Bodies and Dollars: Crash Course History of Science #41

Crash Course: History of Science
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After World War II, the applications of basic discoveries in biology took off and became big business. Today, we'll look at the rise of Big Pharam and GMO foods. We'll also discuss how life science technologies fundamentally changed reproduction. It's time to invent in vitro fertilisation and clone a sheep.

[introduction credits]

When we last left medicine and the brain sciences, one had antibiotics and the other had talk therapy, which were major developments, but many disorders still lacked effective treatments. That changed during the Cold War. Brain science took off and several researchers found, starting with animal models, that treating brains with different chemicals could affect mood and behavior. One of the first blockbuster brain drugs was a compound called *chlorpromazine*, better known by the brand name *Thorazine*. Approved for psychiatric use by the US Food and Drug Administration in 1954, thorazine is an anti-psychotic. It reduced the need for electroconvulsive treatment. More patients returned ot their families, and it's still used today.

Another early blockbuster was *meprobamate*, the first of the minor tranquilizers, nowadays called anti-anxiety medications. Different companies marketed different versions of meprobamate, the biggest of which was Miltown. Miltown became the best selling drug in the US. Some historians estimate that 5% of all Americans were on Miltown by the late 1950s. It became normal to take tranquilizers. There was even a Miltown martini, the Miltini. That... that's real. Kids at home, and also irresponsible adults, do not put tranquilizers in alcohol. Tranquilizers were the first scientifically created, advertising-promoted, drugs for the "worried well". People who mostly functioned in society, such as problem children and those neurotics in talk therapy.

Then in the early 1960s, drug company Roche developed diazepam, the first anti-anxiety drug of the benzodiazepine family. "Bennies", which include the name brand drug Valium, worked faster and longer than Miltown. Like Miltown, Valium affected culture. These pills became common place. You might have heard them called "mothers little helpers". This nickname tells the story of the US at the time: most women worked at home, many of them suffering frm the "problem with no name" - which we now might call depression and anxiety, owed in part to a lack of options, respect, and rights.

The new anti-anxiety pills worked to calm worried brains, but they didn't change a patriarchal culture. More openly debated at the time was the first drug to treat mood disorders, such as bipolar disorder: lithium. Starting around 1950, some psychologists called for the naturally occurring element lithium to be used prophylactically as a mood stabilizer. That is, to prevent a mood disorder. Lithium can cause serious side effects however that make patients feel sluggish and out of it. Stable, but not exactly great, depending on the dose. So the FDA only approved lithium for prophylactic use in 1974.

Drugs for major depressive disorder were also controversial. In the 1960s, psychiatrist Joseph Schildkraut put forward the chemical imbalance theory: basically, since antidepressants seem to work by elevating levels of norepinephrine and serotonin, depression may be caused by a *lack* of these critical neurotransmitters. This theory is widely talked about, but it's never been proven. Where are you, scientific method? Still in 1987, the antidepressant fluoxetine, marketed as Prozac, was sold as the first selective serotonin re-uptake inhibitor, based on the imbalance theory.

But pills were not the only way of making money from research on bodies. Another was the ability of medical research to turn samples of human tissues in immortalized cell lines using tissue engineering. These cells don't die out, but keep growing indefinitely.

Experimenting on living humans can be dangerous and complicated. Trying out new drugs on a dish full of human cells is cheaper and a lot safer. But the cells came from a specific human, and the new practice of immortalizing cell lines raised thorny questions about ownership.

Help us out, Thought Bubble.

The very first human cell line to be immortalized has been experimented upon on every continent and in outer space, helping of thousands of researchers develop new therapies. And it came from someone who didn't give consent and received no reward. Henrietta Lacks was an African-American housewife in Baltimore who showed up at Johns Hopkins in 1951 complaining of abdominal pain. She was diagnosed with advanced cervical cancer. As he'd done with hundreds of incurable cancer patients before, cell biologist George Gey took a biopsy, or tissue sample, and tried to keep it alive, giving it the kind of nutrient is would get from the body, but in a machine he designed called a roller drum.

Lacks' tumor cells could just keep growing, generation after generation of cell. His idea was that, since cancer cells divide aggressively and don't rely on a plan from the body, they might be easier to keep alive forever outside of one. Gey had tried and failed many, many times before, so he was surprised when Lacks' cells seemed to happily divide and divide, never dying out. His persistence had paid off. Gey freely shared the cells with other researchers, and the cell line - HeLa, became the most important cell line in biomedical research and remains so today.

By 1954, this strain of cells was being used by Jonas Salk to develop a polio vaccine, and HeLa would later be used for cloning human cells and developing in vitro fertilization. But Henrietta Lacks, the human with a family and friends and dreams and bills, was long dead. She had never consented to having her cells used for research. Her family was not aware of HeLa's existence until 1975, and they didn't receive any compensation.

Thanks, Thought Bubble.

As historian Hannah Landecker explains, HeLa is a particularly loaded technology. To Gey and many scientists it was clearly a gift to science. To the Lacks family, the cell line clearly represented the historical and continuing repression of black women. Black body parts used by white people to make knowledge and in the process, make money. Eerily reminiscent of slavery. At least HeLa doesn't cost anything. This is not the case with all cell lines.

In 1976, John Moore underwent treatment for hairy cell leukemia at the UCLA Medical Center, under the supervision of Dr. David Golde. He developed tissue from Moore's cancer into a cell line, Mo, that was later commercialized for millions of dollars. The lucrative cell line is owned by the regents of the University of California - not the man from whose body the cells were taken.

New technologies also raised new questions in agriculture. You've probably heard of GMOs, or genetically modified organisms. A GMO has had its genome, or DNA blue print, edited to include genes from other organisms. Genetically transforming microbes took off starting in 1973. The first genetic engineering techniques didn't work with complex organisms, but new techniques soon followed. In 1977 a biologist named Mary-Dell Chilton used an altered form of a common bacterium called *Agrobacterium tumefaciens* to insert genetic material from a foreign species into a plant. Agrobacterium works by forming a plant tumor, called a gall, on the root of a plant. Chilton's breakthrough was followed by similar in Belgium, but she became and remains the queen of Agrobacterium. In the 1980s, chemical companies used her work to develop GMO crops.

In 1983, John Sanford and Edward Wolf invented a mechanical means of genetically transforming plants at Cornell, the gene gun. This was also used to make GMOs. The first approved GMO was a pest resistant tobacco in China in 1992. That same year, the US approved the first GMO to eat - a bruising resistant tomato, the Flavr Savr -marketed under the farm-y sounding name, McGregor's. These tomatoes contained a gene that turned off the enzyme that breaks down pectin. This kept them from going soft on long truck rides from Mexico. In the 1990s, a company developed the super fast growing AquAdvantage salmon, the first GM animal for food. Canada approved it and the FDA ruled the salmon safe in 2015. But the next year, they postponed AquAdvantage's release until final labelling guidelines for informing consumers of such content are published. And they've postponed every year since.

But the big money GMOs, which at first faced little pushback from consumers, are grains. In 1995, Bt corn was registered with the EPA. Farmers have used Bt, a pesticide derived from the bacterium *Bacillus thuringiensis,* since 1920. On its own, the pesticide is considered organic. Around the same time, Monsanto introduced Roundup Ready soybeans, resistant to their top pesticide, glyphosate. The soybeans were followed by corn in 1998. Each chemical company set up like a vertically integrated system, selling GM seeds and related herbicides, making tons of money as farmers buy both.

GMO grains are common throughout the United States, China, Argentina, and India, but largely resisted in Europe. The market for GMOs today is estimated at over 300 billion dollars, all from only four crops: soy, canola, cotton, and corn. Modified with only two properties: herbicide tolerance and insecticidal action, or both. None of these things makes foods more nutritious or better tasting. These properties are all about yields for grains that are fed to animals or used as ingredients. So much of the recent controversy about GMOs isn't really about the technology changing plant genomes, but the why behind these changes.

Other advances in genetics technologies were more readily accepted, assisted reproductive technology, for example. In 1978 in England, Louise Brown became the first baby born using in vitro fertilization or IVF. *In vitro* means *in glass*. Babies conceived in dishes instead of wombs. Basically IVF and similar techniques involve isolating gametes or sex cells, and moving them around in labs. Egg donation became possible soon after in the 1980s. Today, IVF, the donation of gametes, and other forms of assistive reproductive technology are widely accepted and used. But these technologies are often expensive, so not everyone has equal access to them.

Meanwhile in agriculture, other cell biologists pushed new reproductive technologies. Dolly the sheep was born in 1996, the first animal created using somatic cell nuclear transfer, or SCNT, widely described as cloning. Dolly was created by embryologist Ian Wilmut and others at the Roslin Institute at the University of Edinburgh and named after Dolly Parton. SCNT is surprisingly simple. Somatic cells are body cells, like from skin. The nucleus of a somatic cell contains a DNA blueprint, but its not normally enough to make a new organism - that requires gametes. But with SCNT, the eggs' nucleus is sucked out by a micropipette and the nucleus from a somatic cell is inserted. This causes the egg to start dividing to make a baby and means the genetic material is from that somatic cell. The baby is a clone of the somatic donor. With new reproductive technologies, it's technically possible to clone a baby human now, but that is banned in most countries.

Also, cloning wouldn't result in an exact copy of the single parent. Just a child with a similar genome. Experience would turn off certain genes and others on. This is called epigenetics. And environmental stimuli matter more than genes in many cases. Breathing in polluted air for example is bad, no matter how good the genes related to your lungs are.

Next time, we'll introduce the life science's equivalent of the atomic bomb. It's time for the Human Genome Project, forensic genetics, and a new personalized era in biotechnology. *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 of these nice people, and our animation team is Thought Cafe. Crash Course is a Complexly Production. If you want to keep imagining the world complexly with us, you can check out some of our other channels like SciShow, Eons, and Sexplanations. And, if you would 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.

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