
Women who changed
the history of
medicine
#CONTAGIOUSSTORIES
IBSA FOUNDATION
for scientific research

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Nominees of the Nobel Prizes in Chemistry, Physiology or Medicine & Physics (1901–1966)

Excludes 164 unknown nominees

98.2% Male
(13657 Nominees)

1.8% female
(252 Nominees)

COUNTRIES WITH THE MOST NOMINEES
% (NUMBER)

USA

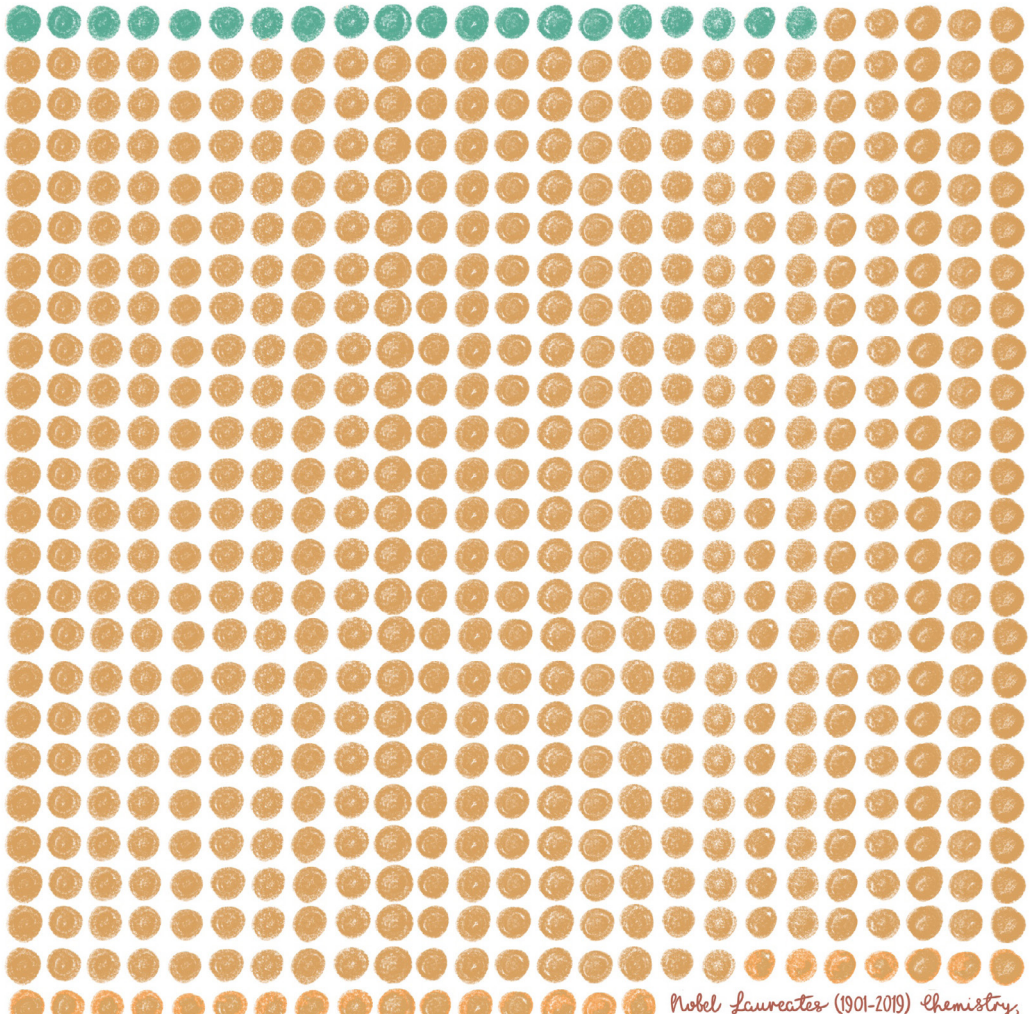
27.6% (3835)

Germany

20.5% (2849)

France

14.0% (1954)


Nobel Laureates (1901-2019) Chemistry, Physiology or Medicine & Physics

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Novel therapy (artemisinin) against malaria

Introduction

It is a fact: women are under-represented among **Nobel Prize** winners. Between 1901 and 2019 out of 923 prize winners

- only 54 women have won this prize
- 20 of which in the **field of science** (physics, chemistry and medicine)
- and among these, **only 12 have been awarded the Nobel Prize in Medicine**
- 2 of whom were awarded the prize as spouses

The reason for this has been **unequal** access to education, technology and leadership positions, which has precluded many brilliant female minds from careers in science and blocked their progress.

The lack of prizes and acknowledgement is a reflection of the inequality that women too often experience throughout their **careers**. The gender gap in science, technology and innovations leads to wasted talent and unexploited discoveries. And without visible and recognized female scientists, who set an example and act as role models, **young female scientists and researchers** can be discouraged from dedicating their lives to scientific research.

The goal of this publication is to draw attention to the women who have contributed to the future of medicine and who are still guiding new gener-

ations of young women by encouraging empowerment and gender mainstreaming. **Each of them has made a fundamental contribution to research.** Let's just think about the discovery of artemisinin, the anti-malarial drug developed by the Chinese immunologist **Tu Youyou** (2015 Nobel Prize), or the research into cellular ageing, which led **Elizabeth H. Blackburn** and **Carol W. Greider** (2009 Nobel Prize) to understand how telomeres protect chromosomes from the deterioration of genetic matter.

Each of their stories is different. Yet, they have several traits in common.

- **audacity** they are not afraid to go down roads never travelled before by their colleagues
- **brilliance** they see unexpected connections between phenomena that seem very different
- **curiosity** they are interested in seemingly "minor" aspects and create new avenues of research
- **energy** they work enthusiastically and tirelessly, which makes them unstoppable
- **generosity** they know how to work as a team and share their discoveries with their colleagues
- **passion** they dream about changing the world and reducing people's suffering
- **resilience** they never give up when faced with the difficulties and obstacles they find along their path

- **tenacity** as young scientists they study a specific area, which they take forward for the rest of their lives

"Their work has changed the way that we look at medicine and their stories deserve to be **known, acknowledged** and **told.**"

Images and drawings have been created by the young and talented Nina Chhita, artist name @nina.draws.scientists.*

***Nina Chhita** is the artist and illustrator of the Instagram account @nina.draws.scientists, which focuses on contemporary and historical trailblazing scientists, who happen to be women. She initially started the account as a way to discover historical figures, and as a scientist herself, naturally gravitated towards scientists. Articles have since been written about Nina in the BBC news and Mental Floss. Her illustrations have appeared on the social media sites of the University of Oxford, the University of Bath, Dementias Platform UK, and in a YouTube video by Vanessa Hill. She lives in Vancouver where she works as a medical writer creating educational content for healthcare professionals.


Gerty
Cori
(1896–1957)

Gerty, the first female winner of the Nobel Prize in Medicine

Gerty Theresa Radnitz Cori was **the first woman to win the Nobel Prize in Medicine in 1947.**

The prize, shared with her husband Carl Cori and Argentine physiologist Bernardo Houssay, was awarded for the discovery of the **metabolic process responsible for the conversion of lactic acid into glucose**, known today as the **Cori cycle**.

Gerty's story

After being awarded a PhD from the German University of Prague's Medical School in 1920, Gerty Radniz married her classmate Carl Cori. The couple emigrated almost immediately to the United States and in 1928 she became a US citizen.

The couple formed a very smooth-working team, where there was no place for competition, also because they had very different skills, which complemented each other perfectly.

As William Daughaday of the Washington School of Medicine said, "Carl was the visionary. Gerty was the lab genius".

In more than forty years of working together, Gerty and Carl co-authored **dozens of studies**. And yet, due to the fact that she was a woman, Gerty spent most of her career in her husband's shadow, encountering hostility from the academic world. In her first job at the State Institute for the Study of Malignant

Diseases in Buffalo, New York state, the director of the institute threatened to fire Gerty unless she stopped working with her husband, accusing her of standing in the way of Carl's career and of not respecting American values with her behavior.

In 1931 Gerty and Carl moved to Washington University in Saint Louis. Carl immediately was appointed head of the biochemistry department, whereas Gerty was employed as a research assistant, with a much lower salary than her husband's. Gerty had to wait until 1947 (the year she won the Nobel Prize) to obtain the same status as Carl.

The day that they were both awarded the Nobel Prize, Carl Cori declared,

"That the award should have included my wife as well has been a source of deep satisfaction to me. Our collaboration began 30 years ago when we were still medical students at the University of Prague and has continued ever since. Our efforts have been largely complementary, and one without the other would not have gone as far as in combination".

Her personality

Gerty was always an educated, reserved woman with a **strong and determined character**. She always expected the best from others and from herself. Her emotional involvement and her dedication made her very demanding, both in her private life and during her career.

"I believe that the love for and dedication to my work seems to me to be the basis for happiness. As a research worker, the unforgotten moments of my life are those rare ones which come after years of plodding work, when the veil over nature's

secret seems suddenly to lift, and when what was dark and chaotic appears in a clear and beautiful light and pattern".

Shortly before receiving the Noel Prize, Gerty discovered that she had myelosclerosis, a rare bone marrow disease. Although seriously ill, she continued her research without ever stopping, spending entire days in the lab. The only luxury that she allowed herself was a little camp bed, which she rested on when she was exhausted. She died in 1957 at the age of 61, after a ten-year fight against the disease.

Her research

In their research, Gerty and Cori were interested in **how the body uses energy.**

In 1929 they described an important metabolism pathway for the first time, explaining how lactic acid is formed when we use our muscles and is then converted into glycogen in the liver.

In 1938-39, Gerty and Carl showed that glycogen is broken down in muscle tissue in the form of lactic acid and is then synthesized back into the body and stored as a source of energy. This mechanism, which is key to understanding of how our body works, today is known as the **Cori cycle**.

Although Carl and Gerty Cori are known for this discovery in particular, they also made many other contributions to scientific research. They were **pioneers** in the study of **enzymatic and hormonal activity**, and their work led to a better understanding of **diabetes**. When little was still known about **enzymes**, Gerty and Carl were the first to identify and isolate them. In addition, Gerty started the study of **hereditary diseases** caused by enzymatic defects.

The precision and accuracy of her measurements became the **hallmark** of Gerty's work.

As her biographer, Joseph Larner, wrote, "Gerty was undoubtedly primarily responsible for the development of the quantitative analytical methodology".

Glucose
2 Pyruvate
2 Pyruvate
2 Lactate

Rosalyn Yalow

(1921–2011)

Rosalyn, the mother of endocrinology

Rosalyn Sussman Yalow was the **sixth woman** in the world to win the Nobel Prize in Science and the **second woman** to win the Nobel Prize in Medicine, after Gerty Cori.

In 1977 she was a joint recipient of the Nobel Prize for Medicine together with Roger Guillemin and Andrew Schally. Rosalyn was awarded the prize for her discovery and development of the **radioimmunoassay** of protein hormones. An investigative tool that has enabled significant progress to be made in the fields of biology and experimental medicine and is still a diagnostic technique widely used in **clinical medicine**.

Rosalyn's story

"I was excited about achieving a career in physics. My family, being more practical, thought the most desirable position for me would be as an elementary school teacher."

Rosalyn was born in New York in 1921. Her father was a wholesaler of packaging materials and her mother a housewife. Neither of them had finished high-school, but did everything to ensure that their daughter had the opportunity to study.

At the end of the 1930s, when she was at college, Rosalyn became fascinated with physics, and in particular, **nuclear physics**. In January 1939, Rosalyn attended a lecture at Columbia University by Enrico Fermi, who was holding a conference on nuclear fission: a discovery that in the space of just a few years not only led to the terror of nuclear warfare, but also to the ready availability of radioisotopes for medical investigation and many other peaceful applications.

When she was admitted to the Physics Department of the University of Illinois in 1940, Rosalyn discovered that she was the **only woman** among its 400 members: the Dean of the Faculty congratulated her on her achievement and told her she was the **first woman** to go there since 1917.

In January 1950 Rosalyn decided to leave teaching and to work full-time at the Bronx VA Hospital in New York, where, for more than twenty years, she managed the **radioisotope research** laboratory together with physician Solomon Berson. Those who saw them work together were struck by the incredible professional alchemy between them, which bordered on telepathy: it often was the case that one of the two 'would finish the sentence the other had started'.

Their collaboration led to outstanding scientific results: for the first time, Rosalyn Yalow and Solomon Berson developed RIA - **Radio Immuno Assay** - a diagnostic technique that is still used all over the world today.

In 1977 their **discovery** was awarded the **Nobel Prize for Medicine** and Rosalyn's great regret was that she was not able to share it with her colleague, who died suddenly of a heart attack on 11 April 1972. Shortly afterwards, the laboratory in which the two scientists had worked for many years was named, at her request, in memory of Doctor Berson.

Even after receiving the Nobel Prize, Rosalyn continued at full capacity with her research, which led to the award of other prestigious acknowledgements: in 1988 she received the **National Medal of Science**, the highest honour reserved for US citizens who have made important contributions to science and technology.

She died in New York in 2011.

Her personality

As a woman, Rosalyn had to overcome many obstacles before being able to devote her life full-time to scientific research. However, being - in her own words - **stubborn** and **single-minded** since childhood, she did not give up and continued along the path she had chosen without a second thought.

Married to her colleague Aaron Yalow and a mother to two children, even after achieving success in her career, Rosalyn never stopped **fighting against female discrimination**. She strived for women to always be guaranteed **equal opportunities in accessing education** and was known to encourage **young female students** to pursue **scientific careers**.

When she was awarded the Nobel Prize, she said:

"We cannot expect in the immediate future that all women who seek it will achieve full equality of opportunity. But if women are to start moving towards that goal, we must believe in ourselves or no one else will believe in us; we must match our aspirations with the competence, courage and determination to succeed; and we must feel a personal responsibility to ease the path for those who come afterwards."

Her research

Her first investigations together with Doctor Solomon Berson concentrated on the application of **radioisotopes** in **blood volume** determination, clinical diagnosis of thyroid diseases and the kinetics of iodine metabolism. Rosalyn and Solomon extended these techniques to studies of the distribution of **globin** and **hormones**.

At that time insulin was the hormone most readily available in a highly purified form, and the two researchers developed a **tool** with the potential for **measuring circulating insulin**.

After several years' work, they managed to transform the concept into the reality of its practical application to the **measurement of plasmatic insulin in humans**. The year 1959 thus marked the beginning of the era of **radioimmunoassay** (RIA), used from then on to measure hundreds of substances of biologic interest in thousands of laboratories all over the world.

Despite its huge commercial potential, Rosalyn and Solomon chose not to patent the technique, so that it could also be available in poorer countries.

During her extraordinary scientific career, Rosalyn became a **mentor** and **reference point** for scientists from around the world, who came to share her **passion** for **investigative endocrinology research**.

This is why she has been called the **mother of endocrinology**.

Barbara McClintock

(1902–1992)

Barbara, the founder of cellular genetics

Barbara McClintock was the **third woman** to win the Noble Prize for Medicine, after Gerty Cori and Rosayln Yalow, and the **only female** ever to have received this prestigious award by herself, **without sharing it**.

Barbara was awarded the Prize in 1983 for her discovery of **transposons**, the **genetic elements** capable of changing position within the genome (the genetic heritage that characterizes all living organisms). Her brilliant and revolutionary intuition dates back to the 1950s and was opposed for a long time by a large part of the scientific community.

Barbara's story

"My life has been well-lived, because I was able to dedicate myself to what I liked doing most".

Barbara was born in Hartford, Connecticut, in 1902. Her father was a doctor and her mother was an artist (pianist and painter).

Barbara became fascinated by **genetics** at high-school. At that time **women were banned** from studying genetics at University and Barbara had to enrol to study botany. She then specialized in cytology, taking genetics as an **additional subject**. Several of her works on the chromosomes of corn plants were already published by the prestigious journal 'Science' at the beginning of the 1930s.

In 1944 Barbara became a member of the **US National Academy of Science** and the following year was the **first woman** to be elected president of the **Genetics Society**

of America. Despite all of this, in 1951 many of her colleagues criticised the results that she presented at a scientific symposium: Barbara announced that she had identified several genes that, depending on where they moved within a chromosome, made the different kernels of the same ears of corn take on different colors.

Her conclusions - that the **genome** is not static in structure and **is subject to changes and alterations** - paved the way to **modern cellular genetics**, but what she discovered was too original and revolutionary for the scientific vision of the time, which saw genes as a static entity within chromosomes that were incapable of moving.

"That woman is either crazy or a genius" said Joshua Lederberg of her (Nobel Prize for Medicine in 1958).

It was only much later that Barbara's achievements were acknowledged. And thus she received the **National Medal of Science** in 1970, the **Horwitz Prize** and the Wolf Prize in 1981 and finally the **Nobel Prize for Medicine** in 1983.

She died in New York in 1992.

Her personality

Already during her college years Barbara was decidedly **non-conformist**: she wore trousers, had short hair and played the banjo in a music group that performed in various clubs.

Her talent for science also became immediately evident: from the very beginning she demonstrated a particular acuity in her observations under the microscope, and she was quick to acquire a **great mastery** of **cytogenetic analysis** (the study of chromosomes within cells).

"The important thing is to develop the ability to see that one seed is different from the others, and to understand why and what this difference consists of. […] One must have the time to look and the patience to listen to what the material has to say to you".

Barbara stood out also because **she did not follow the classic logical and sequential thinking** that was typical of science. She united an extraordinary ability to observe and understand nature with a work method based on a global vision and an **intuitive approach**.

A free and independent spirit, Barbara chose to not marry so that she could dedicate her life entirely to scientific research. She appeared to be exuberant and extrovert, but in fact she was rather shy and reserved. She was always aware of the importance of her work and of being a **role model** for many other **women** that had decided to follow a scientific career.

Her research

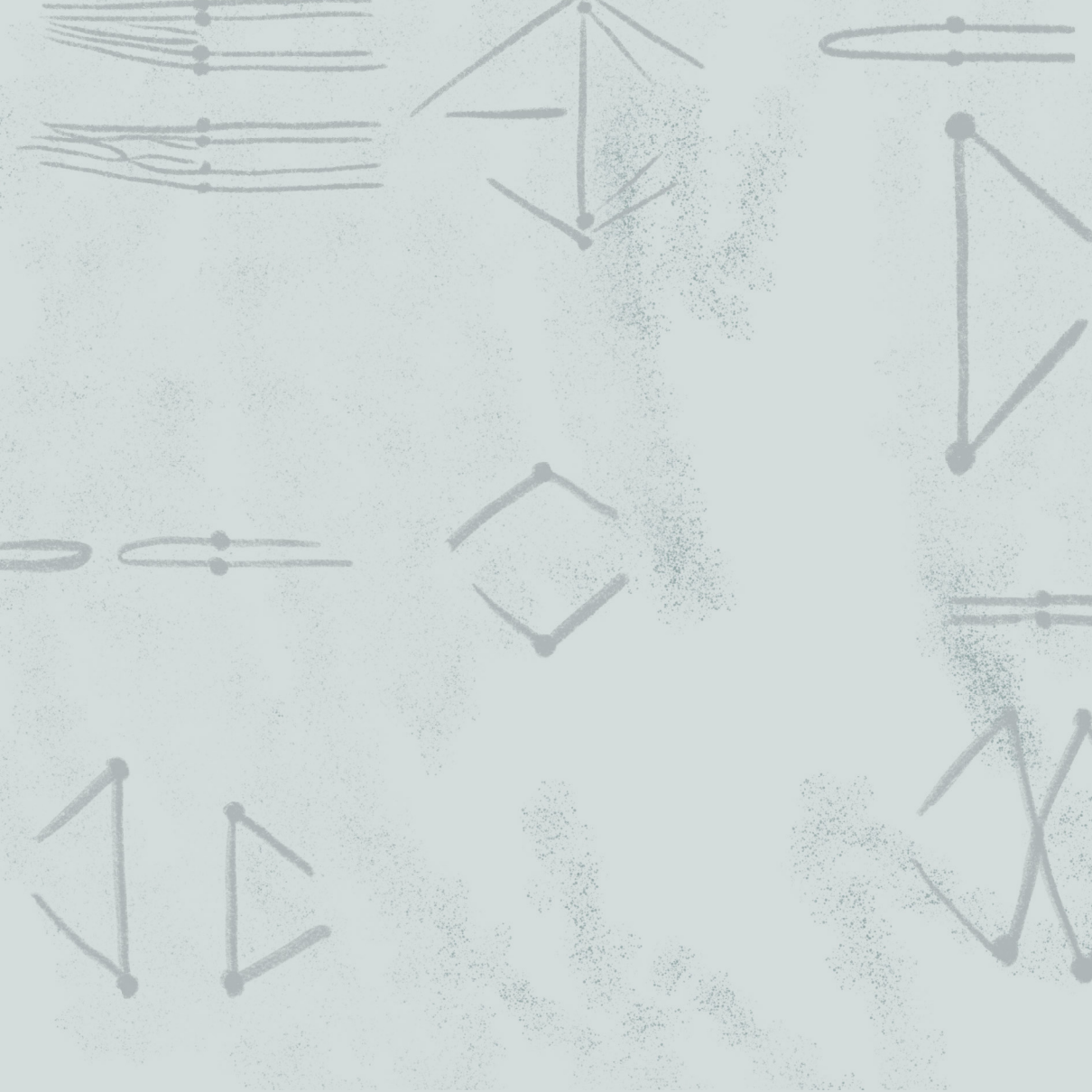
Her most important discovery was the so-called **genetic transposition**. Barbara asserted that **genetic elements** could **transfer from one chromosome to another** in an apparently coordinated manner and that the **genetic code** of an organism was **flexible**, as it was constantly stimulated by its surrounding environment.

This vision did not perceive a predetermined path in the growth of a living being, but rather hypothesized the existence of a **dynamic system**, regulated by the entire cell.

On the basis of these considerations Barbara discovered the **existence of transposons**, genes that **control** the activity of other genes, capable of changing properties by **jumping** within a chromosome or among different ones.

Barbara's work was ignored for decades by the scientific community, but the study of these genetic elements turned out to be **fundamental** in the medical field.

In many later studies the role played by transposons also in the transformation of healthy cells into cancer cells and in the transmission of bacterial resistance to antibiotics was acknowledged, opening important new avenues of research.



Rita Levi-Montalcini

(1909-2012)

Rita, the pioneer of neurobiology

Rita Levi-Montalcini was the **first woman** to be admitted to the **Accademia Pontificia** (*Pontifical Academy of Sciences*) and the **only Italian** to receive the Nobel Prize in Medicine, in 1986.

The Prize motivation states: "The discovery of the **Nerve Growth Factor** (NGF) in the beginning of the 1950s is a fascinating example of how a skilled observer can create a concept out of apparent chaos. Until this time, experimental neurobiologists did not understand how the development of the nervous system was regulated to result in the final complete innervation of the body".

Rita's story

"Everything in life came easily to me. Difficulties to me were like water off a duck's back".

Rita Levi Montalcini was born in 1909 in Turin to a Jewish family. Her father Adamo Levi, was an electrical engineer and mathematician, and her mother, Adele Montalcini, was a painter.

Both parents were well-read and instilled an appreciation for **intellectual research** in their children. However, according to the typical dictates of **Victorian morality**, at home all decisions were taken by the head of the family, who could not imagine his daughters pursuing professional careers.

In 1930, despite the negative opinion of her father, Rita enrolled in the **Faculty of Medicine** at the University of Turin, where in 1936 she **graduated cum**

laude. It is to be noted that there were two other future Nobel Prize winners among her university colleagues and friends, Salvador Luria and Renato Dulbecco. All three of them were students of the famous neurohistologist Giuseppe Levi.

In 1938, following the racial laws issued by Italy that barred Jews from attending and teaching at Universities, Rita moved to Brussels for a short period of time. When she returned to Turin, she decided to continue **to do research**, setting up a small **secret laboratory** in her own bedroom.

Once the war ended, Rita moved to the United States, where she carried out fundamental experiments that, in 1954, led her, together with the biochemist Stanley Cohen, to identify the **Nerve Growth Factor** (NGF), a **key protein for the development of the nervous system.** Rita and Stanley received the **Nobel Prize** due to this discovery in 1986.

The awarding of the Nobel Prize did not put a brake on Rita's energy and enthusiasm, but in actual fact gave her more strength. It encouraged her to **dedicate her life** with great passion to **important social issues, like teaching women and female students** from Africa, the **promotion of scientific research among young people** in the most disadvantaged regions of Italy, and the **fight against discrimination, racism and poverty.**

In 2001, Rita was nominated **Senator for Life** of the Italian Republic. In 2002, she founded the **EBRI** (European Brain Research Institute), an **international research institute** dedicated entirely to **neuroscience**.

She died in Rome in 2012 at the age of 103.

Her personality

"The body does whatever it wants. I am not my body; I am my mind."

Rita always considered herself to be a **free thinker** and chose to not have a husband and a family so that she could **dedicate her life completely to science.**

With her strong character, immense stubbornness and extraordinary vitality, Rita did not find it right to live only for research and teaching, because she was convinced that scientists ought to also **concern themselves with ethical and social problems.**

After being awarded the Nobel Prize, one of her goals was to encourage an **international network of female solidarity** that fought **against injustice and racism**, so that women all over the world could become more self-confident and **take the reins over their lives**.

In 2008, she presented her book *Le tue antenate. Donne pioniere nella società e nella scienza dall'antichità ai giorni nostri* (*Your female ancestors. Pioneering women in society and science from ancient times to our times*) co-written with Giuseppina Tripodi, with these words:

"I wrote a book for young people, I published it with a publishing company for young people. I am proud of it. We entitled it 'Your female ancestors'. It talks about pioneering women. Those who had to fight against prejudice and male chauvinism to get into laboratories, who risked seeing their key discoveries snatched from them and attributed to men, who took on families and research."

Her research

In 1947, Rita accepted the invitation from the neuro-embriologist Viktor Hamburger to come to the Washington University of St. Louis to continue her research. At that time **neurobiology did not yet exist** as a discipline and it was thanks to her work that the foundations were laid for this **new branch of science**.

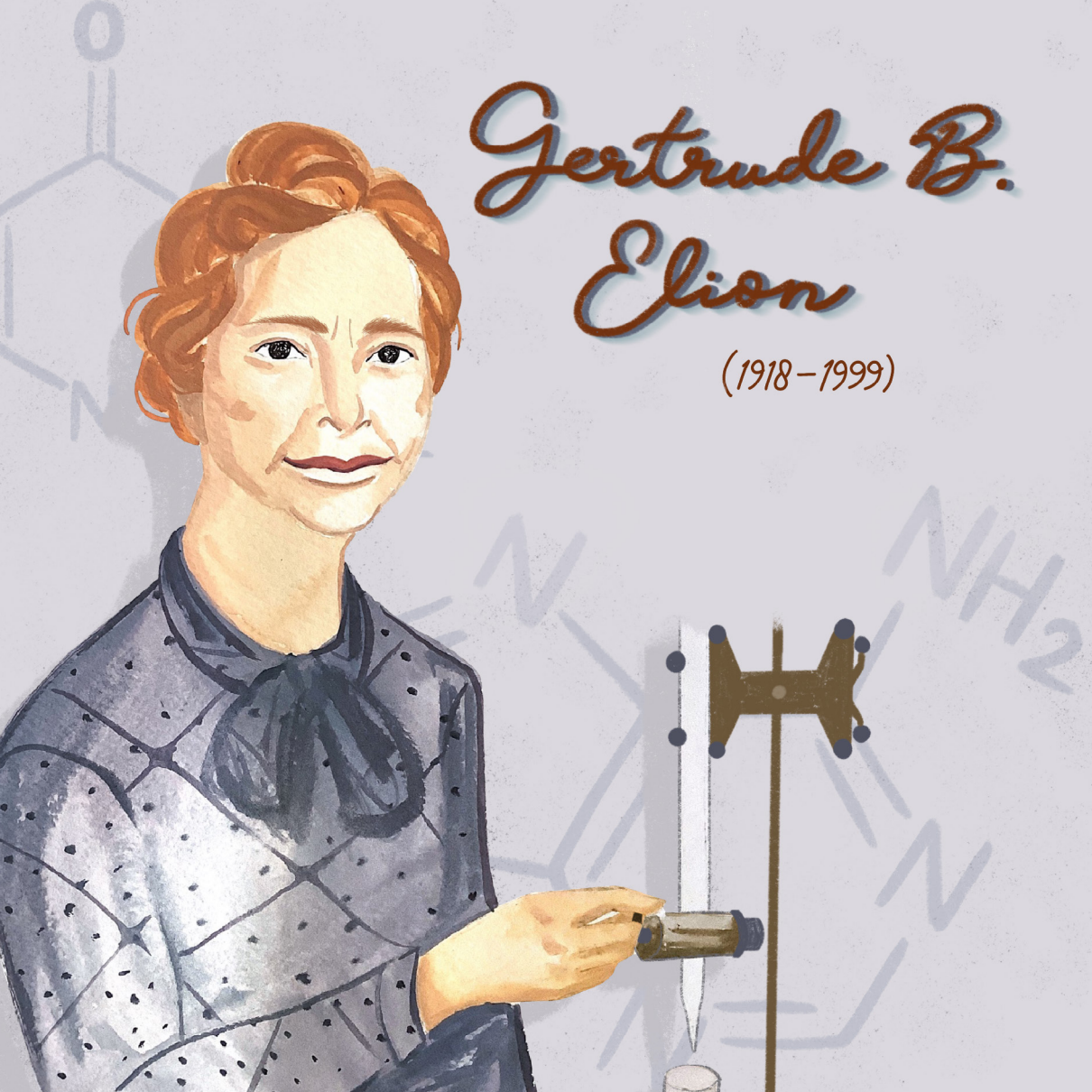
In 1952, Rita, together with the biochemist Stanley Cohen, managed to isolate a substance taken from mice tumors that caused vigorous growth in the nervous system of chicken embryos.

The two researchers continued to work intensively and **discovered the Nerve Growth Factor (NGF)**, a **protein** found in both the nervous system and in other parts of the human body, **essential** in the development of neurons during the embryonic period and with a **key role in the survival of nerve cells**.

The discovery of NGF turned out to be of **fundamental** importance for the **treatment of neuro-vegetative diseases**, and for a better understanding of the development of the **nervous system**, its differentiation and regeneration possibilities.

Gertrude B. Elion

(1918–1999)



Gertrude, the scientist who revolutionized pharmacology

Gertrude B. Elion won the Nobel Prize for Medicine for her research on acyclovir, an **antiviral drug**. Over her career she registered **45 pharmaceutical patents** and was awarded **25 honorary degrees and doctorates**.

In 1988 she co-won the Nobel Prize together with George Hitchings and James Black.

Gertrude's story

"Nobody took me seriously. They wondered why in the world I wanted to be a chemist when no women were doing that."

Gertrude was born in New York 1918 to Lithuanian and Russian parents. Her grandfather and her mother both died of cancer when she was a teenager. She planned to get married, but her fiancé became ill from infective endocarditis. He died just two years before penicillin became available, which could have saved his life. These dramatic personal vicissitudes convinced her **to devote her life to scientific research**.

After being awarded a degree from Hunter College in 1937, she was the **only woman** to be awarded a **Master's degree in chemistry** from New York University. In 1944 Gertrude got a job in the Burroughs Wellcome pharmaceutical company as the lab assistant to doctor George Hitchings with whom she was to share the Nobel prize 44 years later.

Gertrude and George developed a **revolutionary approach**, which consisted of a **thorough examination** of the differences between the biochemistry of healthy human cells and that of cancer cells, bacteria, viruses and other pathogens in order to pinpoint differences in how the nucleic acids are metabolized in these various cells. They subsequently used the information obtained to **develop drugs** that were able to kill the pathogen or block its production, leaving healthy cells intact.

Their approach constituted a **momentous change** and produced **new drugs** at an incredible pace. To the point that the Nobel Committee declared that each of the drugs developed by Gertrude and George would have been deserving of the award.

As soon as she retired, Gertrude became **head of the Department of Experimental Therapy** (which she had created) and continued to conduct research at Glaxo Wellcome in Research Triangle Park, North Carolina.

She died in Chapel Hill in 1999.

Her personality

"When we began to see the results of our efforts in the form of new drugs which filled real medical needs and benefited patients in very visible ways, our feeling of reward was immeasurable."

Gertrude was famous for her **precision**, **intellectual brilliance** and **ability to work with others**. She was cheerful and outgoing, a keen photographer and traveller. She also loved the opera, concerts, ballet and the theatre.

However, the predominant trait of her character was without doubt her **stub-**

bornness. She herself recalled several times that, at the beginning of the 1940s when she was looking unsuccessfully for a job as a chemist, she heard the same sentence repeated over and over again: "You're qualified, but **we've never had a woman in the laboratory before, and we think you'd be a distracting influence**".

And when she presented her first scientific paper at a major meeting, she got into an argument with a distinguished scientist, but stood her ground because she said "**I knew I was right**".

Gertrude **trained and guided two generations of scientists**, winning over all her students with her passion for science and medicine.

"People ask me often whether the Nobel Prize was the thing you were aiming for all your life, and I say that would be crazy. Nobody would aim for a Nobel Prize because, if you didn't get it, your whole life would be wasted. What we were aiming at was getting people well, and the satisfaction of that is much greater than any prize you can get."

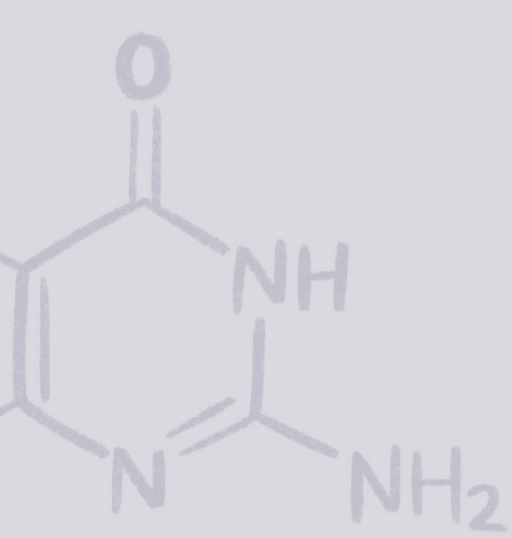
Her research

In the 1950s the joint work of Gertrude and George led to the development of an innovative method of **drug design** that paved the way to **new therapeutic strategies** for the **treatment of diseases** whose remedies were unsatisfactory or simply did not exist.

One of the first drugs created from their research was the **cure for leukaemia**, which helped many children to survive the illness. Other drugs created by Gertrude and George were used to fight **malaria**, **infections** and **gout**, or to help patients that needed **organ transplants**.

The success of **acyclovir** (the drug for which she was awarded the Nobel Prize for Medicine) overturned the theories of many biochemists - including, at one time, even George's - who believed that it was impossible to discover effective and selective antiviral agents. Gertrude's stubbornness proved that these beliefs were unfounded.

The change of perspective introduced by Gertrude turned out to the **fundamental** for preparing the pharmaceutical industry to respond to the challenge of **human immunodeficiency virus** (HIV). In fact, it was the researchers trained by Gertrude that were the first to grasp the therapeutic potential of AZT, at the time an anti-cancer drug that hadn't been used since the 1960s, using it successfully to treat the disease.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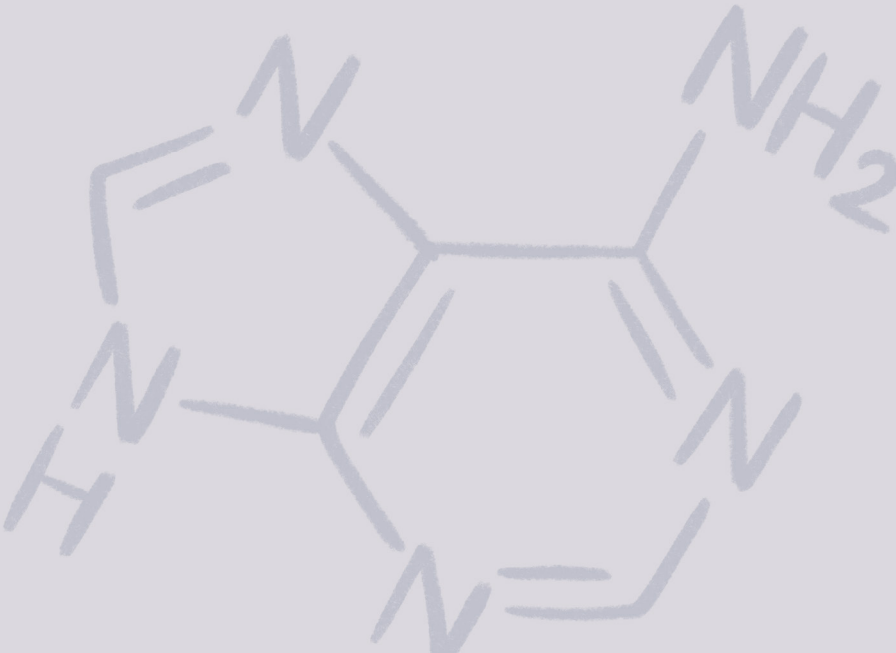
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Christiane Nüsslein-Volhard

(1942 –)

Christiane, the genius of biochemistry

Christiane Nüsslein-Volhard was awarded the Nobel Prize for Medicine in 1995, together with Eric Wieschaus and Edward Lewis, for her discoveries on the **genetic control** of **embryonic development.**

Her work helped to solve one of the greatest **mysteries of biology**: how the genes in a fertilized egg form an embryo.

Christiane's story

"I had a happy childhood, with many stimulations and support from my parents who, in post-war times, when it was difficult to buy things, made children's books and toys for us. We had much freedom and were encouraged by our parents to do interesting things."

Christiane was born in Magdeburg, Germany, in 1942, as the second of five children.

Since childhood, she was interested in observing plants and animals.

After high school, Christiane enrolled in the Faculty of Biology in Frankfurt with the desire to become a **scientific researcher.** In 1969 she completed her studies in biochemistry and started to work on the **morphogenesis of development** (the process that causes an organism to develop a certain shape).

In the following years, with her colleague Eric Wieschaus, she studied the *Drosophila melanogaster* (fruit fly) to identify the genes responsible for its formation. Together they invented a process called **saturation mutagenesis**, where

they produced mutations in adult fly genes in order to observe the impact on offspring. Using this method, as well as a dual microscope that allowed them to examine specimens together, they identified 20,000 **genes in the chromosomes** of fruit flies.

Their fundamental **discovery**, published in the scientific journal "Nature" in 1980, had important implications also for **human reproduction** and paved the way for the understanding of embryonic development, enabling the causes of **mutations and deformities** even in humans to be identified.

Christiane was the director of the developmental biology department at the Max Planck Institute in Tübingen from 1985 until 2014. In 1986 she received the **Leibnitz Prize**, the highest honor awarded in German research. In 1995 she won the **Nobel Prize** for Medicine.

In 2004 she created the "**Christiane Nüsslein-Volhard Foundation**" to help the most promising young female German scientists and to support women researchers with children.

Her personality

"Biology doesn't use the category of beauty to describe organisms. The rigorous researcher avoids applying it to shapes, colors and sounds, as this category depends on the observer and is linked to subjective sensations triggered by non-measurable qualities of objects considered beautiful. And yet the beauty of plants and animals, as we see it, plays a similar role in nature as that played by art and culture for humans."

In addition to being an extraordinary scientist, Christiane has the **sensibility of an artist,** with many interests outside of work: she likes to cook (she has even

written a cookbook), plays the flute and sings, holding small concerts for her close friends. She has a great love for nature and has a large garden at home, which she looks after herself.

Over the years Christiane has been a **mentor for many scientists,** who, being trained in her laboratory, today conduct their research independently.

She created the Foundation that bears her name to **support women** who decide to pursue a **career in science**, helping young female scientists to balance family commitments with the duties of an independent researcher, enabling them to continue working at the highest level.

Her research

"Creativity is combining facts no one else has connected before."

Christiane introduced the **concept of Great Science** for the first time in **biology**, conducting an ambitious large-scale **project on mutagenesis** (the set of chemical and physical processes that cause a mutation to occur).

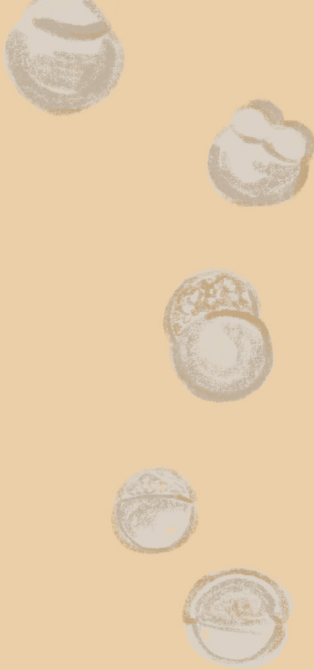
Before she came along, **molecular biology** was mostly based on experiments that demonstrated principles or that gave general examples: the techniques available and the considerable financial efforts involved obstructed scientists from studying the complexity of many biological systems in depth.

Christiane **discovered** how genes regulate the **development process of an individual egg cell in an entire animal and**, with her work, contributed significantly to increasing our understanding of the mechanisms involved in the **regulation of cellular transcription.**

The relevance of her research is huge, both due the importance of determining

the development processes in Drosophila - one of the best-known organisms from a genetic point of view - and because similar genes are present in other species, including humans.

After winning the Nobel Prize, Christiane extended her research to zebrafish, taken as a model for the study of the specific features of vertebrates. Her deep conviction is that the combination of different approaches and systems, in one laboratory, provides a powerful basis for further understanding the development of complexity in the life of an animal.



Linda B. Buck

(1947–)

Linda, the scientist who unveiled the secrets of smell

Linda B. Buck won the Nobel Prize for Medicine in 2004, together with Richard Axel, for her work on **olfactory receptors** and for isolating the genes that, when we smell a certain **scent**, enable us to recognize it again in the future.

Her research revealed the incredible similarity between species, producing the theory that the basic principles of odor discrimination have been preserved for millions of years.

Linda's story

"It may be that my parents' interest in puzzles and inventions planted the seeds for my future affinity for science, but I never imagined as a child that I would someday be a scientist."

Linda was born in Seattle in 1947. Her mother was a housewife who loved doing word puzzles. Her father was an engineer who spent his free time inventing and building things in their garage. Since childhood she dreamt of helping others and, when she finished high school, she decided to study psychology in order to become a psychotherapist.

While at university, however, her **vocation for science** became very apparent. In 1975 she graduated with a degree in both psychology and biology, and continued her studies at the **immunology** laboratory of the *University of Texas Southwestern Medical Center* in Dallas. There, with the help of her thesis ad-

visor Ellen Vitetta, she learnt to do research and conduct experiments. Linda subsequently perfected the techniques of **molecular biology** at the laboratory run by Richard Axel, who was studying the nervous system of the *Aplysia*, a sea snail.

In particular, Linda was fascinated with the **mechanisms** that regulate the **perception of smell**. This is how she began to wonder how mammals and humans were able to detect and memorize **more than 10,000 different smells.**

By studying the olfactory receptors in mice, Linda discovered that they have approximately 1000 **genes** that control an equivalent number of olfactory receptors, all different, located in the cells of a small area of the **nasal epithelium**. Humans have far fewer receptors (350 compared to 1000), but they work in the same way.

In 1991, she published her work on the **organization of the olfactory system** in the journal 'Cell' together with Richard Axel, which resulted in both of them being awarded the Nobel Prize for Medicine.

In 2001, having become a **full professor at Harvard**, Linda published new research on how **olfactory neurons** are **mapped** in the cerebral cortex, studying the profound effects of smell on the brain in terms of attraction and aversion, memory and emotion.

Her personality

Linda had a happy childhood. Her parents taught her to think **independently**, urging her to **do something worthwhile with her life** to "not settle for something mediocre". These teachings have always influenced her work as a scientist.

She considers herself to be very lucky, because very few have had the opportunity to do what they love everyday, as she has. Her motto is:

"Do something that you're obsessed with, because that's where the great discoveries come from."

Linda loves doing jigsaws and puzzles. In her work, she appreciates in particular the fact that she has had amazing mentors, colleagues and students with whom to explore what fascinates her. She loves challenges and cannot wait to find out what new surprises nature has in store for us in the future.

She has always been committed to full **gender equality** in the **scientific** world. When she won the Nobel Prize, she said:

"As a woman in science, I sincerely hope that my receiving a Nobel Prize will send a message to young women everywhere that the doors are open to them and that they should follow their dreams."

Her research

"How could humans and other mammals detect 10,000 or more odorous chemicals, and how could nearly identical chemicals generate different odor perceptions? In my mind, this was a monumental puzzle and an unparalleled diversity problem."

Thanks to Linda's work, it was discovered that **each cell in the nasal cavity** is associated with a **specific receptor**, which specializes in the recognition of a wide range of different smells. When the molecules coming from the air outside combine with the nasal receptors, the cells send a series of electric signals at the olfactory bulb in the brain, which then reprocesses all the information received and produces the **perception of a well-defined odor.**

In practice, by working together, the receptors create a **combinatorial code**, forming an **odorant pattern**. This code underlies our ability to recognize more than 10,000 different smells, just like we are able to spell thousands of words using just the 26 letters of the alphabet.

Today, Linda continues to study the olfactory system, but is also involved in **new research activities** that explore **the ageing of the brain**, the functioning of cognitive abilities and the mechanisms of memory.


Françoise
Barré-Sinoussi
(1947 –)

Françoise, the virologist who discovered the HIV virus

Françoise Barré-Sinoussi won the 2008 Nobel Prize in Medicine, together with Luc Montagnier, for the discovery of **human immunodeficiency virus** (HIV), the cause of AIDS. Her research has been instrumental in radically improving the therapies used to treat patients.

Françoise's story

"We are not making science for science. We are making science for the benefit of humanity."

Françoise was born in Paris in 1947, the city where she still lives today. As a child she spent long periods of time in the countryside: her great attraction to the natural world was perhaps the first sign of the direction her life would take in the future.

When she finished high school, Françoise decided to enrol in the faculty of **Natural Sciences** instead of Medicine, so as not burden her family, who were not particularly well-off.

During her university years, she worked as a volunteer at the **Institut Pasteur**, where Jean-Claude Chermann was studying **retroviruses** (the viruses that convert their own genome from RNA to DNA during their replication cycle), which cause leukaemia in mice. Françoise was so **enthusiastic** about the research that she spent all her time in the laboratory and only went to university to sit her exams.

After completing her PhD in 1974 and spending a period of time in the United States, at the National Institutes of Health, Françoise returned to the Institut Pasteur. Her laboratory, run by Luc Montagnier, investigated the **link between retroviruses and cancers.** And it was precisely there that in 1982 many doctors looked to understand the mechanisms of a new mysterious disease, which seemed to predominantly affect homosexual men and was assumed to be caused by a retrovirus.

On February 4, 1983, Françoise and Montagnier observed the retrovirus that caused AIDS for the first time under an electronic microscope and on May 20 of the same year they published the article in the journal *Science* in which they announced that **AIDS was caused by HIV**. A virus so powerful that it seriously damaged lymphocytes to the point of destroying an individual's immune system. Their major discovery led to the development of **specific blood tests** to detect the infection and to study **antiretroviral drugs** that help keep AIDS patients alive.

In 1988 Françoise got her **own laboratory** in the Institut Pasteur and became **head of the Biology of Retroviruses Unit** in 1992, where she remained until 2015. In 2008 she won the Nobel Prize in Medicine. In the following years, her research group initiated projects, partnerships and scientific exchanges with numerous African and Asian countries.

Her personality

"I knew as a scientist that we will not have a treatment tomorrow because we know that science needs time to develop drugs. To see the patients dying and expecting so much from us, it was terrible."

Françoise is a passionate woman and activist, who loves to call herself a **scientist**

and an activist at the same time. She has travelled throughout Africa and Southeast Asia, promoting better public education on the prevention of AIDS and creating centres for identifying and treating cases of HIV infection.

Achieving the Nobel Prize encouraged her greatly to intensify her commitment and use the visibility acquired to support her cause with governments and institutions.

As she has publicly admitted, being at the front line in the battle against AIDS has been **very hard psychologically**. In 1996 Françoise suffered from depression and for a certain period of time withdrew from her public commitments. But she quickly recovered and returned to the fight, stronger and more determined than ever.

"Like everybody, I have some times in my life when I'm pessimistic. I wonder whether I should continue… Then I go and have a trip to Africa or Southeast Asia and have a small meeting with people affected by HIV, and I forget my mood. I say, 'OK, let's go on. Let's continue. This is real life. Don't think about yourself'."

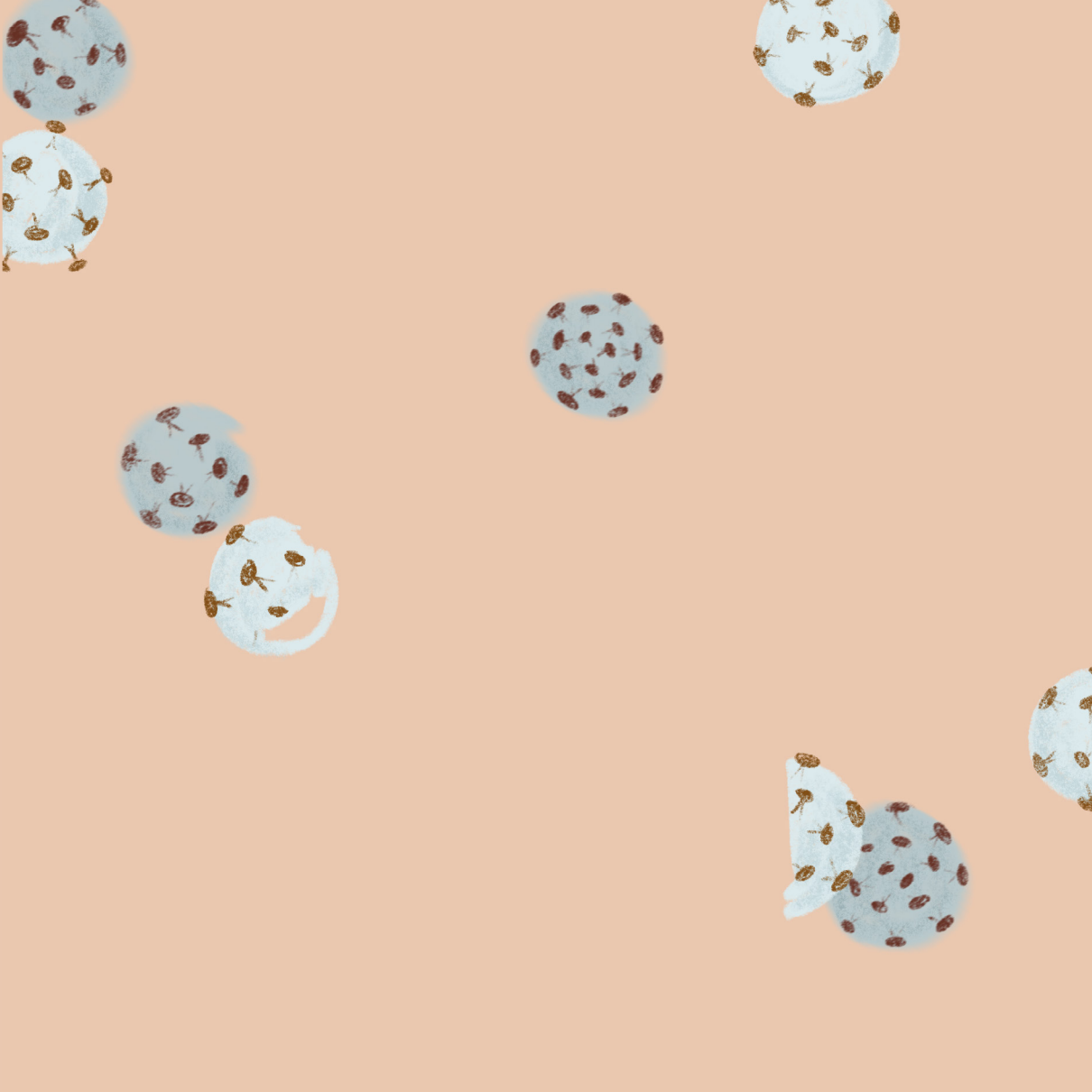
Her research

After devoting her entire career to **studying AIDS**, in recent years Françoise has focused her efforts on developing a global strategy to **combat the disease**, involving scientists, doctors, patients and ordinary citizens and institutions.

In addition to working on a better understanding of the **pathogenesis** (growth and progression on the disease) of AIDS and the ways of controlling HIV, Françoise's research is aimed at examining the **immune response** that is developed with new experimental treatments, yet to be tested.

Françoise's goal is to develop increasingly effective antiretroviral therapies to be used in sub-Saharan African countries in particular, where a large number of people with HIV still do not have access to any treatment today.

So far more than 8 billion dollars have been invested in the search for a truly effective vaccine against the HIV virus, but unfortunately all attempts up to now have been unsuccessful. However, we can rest assured that Françoise will continue to work, both inside and outside laboratories, to defeat this terrible enemy of humanity once and for all.




Carol W.
Greider
(1961–)

Carol, the youngest woman to win the Noble Prize in Medicine

Carol W. Greider won the 2009 Nobel Prize in Medicine, along with Elizabeth Blackburn and Jack Szostak, for her research on cellular ageing and in particular on how **chromosomes** are protected by telomeres, our **biological clocks.**

Carol also discovered **telomerase**, an enzyme that has major implications for medical research on the ageing process and growth of cancer cells.

Carol's story

"I believe that learning to develop my compensatory skills also played a role in my success as a scientist. Perhaps my ability to pull more information out of context and to put together different ideas may have been affected by what I learned to do from dyslexia."

Carol was born in San Diego (USA) in 1961. Both her parents were scientific researchers and worked at the University of California, Berkeley.

Carol did not have an easy childhood: she lost her mother when she was just six years old. In addition, she had a hard time at school, because she mispronounced words and had difficulty spelling. In the beginning, this made her feel dismayed and deeply inadequate, but she then discovered that she was **dyslexic**. She accepted this aspect of her character and, with time, turned it into one of her **strengths**.

After high school, Carol decided to study **marine biology**. Once she graduated, she met **Elizabeth Blackburn** at Berkeley and started to work in her laborato-

ry. At that time, Elizabeth had already described the molecular structure of telomeres and was investigating how their process of shortening and lengthening worked.

Carol decided to look for a hypothetical **enzyme that re-lengthened shortened telomeres**. After around nine months of attempts and experiments, she identified it on Christmas Day, 1984. Carol and Elizabeth called it **teromerase** and published their findings in the scientific journal "Cell". At the age of 23, before she had even got her PhD, Carol made the **discovery** that was to result in her winning the 2009 Nobel Prize in Medicine.

In a joint interview, given several years after the discovery of telomerase, the two researchers recalled the special **symphony** that had been created between them:

"It was like solving a kind of puzzle. We wanted to understand how telomeres worked and we did experiment after experiment. And we didn't always agree. One experiment we talked for a long time and neither of us would give up our stance. Then the next morning she decided to do as I said, and I as she said. We both laughed".

Carol then met the scientific writer, Nathaniel Comfort, who she married in 1992. In 1997 the couple moved to Baltimore, when **Johns Hopkins University** hired Carol as an **associate professor.** Carol still works there today, as director of **Molecular Biology and Genetics.**

Her personality

Carol is very creative and very **determined**. She loves and is enthusiastic about being in the laboratory, which brings her great joy. She is truly grateful to many scientists that she has met throughout her career and all the students, postdocs

and technicians who brought their energy and great ideas to the lab when working with her.

Being a mother is very important to Carol, and she is particularly sensitive to the subject of public policies that **support mothers**:

"Two years after I moved to Johns Hopkins, my daughter Gwendolyn was born. Having two kids and a full-time job in the lab is a challenge, but having Charles and Gwendolyn is the best thing that has ever happened to me. My lab knows that I am a mom first, and the flexibility that academic science provides makes having a career and a family possible. I can go home when needed, or to a school play in the middle of the day, then come back and finish my work-day; or work from home on the computer. The main thing is to find the time to get things done, it is not the hours at work but the overall productivity that counts. Having flexibility takes a huge amount of pressure off."

Despite being awarded the Nobel Prize, Carol is still concerned with the "under-representation of the 50% of the brain power of this world." This is why she continues to **support women**, who want to have a **career** that they love and a **family**, encouraging them to find a way to **combine both** their passions.

Her research

"Science is not done alone: it is through talking with others and sharing that progress is made."

Carol discovered **telomerase**, an enzyme that is a small machine inside the cell that keeps the end of chromosomes - the telomeres - intact, by playing a fundamental role in determining the lifespan of cells. Because of this characteristic, telomeres are considered to be a kind of **biological clock**.

The medical significance of this initial discovery has been confirmed over time: today telomeres and telomerase are the **focus of studies** dealing with **ageing and tumors**.

Carol's work continues to concentrate on understanding telomerase and the consequences of telomere dysfunction.

And she continues tirelessly with her research, with her usual enthusiasm and rigor:

"I learned to step aside from myself and view my data through the eyes of a sceptic. I learned that getting the correct answer is more important than getting an answer you might hope for."

Elizabeth H. Blackburn

(1948–)

Elizabeth, the explorer of cellular ageing

Elizabeth H. Blackburn won the 2009 Nobel Prize in Medicine, along with Carol Greider and Jack Szostak, for her research on cellular ageing and in particular on how **chromosomes** are protected by telomeres, our **biological clocks.**

Her work has added a new dimension to the understanding of cells and has prompted the development of **potential new therapies**.

Elizabeth's story

"The main influence that my parents' work, both physicians, had on me was that it gave me the idea that women and men were equivalent in careers. It showed me that motherhood and career can go together. My mother worked part-time much of the time, as I was the second of seven children!"

Elizabeth was born in Tasmania (Australia) in 1948. Growing up, she was fascinated by animals and also by the nobility of scientific research: she read and reread Marie Curie's biography and, in late adolescence, it was clear to her that **she wanted to become a scientist.**

After being awarded her Bachelor's and Master's degrees in biochemistry from the University of Melbourne, Elizabeth left Australia at the age of 24 to do a PhD in **Molecular Biology** in Cambridge (UK). It was there that she met and fell in love with John Sedat.

Elizabeth and John got married in1975 and they moved to the United States. Since her husband was destined for Yale University, she looked for a place to

do her **post-doctorate work**. She ended up in the laboratory of John Gall, who encouraged her to study *Tetrahymena*, **single-cell organisms** with ample linear chromosomes. "I knew she was extremely good", said Gall, "but I didn't know she as a superstar until she started doing her own independent work".

At the end of 1977, Elizabeth moved to San Francisco with her husband. She tried to enter the academic world, but received a series of rejections, until **Berkeley University** finally offered her a position as **assistant professor** in the department of molecular biology.

In 1984, Elizabeth and her PhD student, Carol Greider, started to conduct experiments on cell structure. Together they discovered **telomerase**, an **enzyme** that lengthens each strand of DNA before the copying phase and that is responsible for compensating for the shortening that takes place during **cell division**. She became full professor at Berkeley in 1986 and her son, Benjamin David, was born in the same year.

In1998 she was elected **President** of the **American Society for Cell Biology**. Two years later, Elizabeth was invited by the US government to join the President's Committee on Bioethics. In 2004, she was removed from the panel, after she declared that she was in favor of using discarded embryos in in-vitro fertilization procedures for research purposes.

In 2008 she received the **L'Oréal-UNESCO award** for women in science, in recognition of her own career and for having started the career of many young female researchers.

In 2009 she won the Nobel Prize in Medicine.

Her personality

"In addition to looking through the lens of the microscope, I also look out the window to see how science can be used to deal with problems."

Elizabeth is open, pleasant and generous and often repeats that it is important to **pursue joy and aesthetics** in scientific research. In her opinion, each experiment should have the beauty and simplicity of a Mozart sonata.

Her meeting with another winner of the Nobel Prize in Medicine, Barbara McClintock, was fundamental to her learning:

"Barbara McClintock gave me a memorable lesson: in a conversation I had with her in 1977, she urged me to trust my intuition. This advice was surprising to me then, because intuitive thinking was not something that at the time, I allowed myself to admit might be a valid aspect of being a biology researcher. Today, on the other hand, I think her advice recognizes an important and sometimes overlooked aspect of the intellectual processes that underlie scientific research, and for me it had a liberating aspect to it."

Over the years Elizabeth has evolved from a **lab rat** (as she jokingly describes herself) into an **expert in the field of health and public policy.**

She firmly believes that **bioethics**, supported by the best scientific evidence available, can play an **important** role for researchers dedicated to biological science and medicine.

Her research

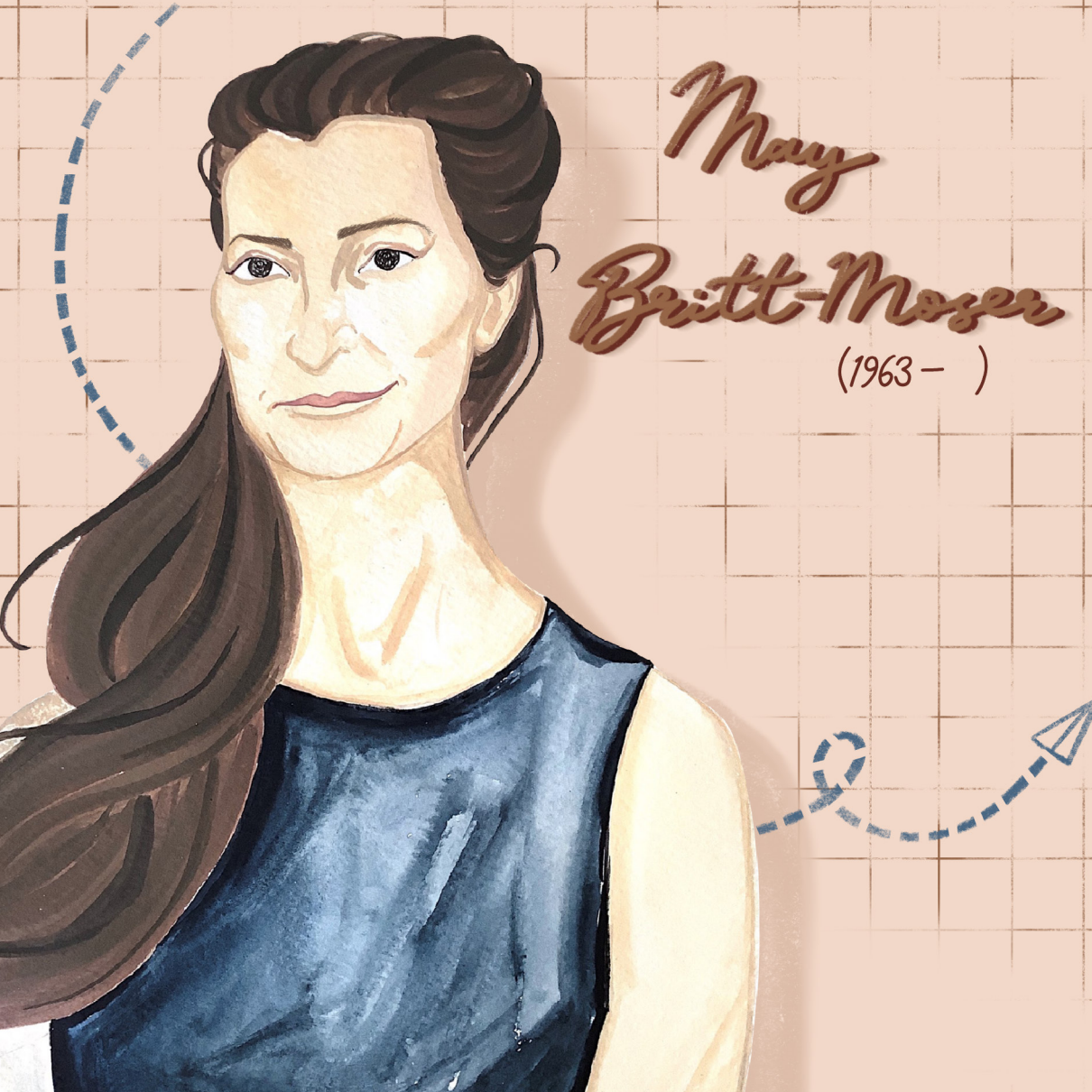
Elizabeth identified the **molecular structure of telomeres**, clarifying several key aspects of cell division and DNA replication. As telomeres shorten, **cells age**. On

the contrary, if telomerase activity is high, telomere length is maintained and **cell ageing is delayed**.

These findings have had a significant impact within the scientific community: many scientists have speculated that the **shortening of telomeres** could be the **reason for ageing**, not only in individual cells but also in the body as a whole.

Furthermore, with the contribution of the psychologist Elissa Epel, Elizabeth discovered that chronic **stress** shortens telomeres and plays a role in various diseases, including cardiovascular diseases in particular. The cure? Improve our lifestyles.

"Health is the number of years of your life in which you are free from illness, are productive and enthusiastically enjoy life. Disease is the opposite, it is the time in your life spent feeling old, sick and dying".


May
Britt-Moser
(1963 –)

May, the neuroscientist who reconstructed the map of our brain

May Britt-Moser won the Nobel Prize in Medicine in 2014 together with her husband Edvard I. Moser and John O'Keefe, thanks to her studies on neuroscience, which mapped the cells that constitute the **positioning system in the brain**.

Her work has been instrumental in discovering the area of the brain responsible for **spatial memory**.

May's story

"I was not always the best student with the highest grades, but my teachers saw something in me and tried to encourage me."

May was born in Fosnavåg, Norway, in 1963, the last of five children. Her father was a carpenter, whereas her mother looked after the children and the farm where they lived. As a young woman her mother dreamt of becoming a doctor and encouraged May to study.

After high school, May went to the University of Oslo and enrolled in Psychology, together with another young student, Edvard Moser. Their friendship and shared **intellectual passion** blossomed into a romantic and professional partnership that was to last for decades. They got married in 1985.

After being awarded a PhD in **Neurophysiology** in 1995, May and Edvard moved to Edinburgh and then to University College London, where they

worked with the neuroscientist John O'Keefe, who was to share the Nobel Prize in Medicine with them almost twenty years later.

They had only been in London for a few months, when May and Edvard were offered two assistant professor posts at the University of Science and Technology in Trondheim, Norway. They moved there in 1996. During that time their two daughters were born.

In the years that followed, May's career continued to progress. In 2000, at the age of 37, she was promoted to the position as full professor. In 2002 she co-founded the **Centre for the Biology of Memory** and, ten years later, became the **founding director** of the **Centre for Neural Computation.**

In 2005, May and Edvard made a **revolutionary discovery**: they were able to understand how the brain processes data on where we are and how we move in space, and then generates its own internal code so it can make use of the information collected.

In 2014, at the age of just 51, she shared the Nobel Prize in Medicine with her husband and John O'Keefe. May and Edvard divorced in 2016, but continue to work together to this day, united in their shared passion: to discover how the brain works.

"We have a common vision. And it is stronger than most."

Her personality

"Our two daughters have long joked that our lab is like our third child, and in many ways, they are not wrong. Having two real "biological" children in addition to our laboratory "child" has brought an amazing happiness to my life!" It has made it easy for me to do good science."

May has always been a natural in her **dual role as a scientist and a mother.** From the very beginning, May took her daughters to the laboratory: they were both very well-behaved, very polite and hence comfortable to play there without any problems. She did it, she explained, because "**I just didn't see the barriers** that others might have seen."

In addition, May has always worked tirelessly to ensure that her lab animals, rats and mice, have the best environment to live in and are **as happy as possible**: the majority of them stay together with their mates, in large cages full of nests and toys. She has a veterinarian for her research centre, who works full-time, and four employees to look after the animals.

She considers herself to be very privileged and is very grateful for all that life has offered her:

"I have been lucky to live a fairy tale life, with a partner and a long-time collaborator, Edvard Ingjald Moser, who has supported me and helped me fulfil my dreams ever since we met. We have two wonderful daughters, Isabel Maria Moser and Ailin Marlene Moser. They are wise and loving human beings. Being an internationally recognised scientist brings a lot of adventures and a large network of friends and colleagues across the world."

Her research

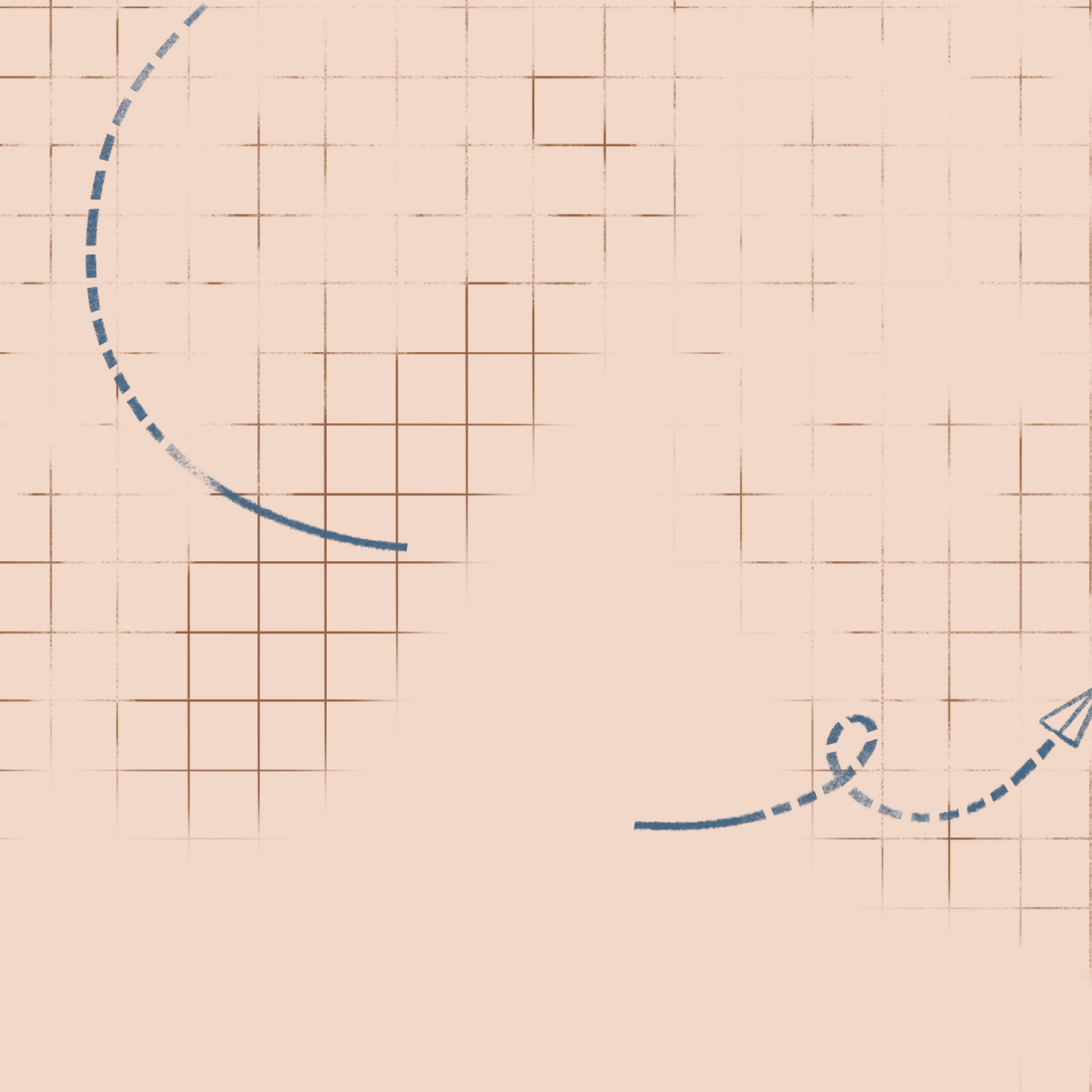
"We are working with findings that are the very essence of being a human being: our conscious memories are what make us who we are, and these memories are anchored in space, in knowing where we are in the environment".

May discovered what has been defined as a kind of **brain GPS**, namely the way the brain is able to **navigate in space**.

In practice, this is an ingenious coordinated orientation system (so-called **grid cells** - neurons that are activated when an animal finds itself in a particular position in the environment), which enables us to **memorize** not only our momentary **position**, but also the **direction to take** to reach our desired destination.

Her work has been key to a better understanding of how several highly specialized brain cells are organized and has allowed us to deepen our knowledge on how cognitive processes work, as well as our memory, and ability to design and think.

"Our discovery raised new questions that have continued to shape our research, as we seek to understand how grid cells operate and are generated and how they interact with other cell types and in more distant brain structures. Here, we think, lies a key to unlocking the mystery of how the brain computes."




Tu
Youyou
(1930-)

Tu Youyou, the Nobel Prize for her work on malaria

Tu Youyou won the Nobel Prize in Medicine, together with William C. Campbell and Satoshi Omura, for her important work on the **cure for malaria.**

She is the **first Chinese scientist** to have received a Nobel Prize in a scientific category, without having a doctorate, a medical degree, or training abroad.

Tu's story

"Every scientist dreams of doing something that can help the world."

Tu was born in Ningbo, a city on the east coast of China, in 1930. Her family strongly believed in the importance of education, but when she was 16 Tu had to take a two-year break from studying because she had contracted tuberculosis. When she returned to school, she knew exactly what she wanted to do: enrol to study medicine.

At Beijing Medical College, Tu studied **Pharmacology** and learnt how to classify medicinal plants, extract active ingredients and determine their chemical structures. When she graduated in 1955, Tu went to work at the **Academy of Traditional Chinese Medicine**, where she would remain for her entire **career**.

In the 1960s, North Vietnam asked China for help with fighting malaria, which was causing huge losses among its soldiers. The single-celled parasite that causes malaria had become resistant to chloroquine, the standard treatment for malaria. On May 23, 1967, Chairman Mao Zedong launched **Project 523** with the aim of finding a **cure for malaria**.

In 1969, at 39 years old, Tu was appointed **head** of 'Project 523'. She decided immediately to travel to Hainan island, in southern China, where there was a terrible malaria epidemic. In those rainforests, Tu witnessed first-hand the devastating effect of the disease on the human body.

When she returned to Beijing, Tu reviewed ancient Chinese medical texts in order to try and understand the traditional methods of fighting malaria. She found a reference to **sweet wormword**, used in China around 400 AD to treat "intermittent fevers", a typical symptom of malaria.

Tu and two colleagues tested the substance on themselves before administering it to 21 patients in the province of Hainan. All of them recovered.

The following year, Tu's team distilled the compound's **active ingredient**, **artemisinin**. Although her work wasn't published in English until 1979, the WHO, World Bank and UN invited her to present her findings publicly in 1981.

It took another two decades, but in the end the WHO recommended **artemisinin therapy** as the first line of defence against malaria. In 2011 the Lasker Foundation awarded the **Clinical Medical Research Award** to Tu, calling the discovery of artemisinin "arguably the most important **pharmaceutical intervention** in the last half-century."

Tu won the Nobel Prize in Medicine in 2015.

Her personality

"The work was the top priority so I was certainly willing to sacrifice my personal life."

As she said herself, as a young scientist Tu felt overwhelmed by the **responsibility** of the task assigned to her: to find an effective cure for malaria.

In addition to the huge pressure she was under, this challenge had a **shocking impact on her family life**:

"By the time I accepted the task, my elder daughter was four years old and my younger daughter was only one. My husband had to be away from home attending a training campus. To focus on research, I left my younger daughter with my parents in Ningbo and entrusted my elder daughter to a teacher. When I saw them again after three years, my daughters didn't recognize me."

A sense of duty, spirit of sacrifice, **great courage** and tenacity are several of the most evident traits of Tu's personality. In addition to these there is also **modesty**: Tu was always reluctant to take credit for her discovery. When she received the Nobel Prize, she entitled her lecture, 'Discovery of Artemisinin: A Gift from Traditional Chinese Medicine to the World'. But she was proud of her work, and rightfully so.

Her research

"The discovery of artemisinin inspires us to approach research through the integration of diversified disciplines. Exploring the treasury of traditional Chinese medicine has provided us with a unique path leading to success, while utilizing modern scientific techniques and approaches are no doubt an effective and efficient way of realizing and expediting discoveries."

In her training, Tu added her in-depth knowledge of **ancient Chinese medicine** to her background as a modern **Western doctor**. This **unique combination** allowed her to link the best of the knowledge and therapeutic approaches of both these schools.

By the time Tu started searching for **anti-malaria remedies** among traditional

Chinese medicines, more than 240,000 compounds had already been tested for use in potential anti-malarial drugs and none had worked.

In 1971, Tu and her team **isolated an active ingredient in wormwood.** Initially it didn't seem to work. But then Tu sensed that the extract had to be prepared with a solvent other than water at a relatively low temperature in order to prevent the active ingredient from being destroyed. When they tested it on mice and monkeys, they achieved a 100% success rate.

Tu then **volunteered** to be the **first human subject to test the drug**.

And thanks to her research and her courage, today more than two hundred million malaria patients have received artemisinin combination therapies.