

## the queen's dinner

Vivienne Baillie Gerritsen

Besides Dr Jekyll, humans cannot become something else after dinner. Bees can. Feed honeybee larvae some royal jelly, and they will grow into a larger, fertile and longer-lasting individual. It is no scoop. Scientists have known about it for over a century now. Nonetheless, it is a very thought-provoking notion for biologists – it means that a living being's fate can be quite dramatically altered depending on what it feeds upon, very early on in development. The systems we are most acquainted with have a strong genetic component; give us a gene, with an environment, and that will make you into a heavy-built, tall, bald or curly-haired person. But here is some jelly that will shape a bee's destiny. More specifically, there is a protein in the royal jelly that seems to be able to trigger off a series of metabolic processes in bee larvae, which will gradually turn them into queens. The protein has been baptized royalactin.



larvae immersed in royal jelly

wikimedia

A bee's world is very much a lady's one. Female bees nurse, make wax, produce honey, attend to the queen, build the honeycomb, pack the pollen, fan the hive, guard the premises, carry water and forage for nectar. While the male bees – known as “drones” from the old English “draen” meaning “male honeybee” – are somewhat idle and do nothing but wait for an opportunity to fertilise a virgin queen. Following which, they die. A drone's life is therefore short and sweet, barely a few months long. A queen's life, however, can last for as long as two years.

The worker bees – all female – have been given the astonishing ability to decide whether a larva is to become a queen or not, and when. A faculty which has baffled biologists: which of the two – the queen or her subjects – really has the power? It is a sort of chicken or egg dilemma. Certainly, a hive needs worker bees to produce the royal jelly – something they secrete from their cephalic glandular system – which they will then inject into the cell, fully immersing the queen-to-be larva in the viscous product. From this point onwards, the larva will develop much faster than any of the other bees. It will also become bigger, its ovaries will develop and it will live far longer than any of its siblings. More importantly, once fertilised by a horde of indolent drones, it will lay a mere 2000 eggs a day!

Royal jelly is a mixture of moisture, protein, sugar, lipids, vitamins, salts and free amino acids. The greater part of its protein content is made up of one protein family known as MRJP, for major royal jelly proteins. There are five members in this family, one of which is MRJP1, otherwise known as royalactin. Royalactin is a modest-sized protein that acts on its own. It somehow manages to avoid degradation within the larva's digestive system and, instead, acts much in the same way as a hormone would, by triggering off a whole series of metabolic

processes that are characteristic of a queen's development.

How royalactin actually achieves this still remains obscure. It may well reach the larva's fat body, which is a sort of dispersed tissue in the insect's abdomen that is thought to store energy and be able to control development and metabolic processes. In the fat body, royalactin seems to have the potential of setting off a number of developmental reactions via the epidermal growth factor (EGF) mediated signalling pathway, either by acting as an EGF ligand or by giving a wake-up call to other EGF ligands. Following this, three major events take place: 1) the larva's body size increases via P70 S6 kinase, 2) development time is shortened by way of mitogen-activated protein kinase, and 3) the ovaries mature thanks to juvenile hormone. And last but far from least, royalactin also seems to have the capacity to lengthen the queen's life-span.

So royalactin is directly involved in making a queen out of a bee, but it can still do more. Or at least parts of it can. Its protein sequence is

sometimes cleaved to give rise to three small antimicrobial peptides, known as jelleines. This is hardly surprising, since royal jelly is prone to bacteria or yeast colonisation, what with worker bees bringing in products that are external to the beehive, such as honey and pollen. Jelleines probably assemble to form pores in the bacterial and yeast membranes thus making them permeable and hence fragile.

Biotechnological companies are always on the lookout for novel antibiotic drugs, and the smallness of insect antimicrobial peptides is ideal for such technology. Research in this field is only just beginning, as is that carried out on royalactin and queen differentiation. It is a fascinating field of study for biologists. What is more, royal jelly has always been regarded as a kind of panacea and believed to have vasodilative, hypotensive, antitumour, anti-hypercholesterolemic, disinfectant and anti-inflammatory activity – to name a few. And if it can turn a bee into a fertile and long-living queen, would you not be inclined to take it by the spoonful?

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*N.B. Also read Protein Spotlight issue 12, "Why Pooh luvvs hunny"*

## Cross-references to UniProt

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