Weightlessness weighs heavy on genes -- a fly's perspective

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On Earth all biology is subjected to gravity. Some biological systems require gravity for correct orientation (geotropism: plants grow up, roots grow down). In the absence of gravity even human biology is affected: astronauts lose bone density at 1-2% a month rather than the usual 1-2% a year on Earth. But the effects of gravity on cellular processes are less well understood. New research published in BioMed Central's open access journal *BMC Genomics* has used diamagnetic levitation to counteract the effects of gravity on the fruit fly (*Drosophila melanogaster*) and found that the expression of several genes was affected. This included genes involved in cell signalling, the immune system, response to stress and changes in temperature, such as the heat shock proteins.

A specially designed superconducting magnet was used to continuously 'levitate' the flies for 22 days, from embryo to adult. The magnetic field repels water within the fly's cells and a strong enough force can balance out the effects of gravity. With the magnet producing a force of 11.5 Tesla (T), at a certain distance above the centre of the magnet the net effect of gravity is zero (0g). At the same distance below the centre of the magnet the flies experience double Earth's gravity (2g).

During the experiment eggs developed to larvae, pupae and finally adults. This progression was slightly slowed by the magnetic field - it took flies at 1g in the magnet one day longer to reach adulthood than flies outside. Almost 500 genes were sensitive to the magnetic field (up or down regulated) and only 10% of these were common to male and

female females flies. By subtracting the effect of 1g from the gene transcription profile at 0g and 2g the researchers were able to isolate the effect of gravity on the flies.

Hypergravity altered the expression of 44 genes while weightlessness affected over 200. Dr Herranz, from the Centro de Investigaciones Biológicas, Madrid, and Dr. Hill, manager of the Magnetic levitation facility at the University of Nottingham, explained, "Both the magnetic field and altered gravity had an effect on gene regulation for the flies. The results of this can be seen in fly behaviour and in successful reproduction rates. The magnetic field alone was able to disrupt the number of adult flies from a batch of eggs by 60%. However the concerted effort of altered gravity and the magnet had a much more striking effect, reducing egg viability to less than 5%."

Dr Herranz, continued, "The genes most affected by alterations in gravity are responsible for essential cellular processes including metabolism, the immune system, defence against fungi or bacteria, heat response, and cell signalling." This work suggests that the effect of weightlessness on cellular processes and biological systems during prolonged space flight, say the journey to Mars, should not be underestimated.

More information: Microgravity simulation by diamagnetic levitation: effects of a strong gradient magnetic field on the transcriptional profile of Drosophila melanogaster. Raul Herranz, Oliver J Larkin, Camelia E Dijkstra, Richard JA Hill, Paul Anthony, Michael R Davey, Laurence Eaves, Jack JWA van Loon, F Javier Medina and Roberto Marco, *BMC Genomics* (in press)

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