Genetics - Lost and Found: Crash Course History of Science #25

Crash Course: History of Science
https://youtube.com/watch?v=QmiwQ0Kosa8
https://nerdfighteria.info/v/QmiwQ0Kosa8

Sometimes, scientists realize they are doing revolutionary work, and the world agrees. Darwin and Pasteur, for example, were massive celebrities. Other times, revolutionaries toil quietly for decades, leaving behind work that the rest of us appreciate only much later.

This is the story of Gregor Mendel and the birth, loss, and rebirth of classical genetics. [Intro Music Plays] According to Darwin, organisms have slightly different traits, and this slight variation becomes more important over time, as environments change and some traits become more useful than others. Organisms give traits to their descendants. Over millions of years, new species split off as they become so different from their ancestral species that they can no longer interbreed.

Sounds good! But wait, how are traits passed down? If a tall person marries a short person and they have a kid, how likely is that kid to be tall, medium, short?

Darwin knew perfectly well that he didn't know. He theorized the general category of thing that he thought he should—or someone should—figure out. He called the hypothetical unit of heredity the "pangene." This is where we get "gene." But Darwin didn't know what a "gene" should look like.

Would there be a gene for "tall" or "short?" Or a bunch of genes that somehow interacted to influence height? Or was height all a product of what you ate as a kid? Today, geneticists can answer these questions, in part thanks to a contemporary of Darwin's who went largely unknown in his day.

Gregor Mendel was born in the Austrian Empire, in what is now the Czech Republic, in 1822—the same year as Galton and Pasteur. Mendel's family were poor farmers. He was always interested in growing plants and beekeeping.

He went off to college to study philosophy and physics at Palacký University. There, he studied with an agricultural scientist named Johann Karl Nestler who specialized in breeding sheep. But he ultimately became a monk at St.

Thomas's Abbey. Still, that didn't stop Mendel from studying science. He asked his abbot for some land to set up an experimental garden, specifically to study natural variation in English peas.

And from 1856 to 1863, that's what Mendel did. Thought Bubble, show us the wonders of counting English peas: Mendel grew and tracked 28,000 plants. He focused on seven traits: seed color, individual seed shape, unripe seed pod color, seed pod shape, flower color, flower location, and plant height.

Importantly, these traits seemed to be inherited independently of each other, which made these seven traits really useful for doing quantitative, or measurement-based, biology. This work on peas wasn't that different from Darwin's pigeon breeding: both scientists wanted to see how traits vary over time. But you can grow more peas, faster, than you can pigeons.

So, after seven years of carefully tending peas, what did my dude conclude? Mendel noticed that some characteristics seemed to be passed down often, and some tended to disappear after only one generation. He coined the terms "dominant" and "recessive" to describe these traits.

Putting numbers to his experiments, Mendel saw that 1 in 4 pea plants had purebred recessive traits. 2 in 4 were hybrids with both recessive and dominant traits. And 1 in 4 were purebred dominant for the traits. You can draw this as a square to help visualize the "crosses" of the dominant and recessive traits.

Mendel also figured out three general claims that are now known as the Laws of Menmdelian Inheritance. The first is the Law of Segregation, which states that the genes that control traits are distinct. Some of them, anyways.

The second is the Law of Independent Assortment: genes that control different traits switch around when organisms breed. Changing a pea's seed color in breeding, say, doesn't seem to change its height. And the third Mendelian law is that of Dominance: some traits are dominant, and others recessive.

Thanks Thoughtbubble. Mendel shared his pea results in a paper called "Experiments on Plant Hybridization" in 1865. And Mendel corresponded with the influential Swiss botanist Carl Nägeli from 1866 to 1873.

Boom! Within one decade of Darwin's Origin, Wallace's Malay Archipelago, Galton's Hereditary Genius, and Pasteur's experiments on biogenesis—Mendel had created a quantitative genetics. And yet… nobody cared.

Why the eclipse of poor Gregor? First of all, Mendel himself didn't care, in the big-picture sense. His goal had been to improve plant breeding.

In no way was he trying to be like Chuck Darwin and promote a grand theory of Life. Second, Mendel was so isolated in a backwater abbey in eastern Europe, far from London or Paris. Third, Mendel just had super bad luck: he tried to reproduce the results of his pea experiments—because, you know, the scientific method.

But his second model plant was hawkweed. No one knew at the time, but unlike humans and mice and flies and peas, hawkweed reproduces asexually. Two parents don't neatly cross traits when they make offspring.

So, no Mendelian recessive and dominant traits. No square. Fourth, right after his hawkweed debacle, Mendel got promoted to abbot in 1868.

This sidelined him with administrative duties. Mendel didn't publish after that, and he wasn't part of a larger scientific debate about heredity. He was just too busy to write a book like Origin.

He had an abbey to run. And fifth and finally, Mendel was scientifically so far ahead of his time that other biologists didn't see how his work with peas related to the grand sweep of evolution. It just wasn't obvious.

So Mendel died, and genetics was lost. For a few decades. Who rediscovered Mendel?

Who didn't!? Right around 1900, four different researchers working on the heritability of traits independently read Mendel's landmark paper and understood just how critical his pea experiments had been. They became champions of "Mendelism," or the science of heredity, which was soon renamed genetics.

The rediscovery of Mendel's research led to the formulation of a specific research plan by these geneticists. In 1900, Dutch botanist Hugo de Vries rediscovered Mendel's isolation of traits. De Vries was already a famous biologist for popularizing Darwin's term "pangene" for the unit of heredity, and for coming up with the term "mutation." De Vries rejected the gradual blending of characteristics that others argued for.

He thought traits could jump around, because he could observe changes in his evening primroses after only one generation. Also in 1900, German botanist Carl Correns rediscovered Mendel. Correns had been a student of Mendel's famous colleague, Nägeli.

Also–also in 1900, Austrian agronomist Erich von Tschermak rediscovered Mendel and developed disease-resistant hybrid crops. And then in 1901, American economist William Jasper Spillman published his own independent high-fiving of Mendel in a paper called "Quantitative Studies on the Transmission of Parental Characters to Hybrid Offspring." Which pretty much sums up classical genetics. Just think about these events: one monk who loved gardening worked out how traits are passed on in living things.

No one cared. And then decades later, in the span of a single year, four separate researchers realized that this monk's data on peas was absolutely priceless. Retroactively, Mendel became the "father" of genetics.

Historians of biology have debated exactly how Mendel well really fits that title. But, overall, his legacy was secured by de Vries and his contemporaries. The work of the first geneticists also gave rise to a controversy in the life sciences.

On the one hand, those scientists who followed Darwin and Galton believed that traits blended smoothly. This is what Galton saw in human populations. On the other hand, the geneticists like de Vries had extensive hands-on experience with plant breeding and could see that Mendel was right: many traits jump around from generation to generation.

But the botanists didn't make Mendel a famous science hero: the Fly Boys did. In the 1910s, a group at Columbia University in New York led by Thomas Hunt Morgan conducted extensive experiments on the genetics of fruit flies. The scientists at Columbia's Fly Room researched mutations in the common fruit fly, Drosophila melanogaster.

One of Morgan's star student's, Alfred "Hot Dog" Sturtevant, pioneered genetic linkage maps, or ways of finding the locations of genes on chromosomes, the tube-like physical structures that store genetic material. This involved painstakingly breeding flies with two different mutations and comparing their chromosomes. Linkage maps are markers of order—of which genes come after which—not exact locations.

But they were still very useful in working out how traits are passed down. With many, many, gross experiments going on, the Fly Room researchers needed a lot of flies. They also had to develop standardized breeding practices.

Over many fly generations, they "reconstructed" their flies into a standard type that could be crossed with stable mutants. This became the first real model organism, a living laboratory technology that could be shared with distant colleagues, upgraded to surpass rivals, customized on demand, and re-made easily in case of emergency. Today, we have many other model organisms, including worms, mice, rats, rabbits, pigs, monkeys, and everyone's favorite, bread mold.

Three of the Fly Guys authored The Mechanism of Mendelian Heredity in 1915, which became the foundational textbook of classical genetics. And Morgan won the Nobel Prize in Physiology or Medicine in 1933 for his lab's work on the role that chromosomes play in heredity. But the Nobelist who did the most work on how chromosomes transmit genetic information—in an organism with way more chromosomes than fruit flies—was American geneticist Barbara McClintock.

In the 1920s, she discovered how genes combine—and thus how information is exchanged when cells divide. She produced the first genetic map for corn or maize, linking regions of the chromosome to physical traits. Then, in the 1940s and 50s, McClintock discovered transposition of genes, or the ability of genes to change position on chromosomes.

She worked out how genes are responsible for turning physical characteristics on and off. She explained color variation in corn, theorizing how genetic information is expressed across generations, including why it's sometimes suppressed. And yet McClintock stopped publishing her data in 1953 due to her colleagues' skepticism.

She was too far ahead of her time. Basically, she got Mendeled. But at least McClintock was awarded the Nobel in Physiology or Medicine in 1983—four decades later—for her discovery of jumping genes.

She remains the only woman to receive an unshared Nobel Prize in that category. Next time—we'll heat things up and get to work with the birth of thermodynamics! Crash Course History of Science is filmed in the Dr. Cheryl C. Kinney studio in Missoula, Montana and it's made with the help of all this nice people and our animation team is Thought Cafe. Crash Course is a Complexly production.

If you wanna keep imagining the world complexly with us, you can check out some of our other channels like Scishow, Eons, and Sexplanations. And, if you'd like to keep Crash Course free for everybody, forever, you can support the series at Patreon; a crowdfunding platform that allows you to support the content you love. Thank you to all of our patrons for making Crash Course possible with their continued support.