proteinspotlight

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**Issue 150, June 2013**

***www.proteinspotlight.org***

# the intricacy of a smell

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**We all need a nose. Inside this part of an animal's body lie millions of olfactory receptors awaiting smells that they will send on to the brain. In turn, our brain will say whether the smell is good, or bad – a simple way of informing an animal of what could be potentially harmful for it or, on the contrary, beneficial. The mechanism is pretty straightforward and has evolved over time to give the best chances of survival to living species. As for humans, their olfactory capacities are naturally far less fine-tuned than a dog's or a wild animal's, but they remain essential nevertheless. We are still very much aware of smells that spell 'not good' or 'lovely', and react accordingly. For years, researchers have wondered whether the actual perception of a smell has a genetic basis. Much has already been written on the subject, and the answer seems to be 'yes'. Recently, scientists discovered that the perception of the characteristic smell of cut grass has a genetic basis, and is probably under the influence of an olfactory receptor dubbed 'olfactory receptor 2J3', or OR2J3.**

Clumps of Grass, by Vincent van Gogh

Arles, 1889

Most of us are familiar with the smell of freshly cut grass. We have either mown lawns or sat in parks whose grass has just been trimmed. For the reader's amusement and curiosity, the word lawn probably originates from the Celtic 'laun' which means enclosure. Lawns were indeed grassed enclosures in medieval times, intended for the communal grazing of livestock, as opposed to fields reserved for farming. From the middle ages on, lawns became popular within Northern European aristocracy, especially on the western fringe where rain is plentiful. In those days, a lawn was a sign of wealth since its owners were able to afford land that was neither for building nor for producing food. The cropped English lawn appeared in the 17$^{th}$ century, and was taken to exotic parts of the world by colonists. For the technically-minded, the first lawnmower was invented by an Englishman – Mr Edwin Beard Budding – in 1830. Apparently, the first machine had trouble actually cutting the grass but it rapidly became one of the most popular pieces of household machinery in Western Europe!

The molecule responsible for the aroma of cut grass is *cis*-3-hexen-1-ol, which has been coined 'green grassy'. It is not a smell that is particular to cut grass, however, and can be found in many different foods and drinks. It is, for example, a key flavour in fresh fruits and vegetables, such as raspberries and broccoli, and is frequently found in wines. *cis*-3-hexen-1-ol is a pleasant smell for most of us, and some scientists even argue that it has a soothing effect. Aggression in honey bees, but also humans, can apparently be lessened – i.e. gene expression in the brain is somehow altered – if they are exposed to a pleasant smell such as 'green grassy' for instance. Such smells could then be used to calm individuals suffering from stress. It is, indeed, almost common knowledge that smells – like music – have a direct effect on our feelings.

There are about 400 genes in humans that code for olfactory receptors and take part in the smell

experience. It is not so much a question of one receptor/one smell but more a combination of receptors that welcome one or more odour molecules, the combination of which results in a specific smell. If a receptor is modified – or switched off – for one reason or another, would this have an effect on the overall smell that is perceived? In other words, if the 'grassy green' olfactory receptor – OR2J3 – is modified what kind of effect does it have on its owner? And would the perception of smell be dependent on a geographical origin? One way of answering these questions is to study a cohort made up of people from different ethnic origins and of different ages.

In this light, researchers in New Zealand studied a cohort of individuals of Caucasian, Indian, Asian and Maori origin, and of differing ages. It turned out that the perception of 'green grassy' depended on OR2J3. Like all olfactory receptors, OR2J3 belongs to the large family of G-protein coupled receptors. The lack of 'grassy green' perception was the doings of two mutations: T113A and R226Q. Individuals who carried either of the variants were not so fine-tuned in their perception of *cis*-3-hexen-1-ol as those who carried neither of the variants. And the perception of 'grassy green' by individuals who were the bearers of both variants was greatly dulled. Funnily enough, those who carried both variants were more likely to be of African descent.

What exactly is it that occurs within OR2J3 to make it less sensitive to *cis*-3-hexen-1-ol? Both mutations, T113A and R226Q, involve amino-acid substitutions that are situated at very different locations on the receptor's sequence. T113A occurs in the region where *cis*-3-hexen-1-ol is expected to bind to the receptor. T113A would therefore hinder the odour molecule's binding. As for R226Q, it occurs in a region which is expected to interfere with signal transduction, as it is located in the loop which is involved in G-protein dynamics. Neither of the variants abolish an individual's capacity to perceive *cis*-3-hexen-1-ol but they do diminish it; and if an individual carries both variants, it is not difficult to understand that it may be very difficult for them to perceive the 'grassy green' smell at all.

Any given smell, however, is rarely the result of one ligand that binds specifically to one receptor but more a question of sets of ligands that bind to different receptors. In this respect, OR2J3 is rather broadly tuned since it is capable of responding to more than one odour. Hence, the perception of 'grassy green' – though greatly dependent on OR2J3 and its modifications – is not solely liable to OR2J3. So that seems sorted but, besides scientific curiosity, why do researchers want to understand if we can smell cut grass?

*cis*-3-hexen-1-ol seems to have a positive effect on humans. After a session of lawn mowing, scientists have noted that men are less aggressive. As for honey bees, they are not only attracted by the smell but they too become less brisk. The honey bee is an excellent study model because it is not only a social being but also prone to stress, just like human beings. Besides offering an opening for aromatherapy, 'grassy green' is also simply a pleasant smell for most of us and associated with the notion of freshness, as in vegetables and fruit. As such, the food industry has been adding the molecule to all sorts of beverages – wines included – and food items. Inevitably, the more is known about *cis*-3-hexen-1-ol and its receptor, or receptors, the more the food industry will be able to fine-tune products for the human taste. All in all, our keenness of smell probably has a genetic component, though our eating habits are undoubtedly cultural too.

## Cross-references to UniProt

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## References

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