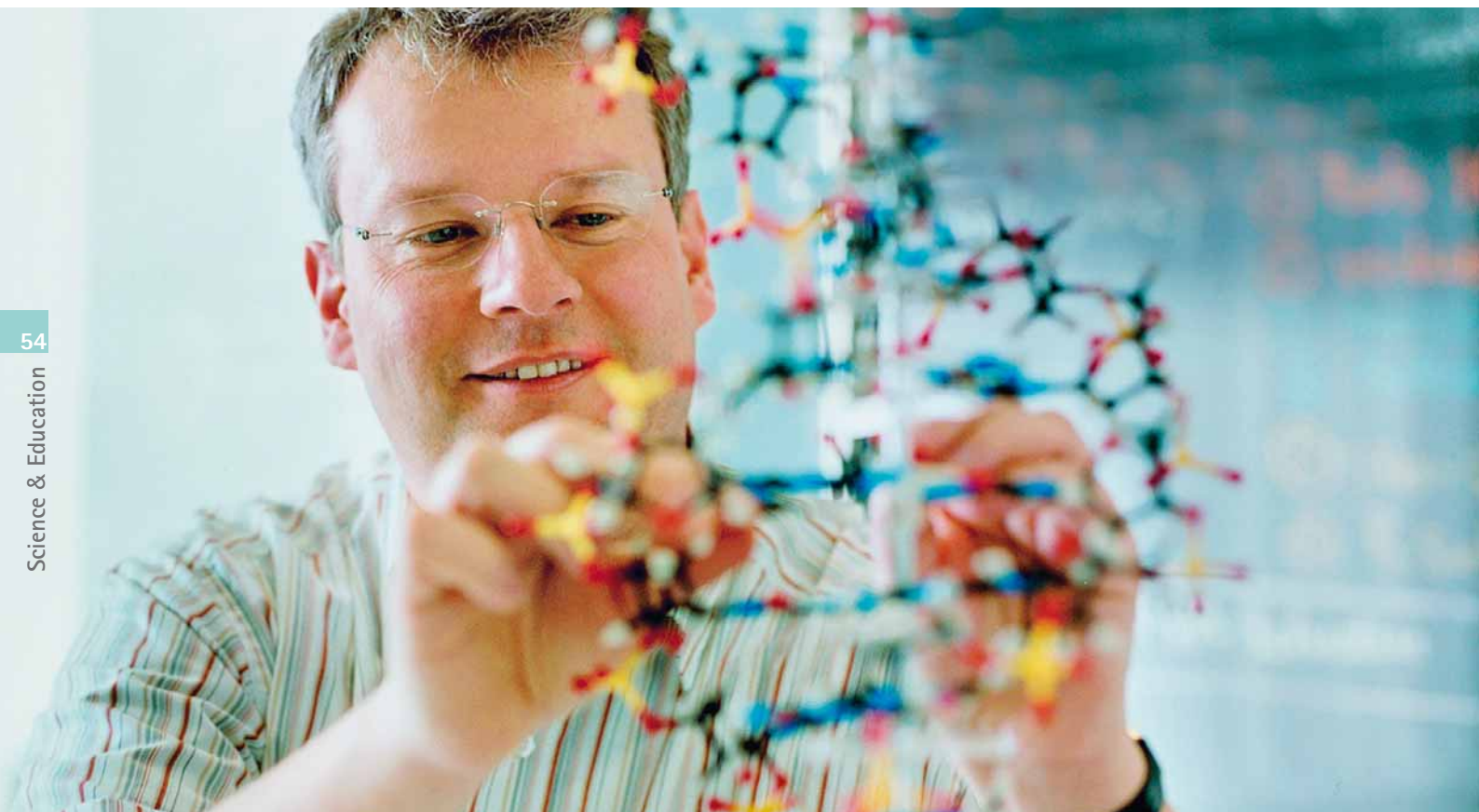


Otto Bayer Prize awarded to Professor Thomas Carell

# Repairs in the nanocosmos



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Science & Education

*Intensive sunbathing – working on your tan – can get you a sunburn, but it can also damage your DNA. High-energy particles, known as photons, incessantly bombard your skin, even as far as the molecules in your cells. Professor Thomas Carell from Ludwig Maximilian University in Munich studies how living organisms have learned to cope with harmful radiation. In recognition of his achievements, he was awarded the 2008 Otto Bayer Prize.*

"Some people can smoke and still live to be 90 years old, while others – exaggerating slightly – get cancer after just three cigarettes," says Thomas Carell, professor of chemistry at Ludwig Maximilian University in Munich. In other words, repair systems must differ from one individual to the next. But whether the damage to our DNA is self-inflicted or a side effect of everyday life, it is apparent that danger lurks everywhere for our cells. Between 50,000 and 100,000 lesions occur in the body's cells every day. Accordingly, that amazing double helix inside that is our

DNA (deoxyribonucleic acid) requires continuous repair.

It is special enzymes that do the job, acting as nanosized assembly systems and replacing lost segments of the DNA strand, correcting defective building blocks or repairing breaks in the strands. In making these repairs, the enzymes prevent mutations, or spontaneous changes in genetic information caused by defects in the DNA. "Theoretically, cancer is extremely improbable," Thomas Carell says, "because it requires the accumulation of 50 to 60 mutations." Nevertheless,

the disease occurs frequently in real life, and its onset is even quite rapid if the repair systems themselves are affected. When this happens, defects can no longer be repaired; they accumulate and cells die or mutate. Similarly, defective repair systems are ultimately also a factor in the normal ageing process.

Thomas Carell explains how these repair crews evolved in the cells of numerous living organisms: when the first bacteria starting performing photosynthesis and using sunlight as a source of energy, they were exposed to an

## Promoting excellence in research

*The Otto Bayer Prize is awarded by the Bayer Science & Education Foundation to outstanding scientists in recognition of pioneering work in the fields of chemistry and biology. It is presented every two years, in alternation with the Hansen Family Award, which acknowledges research in medicine. Established by Bayer AG in 2007, the Bayer Science & Education Foundation's primary objectives are to honor outstanding achievements in research, promote talented scientists and support significant school projects in the natural sciences. Its funding activities focus on the natural sciences and medicine.*



Successful DNA detective work: Professor Thomas Carell (photo, left) and his workgroup (photo above) conduct research into the repair mechanisms of human DNA.



Professor Carell received the 2008 Otto Bayer Prize in recognition of his successful research: Professor Dr. Dr. h.c. Ernst-Ludwig Winnacker, General Secretary of the European Research Council, Professor Thomas Carell, Bayer Management Board Chairman Werner Wenning and Bayer Management Board member responsible for Research Dr. Wolfgang Plischke (left to right).

extremely harsh environment. The ozone layer had not yet developed to shield them from intense UV radiation and its photons. The result was severe damage to their genetic material.

To safeguard their existence, single-celled organisms created ingenious repair mechanisms called "photolyases". These enzymes prevent UV damage to DNA by converting the high-energy photons from sunlight into chemical energy. If these microscopic security guards find an unusual structure while patrolling the DNA double helix, they immediately get to work, uncoiling the helix to access the defective site. Using chemical energy, they transfer electrons, shift atoms back into place and rewire mismatched base pairs. The human body contains no photolyases, but it uses similar enzyme systems to continuously repair DNA. "We succeeded in stabilizing the highly

unstable individual repair phases and were thus able to elucidate the mechanisms," Thomas Carell explains. To do so, it was critical to first generate clearly defined DNA lesions, an area in which his team has specialized.

### Generating precisely defined damage to DNA

In recognition of his research, Thomas Carell was awarded the coveted 2008 Otto Bayer Prize. Established in 1984, it is endowed with €50,000. "Professor Carell's recent achievements in understanding DNA damage and its repair have the potential to serve in the long term as a basis for new treatments, for example in cancer research," said Dr. Wolfgang Plischke, Bayer AG Management Board member responsible for Innovation, Technology and Environ-

ment and Chairman of the Bayer Science & Education Foundation, which awards the prize.



[www.podcast.bayer.com](http://www.podcast.bayer.com)

*Bayer's Podcast Center has a film on the background to this topic.*



[www.cup.uni-muenchen.de/oc/carell](http://www.cup.uni-muenchen.de/oc/carell)

*This Internet website offers more information on the research activities of the 2008 Otto Bayer laureate.*