Biomedicine: Crash Course History of Science #34

Crash Course: History of Science
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===== (00:00) to (02:00) =====

[complexly intro sequence]

[introduction]

Who's ready for some more World War II science? No? Nobody? Ah...well... this story's about all kinds of badness, yes, but also a lot of incredible goodness. The history of science up until the Cold War is often overshadowed by the Manhattan Project, but today we're going to be talking about advances in biomedicine, or healthcare based on a biological understanding of human bodies and diseases.

[role title sequence]

[background]

Many biomedical breakthroughs, like antibiotics, were developed in the 20th century, but a few are much older. The original wonder drug is a natural pain relief compound of the opiate class that we still widely use today: morphine. A German pharmacist's assistant named Friedrich Sertürner isolated it around 1805. Morphine induces relaxation and sleepiness, and too much can kill you. And it's super addictive. But very effective and relatively cheap!

Soon a German company called Merck began selling it. And then, in the 1850s, the hypodermic needle was introduced. Now the last time we talked about medicine, exciting things were happening. Namely, germs. Most diseases are caused by germs, so with germ theory, not to mention a cell theory and vaccines and beer, the life sciences in the late 1800s looked pretty great. But vaccines are slow, so if you're dying right now, maybe due to an infected war wound, they don't work well. And they only work on certain diseases. Also there just weren't that many vaccines and there were a lot of diseases. In fact, even reliable diagnoses were a problem.

So what the life sciences had gained in theories and models, they still lacked in applications. Advances came in the form of chemical compounds that had specific effects on specific physiological systems. In 1907, the lab of German chemist Paul Ehrlich created an arsenic compound sold under the name Salvarsan that was antimicrobial, but not toxic to humans.

===== (02:00) to (04:00) =====

[the applications of Salvarsan]

Ehrlich used Salvarsan to effectively treat syphilis, which was a huge deal. The first modern chemical therapeutic could treat one of the biggest public health problems. But. Salvarsan did not work on late stage syphilis patients who suffered from general paresis of the insane, or GPI, which had very serious symptoms including delusions, and was fatal. But in 1917 Austrian physician Julius Wagner-Jauregg developed an effective therapy which involved infecting them with malaria. While weird, malaria-fever treatment gave hope to people suffering terribly, and Wagner-Jauregg won a Nobel for his efforts.

[shock treatments]

Another psychiatric discovery in 1933 was insulin shock therapy to treat schizophrenia and other mental disorders. Patients were dosed with the hormone insulin, causing them to go into shock, and then a coma. It became common in the 1940s and 50s, but this method of inducing shock wasn't alone. There were several. The most famous, invented in the 1930s, was electroconvulsive treatment, or ECT. Many people have objected to ECT over the years and the exact way it's been used has changed. But today, as a treatment for severe depression, it's considered safe.

[lobotomies]

One pre-World War II treatment that is no longer used is lobotomy, or surgically cutting connections in the brain's prefrontal cortex. This left patients with reduced responsiveness and awareness. They had literal brain damage, which could help control severe symptoms of mental disorder. Lobomotomies became common around 1935, first in Europe, then in the United States. Initially they were typical psycho-surgeries performed in hospitals. But in 1945, neuropsychiatrist Walter Freeman figured out how to perform lobotomies using an ice pick. He practiced on a grapefruit at home, and then he went on the road, popularizing his much faster transorbital technique. In the United States, 40,000 people were lobotomized. Were they all suffering from sever mental disorders and did they enjoy better lives after surgery? Probably some did?

===== (04:00) to (06:00) =====

[lobotomies continued]

But unfortunately in many cases lobotomies were used to make patients easier to manage, or for even worse reasons. In 1977, Congress investigated the history of the lobotomy, concluding that it had often been used to harm minorities.

The biggest advancement in biomedicine at the time was the development of antimicrobial compounds like Salvarsan. In 1931, German chemists developed an effective anti-malaria drug, mepacrine. Allowing medics to treat soldiers with malaria opened up much of the world's equatorial regions to combat during World War II. Even more revolutionary, Gerhard Domagk, a researcher working in the same lab that synthesized mepacrine, discovered sulfanilamide, the first drug that broadly treated a whole bunch of diseases caused by bacteria. He was awarded the Nobel in 1939, which he was forced to give back because Nazis.

Sulfanilamide was only the first of a whole class of antibacterial drugs, the sulfonamides or sulfas. These were the first antibiotics. With them, doctors could quickly and cheaply help thousands of patients, treating everything from meningitis to gonorrhea to burns. But most people today don't go to the doctor and ask for sulfas.

Because, in 1928, in the basement laboratory of St. Mary's Hospital in London, Scottish physician and microbiologist Alexander Flemming noticed quite by accident that some mold growing in his lab seemed to kill some harmful bacteria. He cultured it and started experimenting. Flemming discovered a whole new class of antibiotic drugs: the penicillins, derived from that mold, penicillium.

Alas, at first his colleagues didn't understand. Flemming wasn't great at explaining his work and it took him years to convince them. A few doctors used penicillin in the 1930s, but it wasn't until nearly 10 years later that penicillin became a "wonder drug". Again, Merck scaled up production, followed by Pfeizer, and again, World War II drove demand. The penicillins pretty much replaced the sulfas during World War II, treating sexually transmitted diseases, burns, heart infections, scarlet fever, pneumonia, and infections of the skin, mouth, and throat.

===== (06:00) to (08:00) =====

Whole categories of diseases that had once been deadly became manageable. This is good news for me by the way, because I am

allergic to sulfas as I found out when I took one and became a giant puff.

Later drugs created based on the penicillins, starting with ampicillin in 1961, were even more effective against more diseases. Flemming won the Nobel in 1945, sharing it with two other scientists who had figured out how to scale up production of the mold to industrial levels, English pharmacologist Howard Florey and German biochemist Ernst Chain. They were all knighted. So yay! More treatments for more diseases and doctors becoming knights. Unfortunately one medical pioneer was definitely not treated with this respect. Introduce us, ThoughtBubble.

[moving into the ThoughtBubble to discuss Charles Drew]

African American surgeon Charles Drew showed enormous promise. He graduated from medical school at McGill University in Montreal, Canada in 1933 and became an instructor at Howard University in Washington, D.C. in 1935. A year later, he became a surgical resident at Freedman's Hospital. And in 1938, Drew earned a Rockefeller Fellowship to study at Columbia Unviersity and work at Presbyterian Hospital. There, he became the first African American doctor of medical science. His doctoral thesis, *Banked Blood*, revolutionized medicine. Drew realized that blood plasma, the clear part without cells, lasts a lot longer than whole blood. He worked out how to "bank" or store plasma for longer periods of time. He also discovered that plasma can be dried and rehydrated as needed.

Anticipating terrible casualties, and drawing on lessons from the first World War, New York's Blood Transfusion Betterment Association met with British physician John Scudder to formulate a plan. Scudder had heard of Drew's work on plasma and hired him as soon as he earned his doctorate, in 1940. Drew's new job was to coordinate blood for Britain. His team collected and processed blood plasma from different hospitals in New York, shipping it overseas to save Allied lives.

===== (08:00) to (10:00) =====

A year later, Drew lead another large scale blood project. This time, for the American Red Cross and the US military, but there was a catch. The military wanted Drew to segregate the blood donated by African Americans from that donated by whites. Understandably outraged, Drew resigned after only a few months. By the end of 1941, when Drew returned to Howard, he had created two of the first large blood banks. But he was not a knight, and his country was still so deeply racist that even its official supply of lifesaving biomaterials was segregated. In 1950, Drew died in a car accident. He was only 45 years old. Thanks, ThoughtBubble.

[exiting the ThoughtBubble, back to Hank for Nazi science]

This was far from the worst offense in World War II. The Nazis undertook systematic research on human biology as well, all within the paradigm of "Rassenhygiene" or racial hygiene. This was German eugenics: the application of a distorted understanding of Darwinian evolution to human society. The Nazis believed that certain human groups were better than others, and that biology, not Nurture determined everything. But they wanted proof.

In the 1920s, the racial hygienists had to wait around. But with the Nazi takeover in 1933, they had the research material they needed to understand the human body at a deep level in the form of Jewish people and others whom the Nazi state didn't consider fully human. During World War II, Nazi scientists such as Josef Mengele performed experiments on humans in concentration camps. Among other atrocities, Mengele conducted studies of genetics, including twin studies, but killed subjects afterward, sending tissue samples back to Berlin for further analysis.

Like the Allies, the Nazis developed drugs. But the Nazis weren't sure if they should focus on antibiotics, which kill bacteria, or on homeopathic remedies, which are based on the idea that a substance that causes disease in a healthy person can cure similar symptoms in a sick person. To conduct their tests, the Nazis simulated brutal war injuries on concentration camp prisoners, and then tried to prevent infections using different agents.

===== (10:00) to (12:00) =====

[Nazi science, continued]

Finally the Nazis developed a robust euthanasia program, or way of testing the cheapest, fastest ways to kill the most people, without causing them to riot.

[Unit 731]

Meanwhile, in occupied China, an infamous group of biologists and chemists within the Imperial Japanese Army, called Unit 731, carried out some similarly horrifying research. They cut patients open while they were still alive without anaesthesia. They tested new biological weapons. They tested the limits of human resistance to hypothermia, or frost bite. It gets worse, but you get the idea.

When the war ended, the United States' government discovered the atrocities committed by the Imperial Japanese doctors, and they cut a deal. The US would grant certain war criminals immunity in exchange for their data.

So where is the goodness that I talked about at the beginning of the episode?

Well, after World War II, more drugs, medical technologies, and novel procedures emerged. For example in the 1950s Jonas Salk and A.B. Sabin created the polio vaccine, which was very good. But the deeper point is that medicine, now a global institution, had a long look at its self. The vast majority of doctors and government officials were absolutely sickened by the revelations of the doctors trial of the Nazis. Doctors convened and created a new way of handling medical research with human subjects: the Nuremberg Code of Medical Ethics. In fact, a whole new branch of philosophy was born: bioethics. On the policy side, all human subjects research now has to be approved by Institutional Review Boards, or IRBs. It's a long process in which scientists and regulators scrutinize what will or won't be done in the name of medicine, to whom, or for what purpose. And, it's one of the greatest, quietest moral wins in the history of science.

[next time]

Next time, we finally bring together Darwin and Mendel in an intellectual supergroup called the Modern Synthesis. Don't miss it.

[end credits]

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===== (12:00) to (12:37) =====

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