

All I Really Need To Know I Learned in Genetics Class

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Among the required biology courses I had to take as an undergraduate major, I remember the course in genetics as being particularly challenging. The class should have been easy—the material was fairly straightforward and the professor, Dr. Jeffrey Powell, was terrific. My problems stemmed from the fact that there were just too many distractions. For one thing, it didn't help that I sat next to my friend David, a fellow biology major on whom I had a terrible crush and who, despite my best efforts, never seemed to acknowledge or even recognize my complete infatuation. I didn't discover until a year later that he was gay. This discovery, by the way, came two years after I discovered that the anthropology major on whom I had a crush freshman year was gay, a year before I discovered that the ornithology graduate student on whom I had a crush was gay, and two years before I discovered, in graduate school, that the medieval Icelandic history graduate student on whom I had a crush was gay. When, as an assistant professor, I finally met the man I would eventually marry, I assumed, since I liked him so much, that he must be gay, and I'm embarrassed to admit four years passed before I figured out that he wasn't.

The other thing I found exceedingly distracting during genetics class were mutations—specifically, *Drosophila melanogaster* mutants. Maybe it was because the course was taught by a *Drosophila* geneticist. It seemed that fruit flies had more than their share of unfortunate genetic peculiarities, and I found that I couldn't listen to a lecture about these mutants or read a problem in our otherwise dust-dry textbook (Strick-

berger 1968) without cracking up. Among my favorites at the time were *Curly, plum, dumpy, shaven, interrupted, doublesex*, and *Prune-killer*. The names just struck me as hilarious—like some sort of parallel universe bizarre version of Disney's *Snow White and the Seven Dwarves* (with *white* of course being the first and foremost mutant, described by T. H. Morgan himself in 1912).

Whenever I should have been listening to lectures or studying for exams, I found myself instead mentally concocting etymologically amusing but genetically improbable crosses: *raspberry lozenge? Bent blade?* Genetics with other organisms at the time simply couldn't compare. Strickberger's index listed fewer than two dozen *Escherichia coli* mutants and absolutely none had names that inspired creative daydreaming; *Neurospora crassa* was only slightly better (offering *poky* and *snowflake*). Mutant mice were a disappointment, too, only 1 of 18 mutations—*Danforth's short tail*—had even the slightest hint of whimsy.

I'm just grateful I took genetics more than 30 years ago. Today, I would lose all semblance of focus after the first 10 minutes of any *Drosophila* genetics lecture. Whereas new model organisms, such as *Arabidopsis thaliana* and zebrafish, have entered the literature in the past three decades with decorum, the mutations for the most part neatly numbered and coded, *Drosophila* geneticists have tapped into seemingly all of human knowledge for naming inspiration. The site Flybase (<http://flybase.bio.indiana.edu/>) provides a comprehensive database of all *Drosophila melanogaster*-related genetics and molecular biology. Consequently, end-



"To be or not to be...a Mutant"!

less hours of entertainment are available; at the click of a mouse (not of the *Danforth's short tail* variety), any interested party can discover the etymology of more than 400 gene names. For those unwilling to devote hours of displacement activity to unearthing etymologies, there's also the site Flynome, <http://www.flynome.com/>, which recounts the origins of a select group of interesting *Drosophila* gene names.

Learning about *D. melanogaster* mutants is a four-year liberal arts education crammed into a single genome. It's not surprising that fly geneticists are conversant with biology and have named mutations for resemblances to animals extant and extinct, including *pangolin, hedgehog, armadillo, baboon, rhino*, and, for wing mutants, *moa* (which is an extinct wingless bird, for the vertebrally challenged).

But it is surprising, I guess, that there are

mutants with names that require a knowledge of European history; *tudor*, *staufen*, *vasa* and *valois*, for example, are all lethal “grandchildless” mutants named for European royal families that ended without issue. Cell division mutations in which nuclei or parts thereof fail to reach the posterior pole of the cell are named *barentsz*, *scott of the Arctic*, and *shackleford* in memory of explorers who also failed to reach a Pole (albeit a global and not cellular one). Not only is astronomical science represented (*hale bopp* and *Schumacher-Levy* are two mutations producing developmental comet-shaped abnormalities in elongating spermatids named for two twentieth-century comets), but astronomical science fiction is as well (plot details in various episodes of *Star Trek* inspired the naming of *klingon* and *tribbles*).

Mutants invoking the great canon of Western literature (*prospero*, *hamlet*, *malvolio*, and *capulet* from Shakespeare’s opus) share a genome if not a chromosome with fictional pop culture icons. Television has probably provided about as much metaphorical fodder as has the entire western European literary tradition; *maggie*, for example, is a mutation that arrests larval development in the first instar, much as Maggie Simpson has remained an infant for 17 seasons of *The Simpsons*, and mutant *kenny* flies with immune system defects are prone to early demise, much as is Kenny on *South Park*, who reliably dies before the end of each episode. Movies, too, creep into the genome; *indy*, a mutation that extends lifespan beyond the norm, is actually an acronym for “I’m Not Dead Yet,” a line from a *Monty Python and the Holy Grail* spoken by an ostensibly dead plague victim mistakenly being carted away for burial. And even food can be fodder for *Drosophila* geneticists—the list of mutations that cause defects in oogenesis or oocyte formation, for example, reads like instructions for a short-order cook, with *fried*, *omelet*, *sunny-side up*, *hard boiled*, *soft boiled*, *poached*, and *benedict* (inventorying, as Morris et al. 2003 describe, “the unfortunate fates commonly met by eggs”). Beyond eggs, other fare whetting geneticists’ appetites includes *currant bun*, *clottie dumpling*, and *spotted dick*.

Clearly, naming genes is an international effort, and there’s nothing better for fostering an appreciation of other cultures than learning a little about their language. Genes have acquired names in Hebrew (*keren*), Catalan (*capicua*), Yiddish (*nebbish*), Chinese (*hu li fai shao*), Russian (*zloday*) and French (*tout-velu*), among other languages. Thanks in large part to the enormous influence of Nobel laureates Eric Wieschaus and Christine Nusslein-Vollhard, parts of the *Drosophila* genome look like an introductory German

Vokabelnprüfung (with, for example, *hitzschlag*, *kastchen*, *klarsicht*, *klumpfuss*, *klotzchen*, *kelch*, *krotzkopf verkehrt*, *vererbt*, *mochtegern*, *toll*, *zerknüllt*, and *weniger*, to challenge a bilingual speller).

Beyond mere words are arcane cultural references. The mating behavior mutant *la voile et la vapeur*, in which male heterozygotes court flies of both sexes, owes its name to a French slang expression that’s roughly the equivalent of “AC–DC,” and *bruchpilot*, which is German for “crash pilot,” describes a mutant that survives despite impaired flight capacity and invokes a 1941 German cult film favorite, *Quax, der Bruchpilot*. One mutation named *matotopetli*, which means “balls” in Nahuatl, “apparently refers to the many balls of cells found in ‘topi’ mutant testes” (Perezgasga et al. 2004) (Flybase). I have a sneaking suspicion that it’s actually a bilingual pun.

Drosophila geneticists have prevailed in their learned naming practices despite objections from other, more staid geneticists. There have been a few problems (Vacek 2001), and under pressure some names in questionable taste have been revised. In 1963, the mutation that causes male flies to court other males was informally named *fruity*, but political correctness led to a name change to the equally apt but less offensive *fruitless* years later (Hall 1978). The propriety of naming learning defect mutants after vegetables (e.g., *turnip*, *radish*, *rutabaga* [Aceves-Pina and Quinn 1979]), drew criticism in the more politically correct decades that followed. And at least one mutant name, *kuzbanian*, named in reference to the Koozbanian alien puppet creatures (equipped with supernumerary bristles) on “The Muppet Show,” almost elicited a lawsuit for copyright infringement from Jim Henson until the spelling was changed (Flynome).

In part to avoid such problems, but mostly to eliminate redundancies as homologues are identified and functions are clarified, efforts are now afoot to standardize gene nomenclature across all organisms, with good reason. The stated goal of the Gene Ontology Consortium is to “produce a dynamic, controlled vocabulary that can be applied to all eukaryotes even as knowledge of gene and protein roles in cells is accumulating and changing” (Ashburner et al. 2000). I hope, though, that *Drosophila* geneticists stay true to their tradition. They are true Renaissance scholars, living the spirit of multidisciplinary. To maintain such dazzling breadth of knowledge in the face of social and scientific pressures to conform is a challenge these days that takes certain anatomical attributes to stand up to—*matotopetli*, if you will, a trait notably lacking in the aptly named fly mutant *ken and barbie*.

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Note: Thanks to Hugh Robertson, one of those intrepid polymathic *Drosophila* geneticists, who read this text to make sure I didn’t do injustice to any mutants. For what it’s worth, my own contribution to the mutation literature [Wright, C. L., E. S. Green, and M. R. Berenbaum, 1999. A yellow eye color mutation in the cabbage looper, *Trichoplusia ni* (Lepidoptera: Noctuidae). *Ann. Ent. Soc. Am.* 92: 447–450] was to name the mutation that turns cabbage looper eyes yellow *bagheera* after the yellow-eyed black panther in Rudyard Kipling’s *Jungle Book*—not an especially hilarious choice, but at least some reward for watching the Disney movie of the story countless times with our daughter, who was enamored of the film for a while. If there had been a yellow-eyed dog in *101 Dalmatians*, the name would undoubtedly have been different.



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