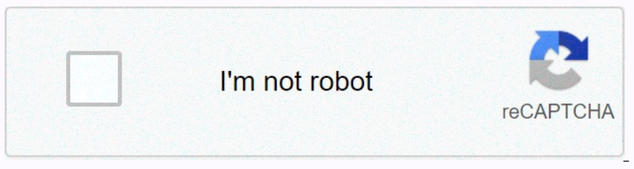

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Video worksheet secret of photo 51

On April 25, 1953, the science journal Nature reported that James Watson and Francis Crick had discovered the double-threaded structure of DNA, a molecule essential to life. But absent from most of his Nobel Prize-winning works is the contribution of a scientist - molecular biologist and crystallist Rosalind Franklin - who would never know that Watson and Crick had seen an important part of his knowledge without his permission and that it would lead them into a double spiral. Fifty years later, the secret of Photograph 51 unravels the mystery of finding a double thread and explores the remarkable role rosalind Franklin and her remarkable X-ray of in one of the greatest discoveries in the history of science. The program is based on extensive interviews with prominent participants in DNA drama survivors, including Maurice Wilkins, vice president of Franklin's lab, who casually showed his crucial photo to 51 Watson; Raymond Gosling, Franklin's PhD student, with whom he made Photo 51; and Nobel Laureate Sir Aaron Klug, Franklin's last and closest collaborator, who inherited his notebook. Klug analyzed Franklin's notebooks for NOVA to show how close Franklin came to the double-thread discovery. Also included is award-winning biographer Brenda Maddox, author of Rosalind Franklin: The Dark Lady of DNA (HarperCollins, 2002), on which the film is partly based. Born into a prominent Jewish family in London in 1920, Franklin was a mathematically gifted student who faced rigid gender barriers in his pursue of a scientific career. He received his PhD in physical chemistry at Cambridge University and became one of the world's leading X-ray crystal experts – a difficult art in studying the internal structure of molecules using X-rays. In 1951, he accepted writing at King's College London to study the structure of DNA with Wilkins. The duo did not get along and continued their work separately, with Franklin finding two different FORMS of DNA and making detailed X-rays of each type. His photograph of 51, which required 100 hours of exposure in May 1952, was exceptional. The following January, Wilkins casually showed the picture to Watson, who worked informally on Crick's DNA problem at Cavendish's lab in nearby Cambridge. My mouth fell open and my pulse began to race, Watson recalled in his famous memoir The Double Helix (Athenaum, 1968). A distinctive pattern in Figure 51 declared that the structure must be helix. In Cavendish, Watson and Crick quickly took the next step by working on a structure that matched Franklin's data and other pieces of the puzzle, including Franklin's unpublished report, which contained more critical information. The discovery won Watson and Crick the Nobel Prize in 1962, which Shared with Wilkins. Unfortunately, Franklin was ineligible because he had died in 1958, at the age of 37, from ovarian cancer; The Nobel Prize will not be awarded after death. Yet it is impossible to say whether Franklin would have been honoured if he had lived, because the second condition is that the Nobel Prize cannot be divided into more than three parts. Ironically, his role in one of the most important discoveries in the history of science was hidden even from him, because he never knew that Photo 51 achieved the ultimate insight that led to a double-twist solution. PBS Airdate: April 22, 2003 Go to partner's Web site NARRATOR: When World War II ends, scientists discover the secret of the atom, unleashing death and destruction on an unimaginable scale. Now they're competing to find the secret of life. It's the discovery of the century. It is May 1, 1952, and what these scientists gathered at the Royal Society, one does not know that at this very moment, near a London laboratory, an X-ray camera clicks on a 100-hour exposure to something called DNA. As it is developed, this photograph reveals the structure of DNA and the key to understanding how the plan for life on earth is passed down from generation to generation. The two most determined DNA detectives are Francis Crick and American James Watson. The Royal Society also has a 31-year-old British scientist named Rosalind Franklin. He's in charge of an important X-ray. As Watson, Crick and their colleague Maurice Wilkins work to solve the DNA puzzle, Franklin's work paves the way. Unbeknownst to him, they have access to his findings and his remarkable X-ray of DNA. It leads to one of science's greatest discoveries, and some believe, one of its greatest injustices. Next up is NOVA, Rosalind Franklin and the secret of Photo 51. Nova's significant funding is provided by the Parks Foundation, which is dedicated to education and quality television. We'll see 400 employees in three years. At Microsoft, your potential inspires us to create software that helps you achieve it: your potential, our passion. Science: it has given us the framework to make wireless communication clear. Sprint is proud to support NOVA. And a public broadcaster and a PBS station like you. Thank you. In 1962, the Nobel Prize is awarded to James Watson, Francis Crick and Maurice Wilkins for their pioneering work on DNA. It is one of the greatest achievements in the history of science, often described as the key to unlocking the secret of life. A few years later, James Watson publishes a personal check on the discovery. In Double Helix, this thin, best-selling book, he describes a race to determine the structure of DNA and introduces a little-known scientist named Rosalind Franklin. BRENDA MADDOX (Author, Rosalind I don't think anyone would have heard of Rosalind Franklin. I certainly wouldn't have written a book if James Watson hadn't written The Double Helix in 1968. But there's a character, a terrible Rosy, this bad-tempered, blue-jacketed guy hoarding his knowledge that wouldn't let men see it, you know, and barked at them all. They were all afraid of him, and that makes the whole story come true. Watson's casting of Franklin as a villain serves as a literary device, but who he is in his book and who he was in real life is quite different. Unfortunately, Franklin wasn't there to defend himself. He died at the age of 37, a decade before The Double Helix was published and became a bestseller. When Double Helix was in a rough draw, Harvard University Press, which was going to publish it, asked that anyone so openly mentioned be given the opportunity to read it. And they did. Wilkins and Crick opposed it first and foremost, but not only in the strongest terms. As Francis Crick wrote to Watson: Your book is misleading and in bad taste. It does not shed light on the process of scientific discovery, but distorts it. Maurice Wilkins complained that the book was unfair to almost all those mentioned except Professor Watson himself. Referring to Rosalind Franklin, he asks Watson: Does your book mention that he died? MAURICE WILKINS (King's College London): Well, that was the most important thing about opposing Jim's book... It... What did he say about Rosalind? It was just stupid nonsense about the wrong clothes or something. I thought, This is pretty crazy, not true. He was a very talented person, to say the least. Who was the real Rosalind Franklin? What is his contribution to one of science's greatest breakthroughs? Rosalind Franklin was born in London in 1920 to a family that achieved wealth through banking and publishing. They had a proud tradition of scholarship, charity and participation in social causes. Franklin's family was one of a select group of English Jews who came to England in the 18th century. They became very wealthy, a very close network, very English in their own way, more English than English. Rosalind stands out from an early age. She enjoys memory games, and aunt writes: Rosalind is alarmingly intelligent. He spends all his time on aritmetic pleasure and always gets his sums right. Her parents sent her to St. Paul's Girls' School, which, despite her name, had no church connections. It had a strong tradition of preparing girls for careers. Sue Richley and Anne Piper went to St. Paul's and were lifelong friends of Rosalind Franklin. Anne Piper (Rosalind Franklin's lifelong friend): She was the best in science, she was the best at math, and she was just one of the best Year... Best that year. He played for teams... SUE RICHLEY (Rosalind Franklin's lifelong friend): Tennis, ice hockey, lacrosse, football, cricket... Yes, he combined his mind play with a certain natural ability. SUE RICHLEY: She was always waiting for... If he did something, he'd run it. He wanted to be, he expected it to be that way. Rosalind shines academically, but the outside world penetrates. The Nazis are marching. As Jewish refugees flee the Nazi invasion, the Franklins are active in finding a safe haven in England for those who manage to escape. Rosalind wants to do something useful in her life. He finishes a year early at St. Paul's and receives a scholarship to study physics and chemistry at Cambridge University. In 1938, Rosalind arrived at Newnham College, one of cambridge university's women's universities. In his classes, he has become acquainted with a new topic of X-ray crystal. This technique can reveal the hidden atomic structure of matter crystallised. The atoms are too small under the light microscope, so crystallized graphs shoot invisible X-rays into them, which then bounce off or diffract, into an detector, such as film. By applying mathematics to the diffraction pattern, it is possible to calculate the three-dimensional shape of even the most complex molecules. During her X-ray diffraction work, Rosalind joins a small band of human race, for whom small particles of matter are as real as billiard balls. In 1939, as Franklin enters the world of science, cambridge university appoints its first female professor, and Britain prepares for german aggression. When he graduates, Franklin will have decided to participate in the war effort. His father is pushing him to continue the family's charitable tradition. He replies that he would be of little use to anything other than science. When he accuses her of making science his religion, he writes: I think all that is needed from a faith point of view is to believe that by doing our best, we will succeed in our goals: to heal humanity. Cambridge did everything Rosalind should do to a good university. It gave him a profession, a philosophy of life. It allowed him to distance himself from his parents. He became a mature, socially and politically conscious individual and was ready to be a working scientist. He joined the war effort in studying coal. His experiments led to a better gas mask, a valuable contribution to England under attack. He published five landmark magazines, which were mentioned today, and was awarded a PhD. When the war was over, his experience earned him the job offer of his dreams, a research site in one of the best laboratories in Paris. One of his closest colleagues and friends There is Vittorio Luzatti, here, in the restaurant rosalind enjoyed. VITTORIO LUZZATI (CNRS): He loved Paris, he loved life in Paris. It was quite clear. He was happy here. He took an apartment on a small street behind St. Sulpice's Church on The 6th. He used Paris fashion, Dior's New Look, for a new woman. She shopped sober without a market and enjoyed cooking for her friends. He walked to work along the Seine, walking through the shadow of Notre Dame to Laboratoire Central, at 12 Quai Henri IV. Here, in a collegiate atmosphere, Franklin refined his X-ray diffraction techniques. LYNN OSMAN ELKIN (California State University, Hayward): She just had a sense of work, experimental work. He loved it. He loved being in the lab. And many people who are very, very good scientists - and even very good experimental scientists - find it boring that they have to get through to get an answer, while he really loved the science process. Franklin gained international fame by speaking at conferences and publishing in professional magazines. A keen hiker, he made trips with his colleagues to Norway, Wales and the Alps. His research wasn't without its risks. Laboratory workers were periodically inspected for X-ray overexplets, and when Franklin exceeded safe levels, he was shocked that he had to stay away from the lab for a few weeks. After four years in Paris, he faced a decision. Should he stay in France or go home to England? She sought advice from Dorothy Hodgkin, a well-known crystal writer who was one of 10 women to win the Nobel Prize. Dorothy advised that it was time for her to decide, and if she decided to keep her scientific life in England, she should go back. He left reluctantly. He liked to leave Paris. I think the decision he had to make... I think it was cruel to some extent. Franklin is being offered a place at King's College London, a prestigious research centre. J. T. Randall, director of biophysics laboratories, hires him to create an X-ray diffraction unit to study the structure of proteins. He accepts the offer, but writes to a friend: The exchange of seines banks in the basement of the strand seems pretty crazy to me. But when he leaves Paris, he receives a letter from Randall shifting his attention from proteins to a little understood substance called DNA. Rosalind Franklin is 30 years old when she unwittingly enters the dark race to unravel the secret of life. Kimberly MOWry (Brown University): So this is DNA. It's really beautiful and amazing stuff. It's responsible for the sedation. It's genetic material. Some claim it's a plan for every cell in your body. But. When Rosalind Franklin started working on DNA, it wasn't at all clear what the DNA really looked like or how it might work. In 1943, after a decade of work, Oswald Avery and his team at Rockefeller University transferred DNA from the disease-causing strain of bacteria to the harmless strain. The harmless strain became viruleene, which strongly suggests a link between DNA and bliss. Avery's experiments showed that the genetic characteristics of one organism can be transferred to another. He showed that DNA was a tool of change, that DNA was genetic material. However, this conclusion was by no means generally accepted. Dna was thought to consist of sugar and phosphates in long chains of unknown shapes. It also appeared to contain only four other chemical ingredients, which are called basics. But how can such a simple molecule be responsible for the diversity of all life on Earth? Some believed that finding out the structure of the DNA would lead to an answer. That was Franklin's job when he arrived at King's College London in January 1951. King's Professor Raymond Gosling studied biophysics when Franklin arrived. When I came in '49, '50 was a bomb crater, the remnants of World War II. We had to walk around the bomb crater and here to the university main hall. Our physics department was at the end of the hall. There was a lab at the end where Rosalind and I were doing X-ray diffraction. Yes, now this is pretty close to what it was actually like. This is about the size of a room, and as you can see, it's right in the basement, so it gives you some kind of taste for the gut-type environment of the earth where the early work was done. Despite the war-ravaged states, King's College was a place for DNA research. Maurice Wilkins' office was just behind these doors. Maurice Wilkins, a physicist at the Manhattan Project, took the first X-ray diffraction scans of DNA. He had to improvise every step of the way to cope with the lab's outdated technology. Maurice came to see what I was doing. He thought for a moment, then took the condom out of his pocket and said, Here you are, son. Poke the hummator through it. And we did. Franklin quickly adapted to the physical limitations of the lab, but not to king's college's separate boys' club culture. He wasn't happy at King's College. And everything he told us about it was almost amazing. I mean, the fact that they shared a room, a lunch place that was forbidden to women, I mean it sounded unheard of... I. It was insane for us. It wasn't the kind of life you'd want to have anywhere, to be a forbidden place because you're a dog, a woman or a Jew. Franklin or Maurice Wilkins were in disambiguous. Wilkins was on vacation when he arrived. While he was away, his PhD student Raymond Gosling came under Franklin's supervision. When Wilkins returned, he walked into an improved lab, but it wasn't his anymore. He lost his lab and his PhD student. Rosalind Franklin, who she thought was her assistant, turned out to be better educated and already independent. When he checked his progress, he was rejected. He said, Go back with your microscopes, which made me confused. What the hell is he talking about? We had a very stressful perspective which therefore did not help the joint work of our laboratory. Wilkins and Franklin's stressful relationship came from a misunderstanding that originated with the lab director, J. T. Randall. SIR AARON KLUG (Medical Research Council Molecular Biology Laboratory: Here are copies of Rosalind Franklin's work notebooks. Sir Aaron Klug, nobel laureate and former president of the Royal Society, was Franklin's last collaborator. After his death, he examined her notebooks and letters, including Randall's notebooks and letters. In December 1950, he wrote her a letter: This means that for experimental X-rays, there is currently only you and Gosling. Wilkins didn't see that letter. And the fact that Wilkins was not present when Franklin arrived at King's College in January 1951 later led to a much dissenting one. He thought he was an independent investigator, and Maurice thought he was his assistant. It was a misunderstanding. And the responsibility for that misunderstanding is in Randall's hands. Perhaps Maurice Wilkins could live in such an ambigible situation more easily than Rosalind. He didn't like such an ambiguous situation. The situation escalated from a basic personality collision. Franklin – articulated, passionate and always a good debate – and Wilkins – softly spoken, thoughtful and shy – just couldn't get along. He was a pretty tough person: determined, spoke what he believed and could actually be quite fierce. If he had been a man, it would have gone unmarked. Another obstacle was social class and private life completely separate from the laboratory. He had a full social life. I know she was dating the first violin of the London Philharmonic. Now that. An incision above finch beer drinking like ours. And so... He had his own apartment, he didn't live in excavations. He didn't suffer fools gladly, he was very intelligent and desperate to get ahead in this job. He was so convinced it was there like a ripe plum that had to be picked from a tree. Despite all the voltages in the lab, Franklin applied himself to the mission with determination and aimed to solve the structure of the DNA. But now a new player was entering the game. When Rosalind was setting up his new laboratory at King's College London, James Watson - much younger, 23 years old, but with a PhD - had come to Europe because he wanted to study the gene, and he was convinced that the gene was a thing to study. This was supposed to be the secret of life. Watson goes to a conference in Naples, where Wilkins shows one of his early, fluffy diffraction images of DNA. Watson's trying to meet Wilkins and wrestle the invitation to work at King's College. JAMES WATSON (Race for the Double Helix, BBC, 1974): I tried to talk to him, but Maurice... After that, you know? His English... He doesn't talk much to strangers. I left and felt it would be nice to work with Maurice. But it wasn't obvious that it came together like minds. Wilkins won't take the bait. But soon after, Watson is invited to Cavendish, the famous research laboratory at the University of Cambridge, run by Nobel Prize winner Sir Lawrence Bragg. There, Watson is assigned an office with another physicist, crystallographer, Francis Crick, an old friend of Wilkins'. Crick and Watson click right away. But an hour away at King's College, the negative atmosphere is getting a new turn for the worse. Rosalind Franklin is given a sarcastical nickname, which Watson later popularized in The Double Helix: Rosy. He walked around the lab waving his bag and sometimes did a little bit of that. He provoked something like this. Poor Rosy, what a joke, a stupid joke. A lot of people called her Rosy behind her back, but no one called her Rosy in her face. Despite the hostile environment, within months of his arrival at King's, Franklin is producing incredible results. VITTORIO LUZZATI: Rosalind did the most professional work. He had a good camera because he developed a good camera. He got great pictures. Within months, Franklin changed king's research, but most of all, he discovered there were two DNA. Franklin's observation that there are two forms of DNA is perhaps the most important step towards the final discovery of its structure. Before Rosalind Franklin noticed it. were two distinct forms of DNA – A and B forms – people probably looked for mixtures of these two forms. It would be like having a picture of Mickey Mouse on top of a picture of Donald Duck. It would be almost impossible to understand what Mickey Mouse or The Duck looked like. A is a drier, crystallised form of DNA and produces more detailed images. B is wetter and how DNA is found in living cells. It produces a simpler image, but reveals a key clue to solving the structure of DNA. The X shape in the middle is called a diffraction signature of helix. Franklin's meaning hasn't disappeared. He notes it in scientific shorthand and presents his findings, according to Klubeg. In November 1951, Franklin gave colloquialism about his work and described forms A and B. He focused mainly on form A. And Form A, he says, is probably more threadbare than B.B he thought was undoubtedly complete. It was quite clear. But he focused on form A because more information was available about it. That was his analytical approach. In the audience that day is James Watson, who Crick sent to gather information about Franklin's work. Crick and Watson plan to use a different approach to solving the structure of DNA: modeling. Within a week, Watson and Crick will invite researchers from King's College to look at their model. Rosalind was really amused. And he didn't take any prisoners anyway, so he criticized the model quite sharply and explained in detail why it couldn't have been right: one, two, three. And then we left. The DNA model watson and Crick advertised is an embarrassing failure. As Watson himself said, he did not know enough about the crystalography to understand the importance of his information. She missed it completely, and she found herself really focused on her looks. Why was he so clear? Why didn't she wear lipstick? She could have been beautiful if she had taken off her glasses and done something interesting to her hair. Lawrence Bragg, president of Cavendish Lab, has been humiliated and denies Watson and Crick continue to model. It was a happy moment for Rosalind and me because it justified her interpretation that you could build models, but you couldn't prove what was right. And here they were, model builders, tough on it, and they had produced a completely wrong model. For Franklin, the case strengthens his training: that data experimentation and patient analysis reveal the answer. Franklin may not be unaware that his unpublished findings will continue their journey to Watson and Crick. And they will. Through Maurice Wilkins, vice president of his own lab. Gradually, Wilkins felt out of his own subject. That's how he started going to Cambridge to talk to an old friend - and he was an old friend - to Francis Crick about the DNA he was still interested in and this terrible Rosy hoarding his knowledge. Wilkins was a conduit. A lot of information from Rosalind and King moved to Cambridge, so although Watson and Crick didn't officially work on the DNA, they speculated. But as Crick and Watson speculate, Franklin continues to analyze and collect new data. In May 1952, he would set up an X-ray diffractometer to take a picture of the moist form of DNA, B. Today, X-ray diffraction technology, which has been greatly improved, is still used to study the molecular structure. Joanne YEH (Brown University): This glass capillary has DNA fiber, similar to what Rosalind Franklin worked on. And it's so small, it's hard to see with the naked eye. Rosalind Franklin had to bundle 20 fibers together to get X-ray diffraction shots. Scientists use DNA crystals that give better results than these microscopic fibers. Of them, 20 are the thickness of human hair. X-rays today are at least 300 times stronger than under Franklin. Now the computer interprets the image and quickly calculates the 3D model. But under Franklin, analyzing diffraction patterns can require thousands of handmade calculations, and it can take more than a year to decipher a single image. For Rosalind Franklin to go through the calculation, she had to have perseverance, motivation and real desire and do all the necessary calculations by hand. In May 1952, Franklin's perseverance and techniques produced the sharpest picture of DNA's B-shape. He marks it as Photo 51 and puts it aside as he continues his work on Form A. But facing the sturgeons, Franklin gets another nickname: The Dark Woman. He's so unhappy at King's, he's arranging a vacation. He agrees to finish analyzing his data, write down his findings and stay until the end of the year. I was very sorry that he had to leave, but of course I appreciated that there was no choice that the Crown Prince and the Dark Lady would never come together. He wasn't going to leave, so it was clear rosalind was going to leave. In the midst of this transition, someone gives Picture 51 to Wilkins. I can't remember how she got this beautiful picture. Rosalind may have given it to him, or it might have. At the same time as Cavendish, a new researcher moves to the lab with Watson and Crick: Peter Pauling, son of a well-known chemistry guru from Caltech, Linus Pauling. Just a year ago, Pauling had pioneered the same modelling technology that Watson and Crick adopted. With little experimental information, Pauling had invented a structure for long proteins, a single-strand helix. Now Pauling sends his son a piece of paper suggesting the structure of his DNA. Of course we were shocked. The question is, could he be right? We knew Linus didn't have a good X-ray. Could he have thought of that without the king's knowledge? The answer was no. Pauling makes the same mistakes as Watson and Crick in his first model. Pauling's mistake will be discovered as soon as he publishes. Watson knows that if Pauling has access to Rosalind Franklin's data, he can quickly come up with the right model. The competition begins in earnest. Watson estimates he and Crick have six weeks to solve the problem. When Franklin performs his last show at King's College, Jim Watson shows up in his office. He's trying to show Pauling's paper, perhaps to convince him that Pauling will beat them to solve the structure of his DNA if he doesn't combine his knowledge with him and Crick. According to Watson's account, he's incompetent in the interpretation of X-rays. He started moving towards me, and he was afraid that in his anger he would hit me, I pulled out. Which is, in fact, absurd; He was almost half his size. Watson reports a run-in with Maurice Wilkins. Wilkins shows Watson's photograph at the 51st. Maurice WILKINS: And when he saw this, suddenly... I was surprised. I said oh! This. I thought this had been done in the last couple of days. But I realized it had been lying there for several months. My mouth fell open and my pulse started to race, Watson says in The Double Helix. A clear X-pattern, helix's signature, ignites his excitement. But there's more. Sir Aaron KLUG: From this image alone, you can tell how many units per turn, per threadbare translation, that were in helix. The number of lines in the image indicates that each helix thread has 10 units, or molecular structure part. And the dimensions of the image correspond to 34 angstrom helix per turn. Wilkins will give this important information to Watson. So they get basic parameters for building a threaded spine. On the train back to Cambridge, Watson sketches a picture for his 51 newspapers and reports to Crick. Based on Franklin's information Watson went to Lawrence Bragg, director of cavendish's lab, and he gave them permission to build a model. They start on 4 February 1953. Then they have another idea. They knew that data from King's biophysics unit, including Rosalind's work, was published in a report by the Medical Research Council. In the MRC report, Franklin places DNA in a molecular class with certain types of symmetry, as illustrated by these simple drawings in his notebook. The consequences of symmetry would be clear to an expert like Francis Crick. The MRC report includes Franklin's details: the symmetry of Form A, all crystal parameters, but above all symmetry. This symmetry tells Crick that two chains ran in opposite directions. Two threads, each with blinds and phosphates running in different directions: anti-parallel double helix. But where do the bases go? Outside, as Watson and Crick described in their first model, or inside, as Franklin had told them? That's two important leads. A few years earlier, the British scientist William Astbury theorized that four nests – adenin, thymine, guanin and cytocin – are stacked like pennies. At Columbia University, Erwin Chargaff discovered that DNA always contains as much adenin and tumin, as well as an equal amount of guanin and cytocin. At first Watson thought the bases had to be paired like: A with an A with an A, a G with a G and so on. But officemate Jerry Donohue shows him using the wrong chemical forms. In the right form, Watson then makes a giant leap. He notices that the helix franklin measures can fit the bottoms if he combines A and T and C. Arranged in this way, the soles form the trunks in a twisting ladder inside the double thread. Rosalind Franklin's experimental framework, a collection of evidence accumulated over two years, guides Watson and Crick to solve the structure of dna. And in another eureka moment, the structure rewards them with an instant ointation about how DNA replicates. Removing Helix produces two models for creating two new helics, each identical to the original. DNA isn't just a molecule, it's a bluework of life. In one of science's best-known understatements, Watson and Crick write: It has not gone unnoticed that a special pairing that we have assumed immediately suggests a possible copying mechanism for genetic material. The day was Saturday 28 February 1953. That day they went to the pub, Eagle and Crick told everyone: We have discovered the secret of life. Now that they've discovered the secret of life, they have another problem to solve. How do they prove it? Once again, they do. He's going to Cambridge to check on the model. Watson writes in his book that his immediate acceptance of the model amazed me... But he immediately realized that the model was the right one. Maybe he didn't know how much of his knowledge they'd known to build the model. Rosalind's part in the great discovery was obscured by the movements made behind her back. The thing is, Watson and Crick wanted to release quickly to get ahead of Linus Pauling in California. But they were held back by the embarrassing fact that all the experimental work that had led to their great leaps of imagination had been done at a rival institution, King's. Rosalind's information had not been released. According to Brenda Maddox, Bragg from Cavendish and Randall King's is approaching Nature's suppliers to find a solution. They agree to publish three articles in one issue: Watson and Crick's article first, Wilkins and his collaborators next, and the last is franklin and Gosling's article. Its location at the end suggests that Franklin's findings only confirm Watson and Crick's model rather than providing the essential information used in its design. Sir John MADDOX (former editor-in-chief, Nature): Crick and Watson's paper does not say which particular freaks they were indebted to Franklin for their work. Sir John Maddox, the later editor of Nature for two decades, shows how Watson and Crick covered Franklin's contribution with a single guarded phrase. Sir John MADDOX: They say: We have been stimulated by public knowledge of his work. But in fact, they had specific knowledge of his work. As editor, I would have smelled a rat. Franklin had written his own article a month before he saw the model. A sentence has been handwritten in the original text: This is how our general ideas are consistent with the model proposed by Crick and Watson. Indeed, his ideas were consistent with their model because they were largely based on his ideas. What did Watson and Crick have without Rosalind Franklin's file? The answer is almost nothing. They were willing to figure it out, their work was brilliant, but they couldn't do it without Rosalind Franklin's knowledge. Rosalind Franklin can be said to be an unidentified and unidentified collaborator of Watson and Crick. When the articles appeared in Nature on April 25, 1953, Franklin had taken up his new position at Birkbeck College in London. Under a leaky skylight in his 5th floor office, he often left an umbrella on his desk to protect his papers. He ran a viral research laboratory from 1953 on 1958 and thrived in birkbeck's collegiate atmosphere, just like his beloved Laboratoire in Paris. This is where he made what he called his greatest discovery. the structure of the virus and its locating of infectious elementes. He collaborated with Aaron Klug, who later won the Nobel Prize. SIR AARON KLUG: He cleared the exact geometry so that... It was important in history that things like this could actually be done. The thing about Rosalind was that she was determined and able to solve these big and difficult problems. Franklin's viral work ensured his international reputation and brought many invitations to speak in the United States. In 1956, he celebrated his 36th birthday when he visited universities in California and climbed Mount Whitney, one of the highest peaks in North America. But at the end of the trip, Franklin suffered from avenging stomach pains. When he returned to England, he was diagnosed with cancer. There has been speculation that his work with X-rays may have triggered the disease. He handled it nicely. He was in Marsden, a cancer hospital, and there he was in a private, very one room at the end of the hall with his work papers and calculations. Donald CASPER (Florida State University): He remained optimistic and confident that things would get better. American colleague Don Caspar recalls his struggle to climb from the basement lab to his upstairs fifth-floor office. To the end, he was still working. We were hoping to help him, but unfortunately there was nothing we could do. After six months of terrible illness, painful treatment, he asked his doctor for a direct prognosis, and he told her to seek the comforts of religion. He was furious. He wasn't religious. He had a full agenda. He had an invitation to a scholarship to Caracas. He was too busy to die. Rosalind and I were going to attend a meeting in Leeds, and she suggested we could drive and visit some of Norman's cathedrals. When I arrived in London, I called him because I expected to stay with him. And there was no answer. After trying to get him on the phone, I called Aaron Klug, who I knew pretty well, and he told me he was in the hospital. Until the last day, he hoped to go to the countryside with a friend. He died when we were in Leeds. His obituary reads : Scientist: his research and findings on viruses continue to benefit mankind. He died on The 16th. On the same day, there was an article at the London Times praising his viral model, which was unveiled at the World Fair in Brussels. His obituary in the New York Times called him one of the selected pioneering bands to investigate viral diseases and genetics... He went to the grave not knowing how much Watson and Crick had relied on their work to make their great discovery. Or if he

knew, he didn't care. In 1962, James Francis Crick and Maurice Wilkins won the Nobel Prize for finding the structure of DNA. Franklin's name is not mentioned, except for Wilkins' passing reference. His important contribution to their work becomes a footnote in scientific history. Rosalind would probably have been forgotten - not by her friends, we would not have forgotten Rosalind, but generally by the audience. If we're talking about Rosalind, it's because jim watson hurt her memory. In 1968, James Watson published Double Helix, his personal account of the discovery of the structure of DNA. In his book, Watson makes Franklin uncooperative, rude and incompetent in his interpretation of X-rays. Yet Watson admits he needs his discovery. He even boasts of using his work without his knowledge or permission, saying: Rosy, of course, did not give us his information directly. No one at King's realized they were in our hands. When the book was in a rough draft, Harvard University Press asked those mentioned in the script to read it. Many, including Crick and Wilkins, objected so strongly that Harvard withdrew its bid to publish in a highly unprecedented move. The book came out with the popular press and became an instant bestseller. But most of the main portraits were edited, except for Rosalind, who was dead. And every writer knows you can't snan the dead. Franklin's family and colleagues protested Watson's description of that talented girl who couldn't defend herself. Watson's duty. And he wrote a pious epilogue in which, as a young man, he said that he had not understood the difficulties that women had to be accepted and accepted in science, and the epilogue exists, but it does not change or soften the character of this terrible Rose. Watson declined NOVA's request for an interview. Franklin now receives some recognition: the plaques she lived and worked in, and recently the Royal Society of Britain created the Rosalind Franklin Prize to support women in science. When Sir Aaron Klug won his Nobel Prize, partly for his work with Franklin, he, unlike the DNA trio, respected his contribution. As I said in my Nobel lecture, he made quite an impression on me, pointing his way to solving important, difficult problems, no matter how long they may be. Rosalind died at the age of 37. He died proudly of his world tastes in coal and viral research. He was tricked into the only thing he really wanted, which was the chance to finish his work. My view? His lost reward was life. Those who admire Franklin take comfort in his uncompromising devotion. It's a pleasure for Rosalind Franklin. science itself was at work and its ultimate reward, the better of mankind. On NOVA's website, find out why Photo 51 by Rosalind Franklin contains so many clues about the structure of DNA, at PBS.org or America Online, Keyword PBS. The Secret of Photo 51 video and book Rosalind Franklin, the dark woman of DNA, are available on WGBH Boston Video. To place an order, call 1-800-255-9424. NOVA is a production of WGBH Boston. Nova's significant funding is provided by the Parks Foundation, which is dedicated to education and quality television. Science: it has given us the framework to make wireless communication clear. Sprint is proud to support NOVA. We see an explorer. At Microsoft, your potential inspires us to create software that helps you achieve it: your potential, our passion. And a public broadcaster and a PBS station like you. Thank you. The secret to Photograph 51 by Sigourney Weaver, Produced and directed by Gary Glassman Edited by Gary Glassman Associate Producer Caroline Toth Music Ed Tomney Consultant Brenda Maddox Additional Editing and Production Daniel McCabe Camera Dominic DeSantis Ned Burgess Mark Daniels Michael Chin Sound Recordings Xavier Griette André Rigaut Steve Bores Gabriel Monts Animation John Biafore Assistant Editor Mark Gottlieb Online Editor and Colorist Mike Dawson Audio Mix John Jenkins Sound Design and Editing Heart Studios Punch Production Assistance Jim Atkins Jennifer Callahan Elizabeth Nicole Player Camille Meyer RECREATION Crew Nancy King, Production Manager Marilyn Salvatore, Costume Designer Tom Walden, production designer Anne Mulhall, casting, LDI Casting Nicky Pleau, hair and makeup red herring, lighting equipment David Rotondo, model builder principals Leah Serinsky rosalind Franklin Sophie Tezenas as Rosalind Franklin Manya Branham Glassman as young Rosalind Franklin Daniel Kirby as James Watson Christopher Wall as Francis Crick Patrick Dougherty as Maurice Wilkins Ryan Culligan Norton Lawrence Bragg as Walter Cotter as JT Randall Special , which made it possible to refresh the archive material Ava Helen and Linus Pauling Papers, Oregon State University Library American Society for Microbiology Archive BBC Worldwide CELLS alive! 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