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Genome Editing, biochemical superpower?

by Freddie Theodoulou, Science Editor

"If you had a superpower, what would be?" a PhD student once asked me. After an evening fighting my way through the crowded London Underground having seen a kids' fantasy film, I didn't hesitate: "I'd like to be able to shoot bolts of lightning from the palms of my hands". The student turned to my colleague and posed the same question. "I'd like the power to heal" he replied simply. Well that told me. But it's an interesting question: if you had a biochemical superpower, what would it be? The ability to quantify all the transcripts in the genome? Sequence a genome in an afternoon? No problem! (provided your genome isn't too large) I'd quite like the ability to find substrates for all the enzymes of unknown function, though sadly that's not quite possible yet. But how would you like to be able alter the genome at will? Courtesy of genome editing, what once seemed like fantasy is now reality.

Editing is not just a reality but a rapidly evolving field: would-be genome engineers have the choice of at least four different tools with which to re-write genetic instructions in their organism of choice- zinc finger nucleases, meganucleases, TALENs or CRISPR. But it is CRISPR that has garnered most column inches in the academic and lay press alike. Unfortunately this owes as much to the fierce patent dispute currently raging between its inventors as to its power and relative simplicity. Such is its popularity that "CRISPR" has entered the vernacular as a verb- I've already lost count of the times I've heard "We're going to CRISPR in this mutation/tag/gene" in seminars. Cynicism aside, this is understandable given the potentially exquisite specificity of the technique: changing a single amino acid can alter protein fate or function; changing a single base can alter a microRNA binding site or an epigenetic mark. All this, without the footprint of standard genetic modifications or the linkage problems and lack of precision associated with breeding by mutagenesis and selection.

This issue brings you a selection of thought-provoking features on genome editing, from the biology behind the technology to applications in agriculture and medicine, plus reflections on the legal and regulatory landscape. The diversity of potential outcomes and the precision of genome editing make a strong case for regulating genome-edited products, rather than the process itself, promising to bring applications to market faster than conventional genetically modified organisms, provided off-target effects can be avoided. Whilst the ethical ramifications of re-writing genomes have provoked anxiety, especially when it comes to human germline modification, approval has recently been granted to several teams seeking to perform embryo editing research. Helen Albert interviews Frederik Lanner, one of the scientists with permission to take the first steps down this potentially life-transforming, but ethically complex route. We also hear from CRISPR pioneer Rodolphe Barrangou and Marco Weinberg, who is using the technology to target pathogenic viruses. Reflecting on their newly acquired superpowers, they may well be contemplating Ben Parker's advice to Spiderman, "With great power comes great responsibility". ■