New study explains how organs coordinate their development with the whole body

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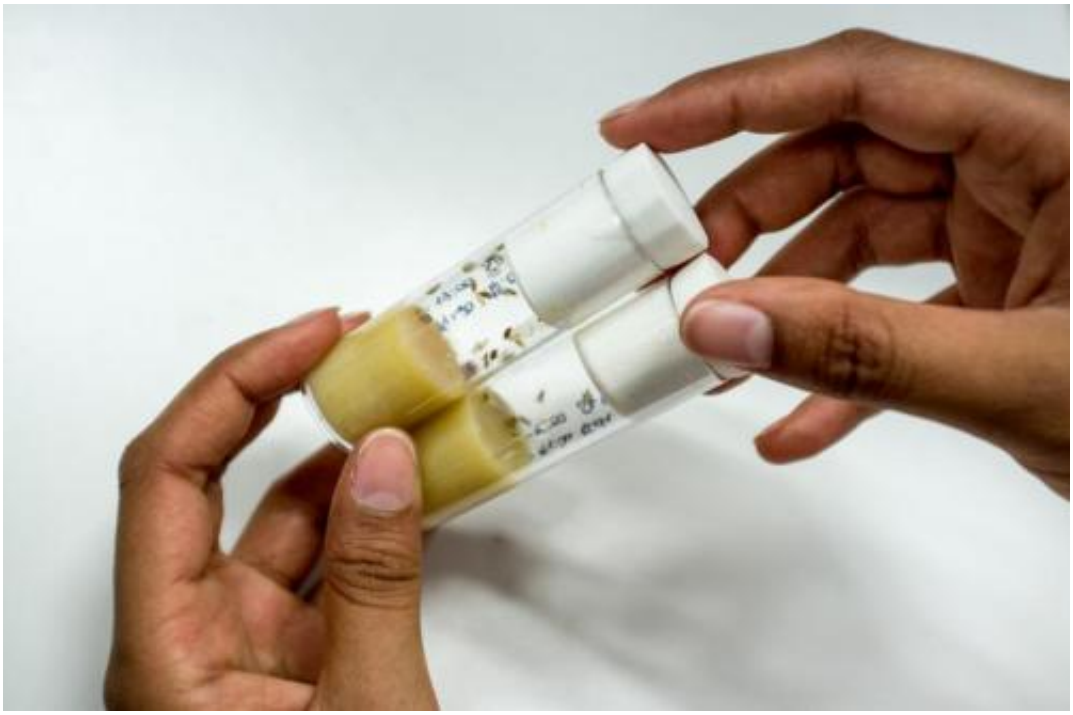

A research group led by Christen Mirth at Instituto Gulbenkian de Ciência (Portugal) uncovered that the development of wings in fruit flies does not progress synchronously with the organism's development. Instead, it is coordinated with the whole body only at distinct 'milestones'. This study, published in the latest issue of the scientific journal *PLOS Genetics*, helps explain how an organism facing

environmental and physiological perturbations retains the ability to build correct functional organs and tissues in a proportional adult body.

For a growing organism it is essential to have robust developmental processes ensuring that the developing organs and tissues are formed correctly even in the face of environmental or physiological perturbations. To achieve robustness, the processes that generate individual organs must, at some level, be integrated across the whole body to ensure that a correctly patterned and proportioned adult is produced at the end of development. Christen Mirth and colleagues proposed to study how organ and whole-body development is coordinated, using the fruit fly, *Drosophila melanogaster*, as a model organism. The juvenile period in the fruit fly comprises three larval moults, followed by a wandering stage where larvae leave the food and search for a site to begin metamorphosis at a stage called pupariation. The research team focused on these so-called developmental events to study how the development of wings is coordinated with the whole body of the fruit fly larvae.

The researchers first analysed the expression of six genes involved in the development of wings in normal conditions of growth, i.e. at a temperature of 25ºC, and generated a detailed staging scheme. Next, the researchers changed the temperature to affect the growth conditions of the larvae and analyzed the rate of wing development compared to the whole-body development. It is known that flies grow faster at higher temperatures and grow slower at lower temperatures. However, the researchers observed that the development of the wings was slower at 29ºC, compared to flies growing in normal conditions or flies growing at 18ºC. "This result surprised us, as we could clearly observe a delay in the development of these wings in wandering stage larvae, but their progression accelerated towards the stage of pupariation. This means that development shows variability in its progression, but converges at the milestone of pupariation", explains Marisa Oliveira, first author of this

study.

Next, researchers modified the larval physiology by interfering with the hormone ecdysone that regulates the different developmental events in the larvae, such as wandering and pupariation. Similar to the temperature manipulations, when they altered the timing of ecdysone synthesis, they found that the wings developed slowly at first, but accelerated their development to achieve coordination at the stage of pupariation.

These results support the hypothesis proposed by this research team, that the development of the wings, in the fruit fly, is aligned with the whole-body development at two milestones: moulting and pupariation.

Marisa Oliveira concludes: "With this work we propose a new paradigm for thinking about organ-organ and organ-body coordination during development. We suggest that organisms achieve this coordination not by continuous but rather by discrete communication focused on developmental milestones".

Christen Mirth adds: "The next challenge is to understand the nature of this communication at milestones."

More information: Oliveira, M.M., Shingleton, A.W., Mirth, C.K. (2014) Coordination of wing and whole body development at developmental milestones ensures robustness against environmental and physiological perturbations. *PLOS Genetics* 10 (6): e1004408, doi/pgen.1004408. www.plosgenetics.org/doi/pgen.1004408

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