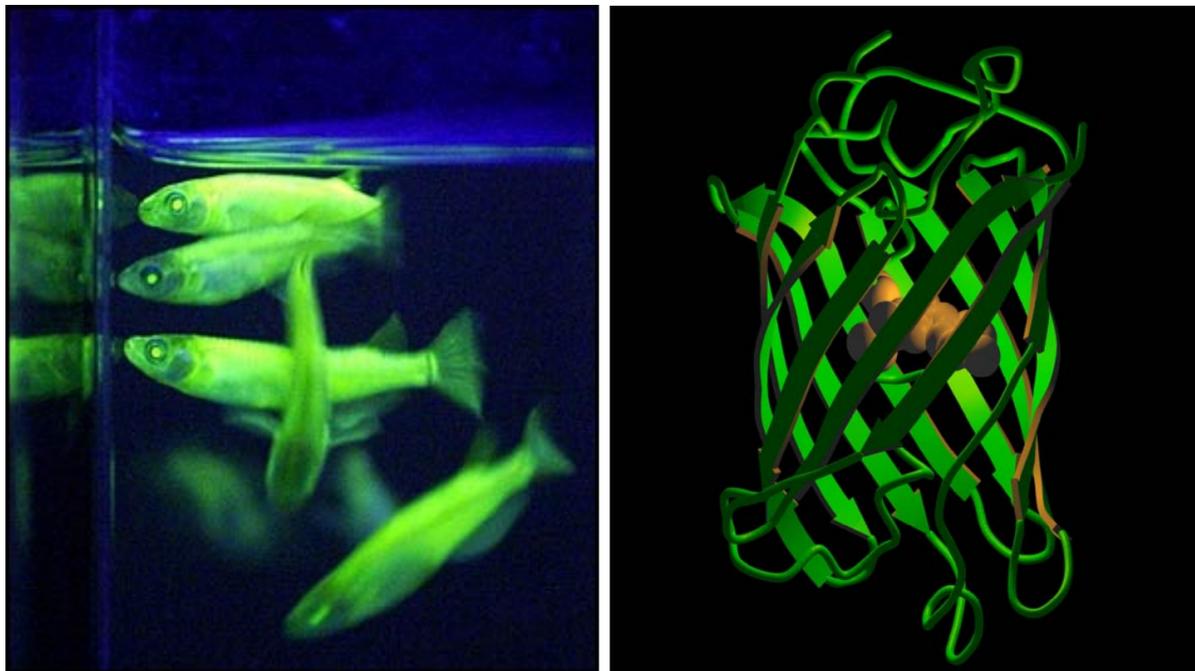


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WHAT IS THE METABOLIC COST OF GFP EXPRESSION IN ZEBRA FISH?

Organisms of every type are on a strict budget of time and energy. Every piece of food consumed is a different piece passed by, and every second not spent gathering or using finite resources is one that might be spent by a rival in order to out compete the others. This extends even to the molecular level, as choices must be made regarding which proteins to be synthesized when, as each reaction consumes valuable energy resources.



The regulation of gene expression is a complex web of feedback and control, a system that varies from species to species, but that has been refined and optimized through time by evolutionary pressures. *E. Coli*, for example, normally survive on glucose, but if supplies run short, are capable of utilizing lactose as well. However, it requires several extra enzymes to digest. These enzymes are costly to produce, so it is to the bacteria's benefit that they are only synthesized when lactose and no glucose molecules are present. *E. Coli* uses a specialized system to predict the types of nearby sugars, produce the necessary enzymes, and to break down those enzymes when glucose is again available.

But what happens when those years of perfection are bypassed? Only a few years ago researchers and industrialists succeeded in transferring genes from one species to another, across evolutionary divides that would have otherwise been impossible to cross. The agricultural sector was one of the first areas where transgenic technology was applied, with strains of crops with resistances to cold, draught and pests spliced into them from all across the tree of life.

These developments sparked debates, studies, and frantic media coverage as people tried to predict whether or not transgenic species would out-compete their wild cousins, destroy the existing ecosystems, and run rampant through their environments as super-powered "Frankenplants." The pesticide from a modified crop might fail to break down safely in the soil, resulting in damage to the local ecosystem. A resistance to freezing might result in a species with an evolutionary edge, allowing it to dominate its environment and decreasing biodiversity. There is the additional risk that, due to mechanisms like pollination, a new trait could spread from species to species. A weed with an unforeseen advantage would have the potential to be truly destructive. And what if a new crop truly managed to become a safe, economical and superior alternative to all others? How would a mass crop failure like the Irish Potato Famine be prevented if all farmers grow same crop?

However, the frankenplant theory fails to take into account the energy required to express every supposedly advantageous trait. Most gene splicing techniques are very inaccurate, as they usually involve forcing foreign DNA into a cell and hoping that it integrates itself into the host genome (or is expressed anyway). Given these rough procedures, it is extremely likely that there are no controls over the expression of the new gene, and that its associated proteins are synthesized whenever possible, rather than whenever they are needed.

So what is the cost of a transgenic modification? How far out of whack is an organism's energy budget really thrown when a foreign trait is wedged into its genome? Is it possible to predict the energetic costs of a novel gene and its effects on its host organism? GFP is a light-producing protein originally found in jellyfish and has a long history of use in transgenic organisms. It serves as a highly visible trait that has no effect beyond its energetic cost on the organism it is produced by. This makes it ideal for the purpose of examining the cost of gene expression. Comparing transgenic organisms with their wild-type cousins is the first step to answering these questions.