how a few sexually dimorphic neurons in the male fly brain promote male-vs-male fightshow specific 'moonwalker' neurons in the brain control backward walkinghow the brain processes simple hot and cold stimuli to keep this little animal away from danger (my own area of research)and many more.

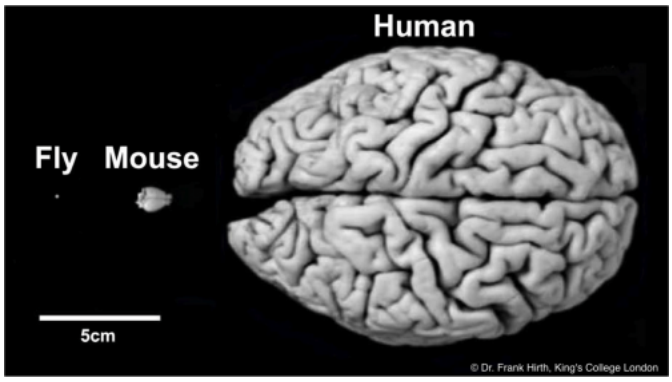


Drosophila salivary gland chromosomes. Credit: Elissa Lei, PhD, NIH, CC BY

Of course, we can do these kinds of experiments in a number of animal models. But the unique advantage of the fly is that we can pinpoint every single neuron that's important for a particular response or behavior, precisely map how they connect to each other and silence or activate each one to figure out how the whole thing works.

Don't forget the flies

Just a few weeks back, Chicago hosted the Genetics Society of America's annual "fly meeting," bringing together thousands of fly scientists from around the world. One of the topics discussed was that, in this tough economic climate, funding cuts to public agencies are disproportionately hurting research on fruit flies in favor of more "translational" approaches – that is, research that has more immediate practical applications.



The fruit fly brain, tiny compared to the mouse and minuscule compared to the human – but still so useful in research. Credit: Dr Frank Hirth, King's College London

It's worth remembering that neither Mendel nor Morgan expected that their work could have a direct impact on medicine. Yet when, hopefully soon, we manage to "cure" cancer – a genetic disease *par excellence* – they should be among the very first people receiving a thank you note from humanity.

Flies still have a lot to contribute to our understanding of all aspects of biology. As with much basic research, the direct benefits from this work may be around the corner, or may take a little longer to find. It would be a big mistake to curb fruit fly research now that the flies are just getting warmed up to tackle some of the most interesting questions in biology.

Source: The Conversation