Can genetic information be controlled by light?

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Researchers at Kiel University have succeeded in showing that DNA strands differ in their light sensitivity depending on their base sequences. Their results are reported by Nina Schwalb and colleagues in the current issue of the journal *Science* appearing on Oct. 10, 2008.

DNA, the molecule that acts as the carrier of genetic information in all forms of life, is highly resistant against alteration by ultraviolet light, but understanding the mechanism for its photostability presents some puzzling problems. A key aspect is the interaction between the four chemical bases that make up the DNA molecule. Researchers at Kiel University have succeeded in showing that DNA strands differ in their light sensitivity depending on their base sequences. Their results are reported by Nina Schwalb and colleagues in the current issue of the journal *Science* appearing on October 10, 2008.

It has been known for many years that the individual bases that code the genetic information contained in DNA show a high degree of photostability, as the energy that they take up from UV radiation is immediately released again. Surprisingly, however, it is found that in DNA, which consists of many bases, those mechanisms are ineffective or only partially effective. It seems that the deactivation of UV-excited DNA molecules must instead occur by some completely different mechanisms specific to DNA, which are not yet understood. Through measurements by a variety of methods on DNA molecules with different base sequences, the research group led by Professor Friedrich Temps at the Institute of Physical Chemistry of Kiel University has now been able to confirm and clarify that assumption.

According to Professor Temps, "DNA achieves its high degree of photostability through its complex double-helix structure. The interactions between bases that are stacked one above another within a DNA strand, and the hydrogen bonds between the base pairs of the two complementary single strands in the double-helix play key roles. Through the different interactions that we have observed the DNA acts to some extent as its own sun-protection".

Nina Schwalb investigated many different base combinations in synthetically-produced DNA molecules. Using a femtosecond pulsed laser spectroscope, she measured the characteristic energy release for each combination. She was able to measure the time for which the molecules continued to fluoresce, and thus how long they stored the light energy. She found that for some base combinations these fluorescence 'lifetimes' were only about 100 femtoseconds, whereas for others they were up to a thousand times longer. A femtosecond is one millionth of a billionth of a second.

Commenting on the conclusions from her research, Nina Schwalb says: "We have investigated the photophysical properties and have found that different base combinations have widely different fluorescence lifetimes. This could lead to the development of a new diagnostic method whereby laser light could be used to directly recognise certain genetic sequences without, for example, having to mark the DNA with dyes as in the method used at present".

One might also envisage linking the photophysical properties to genetic characteristics. When these mechanisms are better understood, it might in the long term become possible to repair gene mutations using laser radiation.

"In the field of nano-electronics it has already been shown that synthetically produced DNA can be used as 'nano-wires'. On the basis of the different reaction times of the molecules it might one day become possible to use laser pulses to 'switch' specific molecules. It might even be possible under some circumstances to make transistors from DNA that would work through the hydrogen bonds," explains Professor Temps.

Source: Kiel University, Germany