



HUMAN NATURE

YEAR 2019 | RUN TIME 94 mins | LANGUAGE English

www.humannaturefilm.com

DIRECTED BY ADAM BOLT

EXECUTIVE PRODUCED BY DAN RATHER,
ELLIOT KIRSCHNER, AND GREG BOUSTEAD

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FILM FESTIVALS

WORLD PREMIERE

2019 SXSW Film Festival

2019 OFFICIAL SELECTION

CPH:DOX Film Festival
Hot Docs Film Festival
Full Frame Film Festival
Newport Beach Film Festival
Seattle International Film Festival
AFI Docs Film Festival
AFO Film Festival (Audience Award)
Silbersalz Science & Media Festival
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Hot Springs Documentary Film Festival
41 North Film Festival
Windsor Film Festival
Scottsdale International Film Festival
Life Sciences Film Festival
DOC NYC

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SYNOPSIS

A breakthrough called CRISPR has given us unprecedented control over the basic building blocks of life. It opens the door to curing diseases, reshaping the biosphere, and designing our own children. Human Nature is a provocative exploration of CRISPR's far-reaching implications, through the eyes of the scientists who discovered it, the families it's affecting, and the bioengineers who are testing its limits. How will this new power change our relationship with nature? What will it mean for human evolution? To begin to answer these questions we must look back billions of years and peer into an uncertain future.

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BACKSTORY

Human Nature is about the power of scientific research to change the course of human history, evolution, and the natural world. But the spirit of experimentation around this film isn't only the story on screen. The documentary itself is an experiment in science storytelling, the product of a first-of-its-kind collaboration between scientists, journalists and filmmakers.

Elliot Kirschner (Producer/Executive Producer *Human Nature*) is the son of an accomplished scientist who grew up surrounded by the excitement of discovery. After going into a career in journalism, reporting and producing on CBS News programs such as 60 Minutes, Sunday Morning and Evening News, Kirschner saw science wasn't getting the treatment it deserved. Here is a human endeavor that's about pushing the boundaries of knowledge and teasing out the mysteries of the unknown. It shapes almost every part of modern society. Why did it come across so esoteric, vague, and often boring when presented to the public? Kirschner approached his longtime collaborator, news icon Dan Rather, who agreed that science was the most important story not getting covered. They dove into science stories on a weekly cable news program, but they were on the lookout for something bigger, bolder. What story could they tell that could revolutionize science communication?

Across the country Sarah Goodwin (Producer/Chief Science Advisor *Human Nature*) was finishing up her PhD in cell biology at the University of California, San Francisco. She was on her way to a career in research when she took what she thought would be a one-year detour to join a fledgling non-profit called iBiology that was dedicated to fundamentally rethinking the way science was communicated to a professional audience. The medium was video and a new technology called YouTube. A decade later, with video views numbering in the many millions, iBiology has become an indispensable tool for researchers around the world. But Goodwin wondered why the documentary films she enjoyed in theaters and on outlets like Netflix never really told the stories of science, at least the reality and excitement of the world she knew.

Eventually Kirschner moved out to San Francisco and joined up with Goodwin at iBiology. In the Bay Area the scientific community was humming about a new discovery that could change research, medicine, and our relationship with nature: CRISPR. Scientists usually are eager to downplay hype, but they spoke about CRISPR using the kind of breathless phrases you usually see on infomercials. The technology was only a few years old, but it was sweeping across lab benches around the world. Rarely has a technology been so transformative so quickly. At that time, however, there was scant awareness of CRISPR in the public at large and little mention in the general press. The team knew they were ahead of a very big story. Dan Rather was eager to help. But how would they turn a science topic into a film for the general public? They also wanted to make a film that would inspire scientists with the power of communication.

Kirschner and Goodwin came up with a hypothesis: what if they brought scientists and storytellers together from the very beginning? It would be a collaboration, akin to the multidisciplinary science collaborations that lead to breakthroughs like CRISPR. Kirschner had experience heading journalism and film projects. Goodwin would be the link to the world of science. Needing a director, they turned to Bolt, with whom Kirschner had worked on a series of short science films. The

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production team met with the leading scientists in the field and brainstormed around what this film should entail. The scope of the project grew from an explanation of CRISPR to a multi-millennial journey of the human impulse to control the natural world.

Over the course of production, the motley band of filmmakers gelled into a unit. Others were brought on who believed in the mission: editors, cinematographers, an animator, a composer. Foundations who had never funded something of this nature pledged their support. From the beginning the decision was made to push the boundaries of conventional wisdom about what a science documentary should be. No narrator; let the scientists speak for themselves. No treating the audience like children who had to be spoon fed information. No shying away from both the facts of the science and the nuance of the ethics. Every time someone told the filmmakers it was impossible to try to make a film on this topic entertaining, or that the material would have to be dumbed down, or that scientists would never want to be a part of their project, the team dug deeper.

The film became part of a broader mission. The scientists who participated in the film said the experience transformed the way they thought about communicating science. Other filmmakers who saw rough cuts and the festival version said they wanted to think more about working on science topics. If *Human Nature* worked, then other films, from feature-length documentaries to short, digital content, should follow. Kirschner and Goodwin launched the **Wonder Collaborative** as a brand-new production entity focused on making science films for the public. It would be linked with that original non-profit iBiology and thus would have the credibility of the scientific world backing its projects. *Human Nature* would be the pilot for a new approach to science film making.

Human Nature has found enthusiastic audiences, both in the general public and among scientists who say they've never seen anything like it. At a time when science is more important than ever as a tool for addressing the world's problems, when its potential raises new ethical quandaries, and when it finds itself attacked under the banner of "fake news," *Human Nature* provides a way forward for debate and discussion. Members of the scientific world are watching closely to see how the film and the other efforts of the Wonder Collaborative can create a new world for science documentaries. The broader public will hopefully find that science isn't daunting but exciting. In a modern world, science will play an ever-increasing role. Citizens must be informed. Scientists must be engaged. And a collaboration like the one that produced *Human Nature* can change the way that scientists and storytellers work together, ushering in a new era of science communication.

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FILMMAKER STATEMENT

We live in a time where science and technology are impacting our society in more and more ways. And the decisions that shape how these new fields of knowledge develop ultimately affect all of us. We need films that bring the public at large into those conversations.

CRISPR is the most important science story that the general public doesn't know about. CRISPR enables fast, inexpensive, and precise manipulation of DNA, the molecule that contains the chemical blueprint for all life on Earth. CRISPR is already sparking a revolution in biotechnology and genetics. Scientists often compare it to the Internet revolution in terms of its scope and importance, with CRISPR playing a role comparable to the personal computer or smartphone: CRISPR is the enabling technology that is making the revolution possible, although of course there are other factors at play as well, such as advances in reproductive technology, automation, and computing power (which is playing an increasing role in parsing all the genetic data scientists are gathering).

Scientists tend to be a cautious bunch. They're suspicious of hype and not known for making outlandish claims. So it was really striking when I kept hearing leading researchers say these extraordinary things about CRISPR: that it could allow us to reshape the biosphere, cure untreatable diseases, and design our own children. They spoke about it as a technology that could change the future in huge and unknowable ways. What's more, CRISPR seemed to explode out of nowhere. Suddenly things that everyone thought would be decades away are literally happening now.

I was also struck by how much debate was going on within the scientific community about how to deal with CRISPR. For example, many scientists are genuinely unsettled by the idea that we could design our own children, and think that altering future generations is a line we should never cross. But others don't see as much of a difference between CRISPR and other technologies (space travel, modern medicine, and even agriculture) that have in some sense "changed what it means to be human." This is a realm where there are no easy answers, even to those who understand the science best.

One thing we knew from the beginning was that we wanted to push the envelope in terms of delving into the science behind CRISPR. When you understand how CRISPR actually works, it affects how you feel about it. For example, the tendency is to call genetic engineering "unnatural." But CRISPR actually evolved naturally over billions of years, so it calls that into question a little. Yes, humans have repurposed CRISPR as a tool to manipulate our own DNA, but often we're seeking to eliminate "natural" mutations that cause a lot of suffering, like sickle cell disease. So the distinction between natural and unnatural doesn't necessarily help you decide what's right and wrong.

At the same time, the fact that CRISPR was in essence *invented* by nature—and that humans couldn't have created it on our own—should give us a degree of humility as we start using this new tool to tinker with nature.

But to get those ideas across, we felt it was important to spend a fair amount showing how CRISPR works in nature, and how humans discovered it and learned to harness it.

For this film, we also wanted to put CRISPR and gene editing in the much larger historical context of human intervention in nature, which goes all the way back to the origins of agriculture and the

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domestication of plants and animals. To most people, nothing is more natural than the food we grow, but actually most things we eat were in a very real sense created by humans. Thousands of years before people even knew what DNA was, they were in a very real sense manipulating it through selective breeding, in order to make crops and livestock that suited our needs. Take corn, for example, which originated from a grass called teosinte. When you compare a giant yellow ear of corn to its ancestor, you suddenly feel like modern corn is a monstrosity. We've also reshaped the ecology of the planet to make room to grow this stuff. Agriculture is a building block of civilization, but it has also led a lot of problems, both in the environment and in human health, because of how it changed our diet. But of course nobody could have predicted those consequences, good and bad, 10,000 years ago. Where might modern genetic engineering lead us on a similar time scale?

The first challenge was understanding it myself. That's where our Producer, Sarah, was invaluable. Sarah is also a PhD cell biologist and she helped me wade through all the scientific papers and prepare for the interviews with the scientists. Then we had to figure out how to explain it without having it feel like an educational film.

Since we weren't using narration, we had to get the scientists themselves to explain all of this on camera, in a way that wasn't boring or confusing. I also knew we needed lots of options in the edit room, because we didn't know in advance what the best way to tell this story would be. So we conducted fairly long interviews, some of them five or six hours, and I tried to make sure they felt like real conversations. I knew if I just said "explain CRISPR," the light would leave their eyes and they would just sort of go into lecture mode. Instead, I asked them to tell me stories, about the first time they heard about CRISPR, about how they figured out a particular piece of the puzzle, about the moment they realized the implications of what they had discovered. People come to life when they're telling a story, and I thought we could explain what CRISPR was and how it worked through the story of how it was discovered, which is an amazing one.

For a film like this to work, we knew we needed great characters. Going in we had a pretty good idea of many of the scientists we wanted to talk to, but we knew we wanted to tell a much broader story. Our Producer, Meredith DeSalazar, came up with people and places that give the film much of its context and contours. How could we personalize the question of using CRISPR to treat disease? She found David Sanchez, a young man with sickle cell anemia who was part of a scientific study at Stanford. David and his family's participation now rest at the heart of the film. I also wanted to think about how would we could make a broader link between CRISPR and human being's earliest impulses to alter their environment. Somehow Meredith got us into an archaeological dig in Turkey at the exact time they were unearthing a human remain. As with many field shoots of this nature, it turns out getting permission was the first of many logistical and editorial challenges that Meredith was able to work out. We got the shot which now ends the film.

Our Cinematographer, Derek Reich, did almost all of the filming, both the interviews, the nature scenes, and the b-roll. He has an incredible eye for composition, and I think this resulted in a visually stunning film.

Our editor Steve Tyler was able to join the project while we were still early in production and help us find our footing with the interviews, in terms of what was working and what wasn't. The early cuts that Steve put together really helped me hone in on my approach for later interviews.

From the beginning, we also knew that graphics would also be critical to bringing CRISPR and gene editing to life. Scientists like to joke that all biology labs look the same: just a bunch of people

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siphoning clear liquids from one test tube to another. This is largely true, and doesn't make for very interesting visuals, nor does it help you understand what's happening in those test tubes. The really cool stuff is happening at the molecular level, which obviously we couldn't film.

Ned Piyadarakorn created all the graphics that bring this molecular world to life, and his designs were so influential on the look and feel of the overall film—and the graphics themselves are so beautiful—that we decided “Art Direction” was the best label for what he did. Usually graphics are created toward the end of a project, but we brought Ned onto the project way earlier, so we could start figuring out the graphic language as we edited and allow that to inform our editing decisions and vice versa.

I'm personally not a fan of graphics that rely too much on metaphors. I didn't want to have Cas9 look like a tiny pair of scissors (which is how it's often explained). I wanted the graphics to be based in reality, but also evocative. Thanks to a technique called x-ray crystallography, scientists actually know a lot about what Cas9 looks like at the molecular level and Ned used that data to build 3D models of Cas9 and DNA. All the DNA sequences we show in the film are real and Ned came up with a way of representing genes that is based on how DNA sequencing data actually looks. A lot of these molecular processes are based on how different molecules fit together, sort of the way a key fits into a lock, and Ned's graphics capture that beautifully. We wanted the graphics to be easy to follow, without losing the sense that there is a lot of intricacy and complexity to what's going on.

My background is as an editor and every film I've ever worked on has taken shape in the edit room. In my opinion that's where a documentary gets written, even if you're not literally writing words on a page. Editor and co-writer Regina Sobel was really in the trenches with me, figuring out how to tell such a big and complex story in a compelling way. Elliot also spent several concentrated periods with us in the edit room, helping troubleshoot problems with the storytelling. It wasn't just a question of figuring out the order of the scenes, but how the film should feel. Regina has a very intuitive sense of emotion and many of the film's most powerful and poetic moments are a testament to her filmmaking instincts. She is also extremely collaborative and open to experimentation, which was essential for this film, because we had no road map going in.

When I would tell someone I was directing a film about genetic engineering, the most common response was some variation of “Wow, that must be scary, huh?” I think in part that's because many of us have a certain visceral reaction to the idea of tinkering with life—and especially with human life—that's very different from how we react to other kinds of technology. But I think the reaction also has to do with certain assumptions or cliches about what a documentary is supposed to do when it takes on a “big issue” like genetic engineering: that it is supposed to scare us or make us angry. And then tell us who to direct that anger at. But the true story about CRISPR is nuanced and complex. There is plenty to be afraid of, but there is just as much to be hopeful about. There are millions of people whose lives could be saved by this technology. And it could also potentially help with some very serious problems that our planet is facing. In our film, we certainly don't shy away from the aspects of CRISPR that make people say “wow, scary,” but we also wanted to capture the part of it that is just plain “wow.” We now have the ability to manipulate DNA, something that is 40,000 times smaller than a human hair. And we can do it in this incredibly precise and relatively easy way. The story of how humans figured this out is incredible. And if humans are capable of that, maybe we're also capable of figuring out how to navigate all the difficult existential questions that genetic engineering raises. But that's only a maybe, and I hope this film inspires audiences to embrace the ethical and philosophical inquiry that comes from this new horizon of knowledge.

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Our film really asks people to think about what it means to be human—and what we want it to mean, now that we have the power to change ourselves in this fundamental way. I hope people walk out of the theater and immediately start discussing and debating that with each other. We don't give a definitive answer in the film (nor would I pretend to have one). Instead, we wanted to take people on a journey through the brave new world of CRISPR and hopefully leave them feeling a little uncertain about how they feel. In a world where technology is changing so quickly, I think some collective uncertainty is a good thing. CRISPR and gene editing have tremendous potential for good. But I think we have to be continuously grappling with how technology is affecting society. And that's what I love about film—it brings people together in a dark room to have a shared experience, and then when the lights come up we can start talking about it with each other.

What is CRISPR?

In the popular media, CRISPR is often described as “molecular scissors” that can be used to cut and paste DNA. But how is that possible? How do you cut and paste something that is 40,000 times smaller than a human hair? The answer comes from nature itself. Remember that every living cell has DNA inside of it, and it turns out a cell needs to manipulate DNA constantly—for example, it has to make copies of its own DNA when the cell divides (which is how DNA is passed from one generation of cells to the next) and it has to repair DNA when it gets damaged by things like x-rays. So over billions of years, cells have evolved mechanisms to manipulate DNA in a variety of ways, powered by tiny molecular machines called proteins.

For decades now, scientists have known about proteins that can cut DNA. That's what powered the first wave of genetic engineering that started in the 1970s. But the real challenge is figuring out how to cut DNA *in a specific place*. Take something like sickle cell disease, which is caused by a single mutation in a single gene—where one chemical “letter” of DNA is substituted for another. If you want to cure sickle cell disease, you have to find this one letter out of the more than 3 billion letters in human DNA and make a cut at exactly the right spot. Then you have to repair it with the correct letter. Until very, very recently, this was so difficult to do that it might as well have been impossible. Which is why, even though the idea of “gene therapy” to cure diseases like sickle cell has been around for decades, it hasn't really worked that well in the past.

But It turns out that certain microorganisms have evolved a system, known as CRISPR, that can cut DNA in a very precise manner. They use it as a defense mechanism. These microorganisms get attacked by viruses, just like our cells do, and the viruses actually inject their own DNA into the cell when they infect it. So the microorganisms have molecular machinery called CRISPR that recognizes viral DNA and cuts it, which effectively disables the virus. A key component of CRISPR is a protein called Cas9. One of the scientists we interviewed called it a molecular law enforcement official. Cas9 literally carries around a short snippet of genetic code that comes from the virus and functions as a sort of most wanted poster. Cas9 floats up to any DNA it encounters and checks to see if that DNA matches the most wanted poster it's carrying. The bacteria doesn't want to be cutting up its own DNA by mistake, so this most wanted poster is an ingenious way of finding only those pieces of DNA that come from its enemies.

The breakthrough came when scientists figured out that they could easily swap out the most wanted poster for something else. So instead of having Cas9 hunt for viral DNA, you could have it find the DNA that contains the sickle cell mutation (or any other gene) and cut it.

Once you cut the DNA, the cell tries to repair it. And you can sort of get in the middle of that process and change the DNA at that point. But the key is being able to cut the DNA at a precise place. And that's what CRISPR does. CRISPR is actually a natural process that humans learned to

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harness. It was discovered more than it was “invented.” Initially, the scientists who were studying CRISPR had no intention of creating a revolutionary new tool for genetic engineering. It came out of basic research, in a field called microbiology.

Among biologists and geneticist, CRISPR became a household word in late 2012 and early 2013, after a series of papers showed that it could be used to precisely edit the DNA of humans, crops, animals, insects, you name it. It turned out to be an almost universal tool for gene editing. And then things started moving very quickly. Within a year, someone had used CRISPR to edit monkey embryos, and it was clear that it would soon be possible to do that in humans as well. And that has really profound implications.

Until very very recently, genetic engineering in humans has been confined to what are called “somatic cells.” Almost all the cells in your body are somatic cells—skin cells, blood cells, brain cells, etc. If you edit the DNA in those cells, that change is confined to that particular tissue. But if you edit the DNA of sperm, egg, or embryo cells, that change is passed down to future generations. This is called germline editing, and it’s had never been possible in humans until CRISPR.

ADAM BOLT
DIRECTOR - “HUMAN NATURE”

FILMMAKING TEAM BIOS

ADAM BOLT
Director

Adam Bolt edited and co-wrote the Oscar-winning documentary *Inside Job*, for which he received the Writer’s Guild Award for Best Documentary Screenplay and was nominated for an American Cinema Editors award for Best Edited Documentary in 2011. He won an Emmy in 2014 for his work on the Showtime documentary series *Years of Living Dangerously*, where he served as senior producer, writer, and editor. His other credits include director Alex Gibney’s *Park Avenue: Money, Power & The American Dream*, which premiered on PBS’s *Independent Lens* and went on to win a Peabody Award in 2013; *Page One: Inside the New York Times*, which was nominated for two Emmys (including Best Editing) in 2012; and the HBO documentary *The Recruiter*, which won a Columbia duPont award for excellence in broadcast journalism in 2010.

ELLIOT KIRSCHNER
Executive Producer

Elliot Kirschner is the Executive Producer of *iBiology* and the *Wonder Collaborative*, a *New York Times* best-selling author, and Emmy-award winning news and documentary producer. He got his start at CBS News, producing for such programs as *60 Minutes*, *Sunday Morning* and the *Evening News*. In 2007, Kirschner joined legendary news icon Dan Rather to help manage a cable news and documentary program where he commissioned and oversaw numerous science reports. He joined *iBiology* in 2015 and is currently leading the group’s efforts to create content for the general public. His 2017 book *What Unites Us: Reflections on Patriotism*, written with Dan Rather, was a bestseller.

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REGINA SOBEL

Editor/Co-Writer

Regina Sobel is a Brooklyn-based film editor and producer. She was the editor and co-writer of *Fail State* (Starz), a feature documentary about inequality in higher education which premiered at DOC NYC in 2017. She also served as editor and producer on *Old Dog*, a verite documentary about sheep dog training in New Zealand, and associate editor on Alex Ross Perry's *Queen of Earth* (IFC Films), starring Elisabeth Moss. Previously, she produced and directed graphics for film and TV, including PBS's *Park Avenue: Money, Power & the American Dream*, Showtime's "Years of Living Dangerously," and HBO's "Game of Thrones."

MEREDITH DESALAZAR

Producer

Meredith DeSalazar is an award-winning news producer with over 16 years experience. She started at ABC News covering the presidential election, then researching and producing for *World News Tonight*. She joined news legend Dan Rather 13 years ago producing investigative stories, often with a science focus such as: the environmental impact of stormwater runoff, the dark underworld of shark finning and the invasion of lionfish into foreign waters. She was the first television reporter to raise red flags about the danger of concussions and the NFL's efforts to sweep the issue under the rug.

SARAH GOODWIN

Producer

Sarah Goodwin is the leading science advisor on the film. She is the Executive Director of iBiology and the Wonder Collaborative, a non-profit that produces videos by the world's leading biologists. Before joining iBiology, she got her Ph.D. in Cell Biology from the University of California, San Francisco. Under her leadership, iBiology has grown in staff and scope, and has produced hundreds of videos with millions of yearly views. Sarah has worked with a wide variety of scientists on communicating their research and stories, and has ensured the science content in this film is accurate in depicting the state of knowledge and the spirit of discovery.

DEREK REICH

Cinematographer

Derek Reich is an Emmy Award winning cinematographer who has traveled to datelines around the globe to capture the images needed for visual storytelling. After getting his start covering the American West for CBS News, Derek expanded into documentary filmmaking with an emphasis on cinematically arresting narratives. He will regale you with stories of bears and dogs.

STEVE TYLER

Editor

Steve Tyler is an Emmy Award winning documentary film editor and long-time collaborator with *Human Nature* executive producers Dan Rather and Elliot Kirschner. Before taking up editing, Steve could be found on Broadway or in theaters around the country as an accomplished music director for shows like *The Producers*, *Jane Eyre* and *The Sound of Music*.

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GREG BOUSTEAD

Executive Producer

Greg Boustead is the Program Director at Science Sandbox, an initiative of the Simons Foundation that he helped launch in 2015 to inspire a deeper interest in science, especially among those who don't think of themselves as science fans. With a background in neuroscience, film, and journalism, Greg has dedicated his career to bringing sophisticated science content to general audiences, across many platforms. Other credits include executive producer of the feature-length documentary *The Most Unknown*, co-produced with VICE Media/Motherboard and released by Netflix in 2018.

DAN RATHER

Executive Producer

Dan Rather is one of the world's best-known journalists for much of the last half century. He has interviewed every president since Eisenhower and personally covered almost every important dateline of the last 60 years. Rather joined CBS News in 1962 and in 1981 assumed the position of anchor and managing editor of the CBS Evening News—a post he held for 24 years. His reporting across the network helped to turn 60 Minutes into an institution, launched 48 Hours as an innovative news magazine program, and shaped countless specials and documentaries. Upon leaving CBS, Rather returned to the in-depth reporting he always loved, creating the Emmy Award winning, Dan Rather Reports on HDNet. Now, he is president and CEO of News and Guts, an independent production company he founded that specializes in high-quality non-fiction content. He has a special interest in telling the stories of science.

FEATURED VOICES

Jennifer Doudna is a living legend. In 2012 this UC Berkeley biologist made what the NYT called “one of the most monumental discoveries in biology” when she uncovered the potential of the CRISPR CAS-9 system: a simple and precise way to edit DNA with explosive implications for every living thing around us. She has won countless prizes and was named one of *Time's* “100 Most Influential People in the World.”

David Baltimore is a giant in the scientific world. He is a Nobel Prize winner, the former president of the California Institute of Technology and has hugely influenced the nation's research and policies on cancer, HIV and recombinant DNA.

George Church is a prominent Harvard geneticist who has co-founded over a dozen biotech companies and authored over 500 papers. His work pushes the boundaries of biology and imagination with goals of age reversal and bringing back the woolly mammoth.

George Daley is the Dean of Harvard Medical School. He is both a medical doctor and an innovative leader in the research and regulation of stem cells and cancer biology.

Fyodor Urnov is a world-renowned gene editor and Scientific Director at the Innovative Genomic Institute where he oversees projects pushing the frontiers of CRISPR to treat and cure disease.

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Alta Charo is one of the world's foremost bio-ethicists. From her dual posts at the University of Wisconsin law and medical schools she keenly considers some of the most controversial scientific issues.

Emmanuelle Charpentier is recognized for her groundbreaking work (along with Jennifer Doudna) in harnessing the CRISPR CAS-9 system as a tool for genome editing. She is the Director at the Max Planck Institute for Infection Biology in Berlin, Germany.

Rodolphe Barrangou is the editor-in-chief of the CRISPR Journal and one of the first scientists to make the stunning discovery that CRISPR is an adaptive immune system. He teaches food sciences at North Carolina State University.

David Sanchez is now a high school junior and is eagerly learning about coding, graphic arts and animation. He continues his monthly apheresis treatments while keeping an eye on the new CRISPR sickle cell treatment trials.

Also Featuring:

JILL BANFIELD

UC Berkeley

HANK GREELY

Stanford University

IAN HODDER

Stanford University

STEPHEN HSU

Genomic Prediction

KELSEY MCCLELLAND

DNA Dialogue

FRANCISCO MOJICA

University of Alicante

RYAN PHELAN

Revive and Restore

MATT PORTEUS

Stanford University

ANTONIO REGALADO

MIT Technology Review

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SYNTHEGO

RNA synthesis company

ETHAN WEISS

Ruthie's father

PALMER WEISS

Ruthie's mother

RUTHIE WEISS

5th grader

LUHAN YANG

e-Genesis

FENG ZHANG

Broad Institute

HUMAN NATURE
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PRODUCTION PARTNERS

SANDBOX FILMS

Sandbox Films is a mission-driven documentary studio that champions excellence in science storytelling. We seek to tell stories that inspire viewers and reveal an authentic portrait of the actual process of science. By emphasizing the pursuit of discovery, in all its beauty and sometimes messiness, these stories humanize science in relatable ways for diverse points of view. Sandbox Films, LLC is a registered affiliate of the Simons Foundation. More info at: sandboxfilms.org

THE WONDER COLLABORATIVE

The Wonder Collaborative is dedicated to bringing together scientists and storytellers in a spirit of collaboration and experimentation to revolutionize science filmmaking. A division of the non-profit science communication organization iBiology, The Wonder Collaborative develops, produces, and shares powerful stories for the general public about the wonder, awe, and diversity of science. The film, **HUMAN NATURE**, about the genome editing revolution known as CRISPR, is their inaugural effort. More info at: <https://wondercollaborative.org/>

NEWS AND GUTS FILMS

News and Guts Films was founded by news icon Dan Rather to combine the immediacy and artistry of independent documentary film with the highest of journalistic standards to tell compelling and important stories to a global audience. A partnership with Rather's long-time collaborator Elliot Kirschner, they focus on projects that are engaging and nuanced, provocative and thoughtful. They have a particular interest in world affairs, science, history, and the arts.

HUMAN NATURE
DIRECTED BY ADAM BOLT

CREDITS

DIRECTED AND PRODUCED BY
Adam Bolt

EXECUTIVE PRODUCER
Elliot Kirschner

EXECUTIVE PRODUCERS
Dan Rather
Greg Boustead

PRODUCERS
Meredith DeSalazar
Sarah Goodwin
Elliot Kirschner

WRITTEN BY
Adam Bolt & Regina Sobel

CINEMATOGRAPHY
Derek Reich

EDITORS
Regina Sobel
Steve Tyler

ORIGINAL MUSIC
Keegan DeWitt

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IN MEMORY OF
Shakir Cannon
a tireless advocate for victims of sickle-cell disease
1983 - 2017

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Genomic Prediction
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MIT Technology Review
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17 JUIN MEDIA / "Savoir Plus Sante 0 Des Cobayes Pour Guerir" Dir. Jean-Jacque Amsallem,
June 3, 2000
A/V Geeks / "Thread of Life"
ABCNEWS VIDEOSOURCE
BFI National Archive
Bundesarchiv / "Opfer der Vergengenheit"
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Institut National de L'audiovisuel / "TF1 20H" Prod. Li, Pierre / "20 hueres le journal" Prod.
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<http://infoproc.blogspot.com/>
<https://www.youtube.com/watch?v=6Y79Kpy4IYA>
<https://www.youtube.com/watch?v=81uH5JeMRYo>
<https://www.youtube.com/watch?v=o6A9bbDI6fo>
https://www.youtube.com/watch?v=Q_zzFRjeGRI
Jurassic Park
kottke
Le Petit Journal
MIT Technology Review
Molecular Microbiology
Nature
Nature Communications
New Scientist
New Statesman
New York Times

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Star Trek: The Original Series
Synthego
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ADDITIONAL MUSIC

“Piano Concerto No. 3 in D minor, Op. 30: III. Finale: Alla breve”
Performed by Lang Lang (Conductor), Sergei Rachmaninoff (Orchestra), Alexander Scriabin
(Performer), Yuri Termirkanov, (Performer), St. Petersburg Philharmonic (Performer)

Courtesy of Telarc, a division of Concord Music
Record Company: Telarc

"Night on Bald Mountain"
Performed by Eduardo Mata (Conductor), The Dallas Symphony Orchestra (Performer)
Courtesy of Sony Music
Record Company: RCA - Sony Classical

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