Barbara McClintock (1902 – 1992)

J. Van Robays

Department of Pathology, ZOL, Campus St Jan, Schiepse Bos 6, 3600 Genk, Belgium.

Editing: Sien Ombelet
Correspondence at: willem.ombelet@telenet.be

Barbara McClintock was an American biologist who dedicated her life to the study of corn grains. She wondered how these grains obtained their different colour patterns. Around the year 1930 – 20 years before the discovery of the structure of DNA – a series of controlled trials led her to conclude that this variation was caused by "jumping genes of transposons". These are genes that jump from one chromosome to the next. Nobody believed her.

Name-jump

Although she had been given the name of Eleanor at birth, her parents renamed her Barbara at the age of four. This name seemed to fit her personality better. And so we can safely say that "jumping" was in Barbara's very nature. After she graduated high school with good grades, she wanted to continue her studies, but her mother was afraid this would

spoil her chances of finding a good husband. After pleading with her mother for more than a year, she was at last allowed to go to Cornell university, where she obtained her degree, and continued to do a PhD in Biology. By the time she was 25 years old, a bright career lay ahead of her. However, her mother would be proven right after all. She never found a suitable husband.

Fig. 2.— Barbara as a Young Scientist

Jumping genes

When corn plants are dried out for a long time in extreme heat, there is a high chance that they will die. To increase their survival, the grains start to "rearrange the furniture". Scientifically speaking: in their genome, large DNA sequences are rearranged, hoping that the resulting new genetic combination is more resistant to extreme heat and drought.

In biology class, this crossing-over of genes always struck us as an extremely unlikely and messy explanation. Why would these chromosomes, which we found hard to imagine physically anyway, not just stay in one place instead of entangling each other? Barbara claimed it was even more complicated. Certain genes appear to be able to copy-paste themselves into another places in the genome. Or to even cut-paste themselves to another genomic region.

On top of that, Barbara realized that the places where those cut pieces of DNA end up eventually, were not as random as they appeared to be. There are places in the genome for which the genes seem to have a special predilection. This is quite logical, when you think of it. If genes rearranged at random, chances are that they would destabilize the genome. If, however, they end up in a place where they can activate an inactive gene, for example, or silence an active gene, this would be much more comprehensible and efficient.

Purely by comparing colour patterns of corn grains, McClintock discovered the basic mechanism of what is now known as the promoter gene. She also described how genes can switch on and off, thereby explaining the basic principle of epigenetics.

Mutations, cancer, death?

Mutations destabilize the genetic material and can thus lead to cancer. Therefore, cells dispose of a mechanism to track DNA mistakes, the proofreading system. If the damage is too big, the error is repaired before the cell starts its division. In the other case, the cell dies off (apoptosis). Then why are these jumping mutations not noticed by the control mechanism and subsequently destroyed? It looks like jumping genes of transposons can suppress or even switch off the proofreading system.

When McClintock introduced her idea of jumping genes in 1951 during a symposium in Cold Spring

Fig. 3.— Different corn cobs used as study objects

Harbor Laboratory on Long Island, her lecture was followed by an uncomfortable silence. No one was prepared for something like this. Nobody understood it. This was either bollocks, either brilliant.

In the next 30 years, with the development of molecular biology and genetics, the work of McClintock was slowly becoming more understood and appreciated. Jumping genes were also discovered in bacteria, fruit flies and other organisms and scientists were surprised by the extent of this phenomenon. This resulted in accordingly silly names for these genes, such as Gypsy, mtanga (Swahili for wanderer), Castaway and Jordan (after the American long jumper).

Late recognition

At the age of 81, in 1983, Barbara McClintock received the Nobel Prize in Medicine. Rightly so, as she taught us that the genome is not a rigid archive of instructions. Not a set blueprint of life, but a dynamic package, continuously remodelled

by an ever-changing environment. This way, she has changed the perspective on the evolution of all living organisms, which appears to have the potential to go much faster and more abruptly than was ever considered possible.

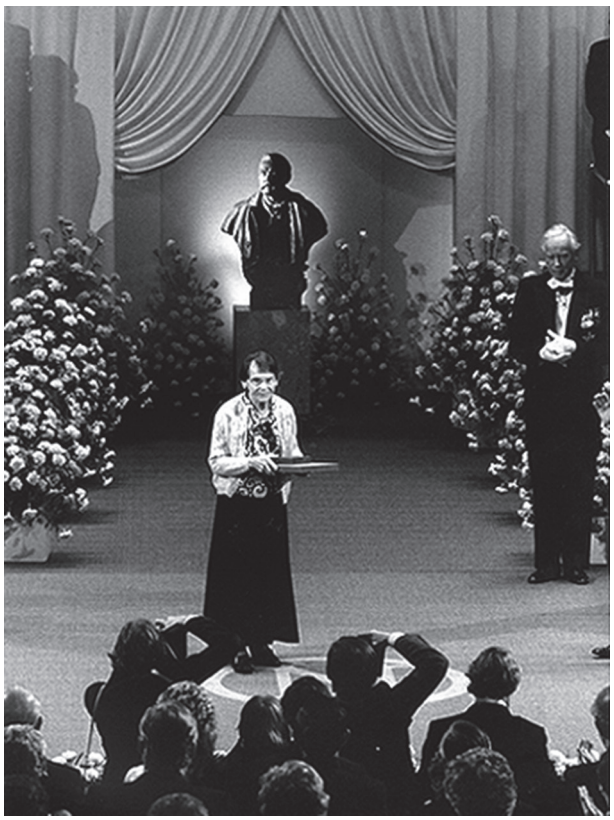

Fig. 4.— Barbara McClintock receiving the Nobel Prize in Medicine in 1983

Fig. 5 .— Stamp dedicated to Barbara