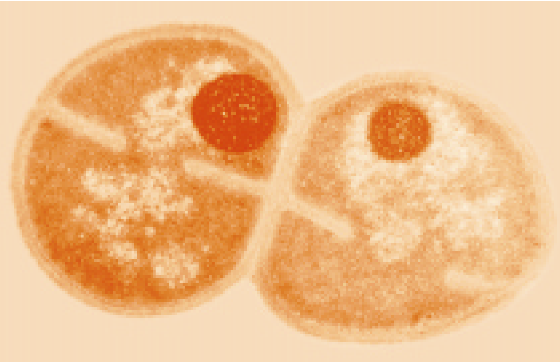
RESISTANT BACTERIA

Living organisms are not equally vulnerable to ionizing radiation. Top prizes for resistance must surely go to certain bacteria. The all-round champion can withstand a thousand times more radiation than the human lethal dose!

Deinococcus radiodurans ***bacterium (lenght about 3 micrometers).***



John R. Battista/LOUISIANA STATE UNIVERSITY

It's called *Deinococcus radiodurans*. What's special about this **bacterium** is its surprising resistance to radiation. It will withstand **radiation** doses 1,000 times heavier than the human lethal dose. Whereas a **dose** of 10 **grays** (Gy) will kill a human being, it takes 100 Gy to kill even the bacterium *Escherichia coli*. But *Deinococcus radiodurans* will survive more than 10,000 Gy!

The reason why *Deinococcus radiodurans* is so radio-resistant is twofold. First of all it possesses an especially efficient enzymatic DNA repair system(1) (see *The caretakers of the genome*). Just after irradiation the **replication** of the **DNA** is blocked so that the bacteria can use a repair process called multiple recombination. This cuts out intact parts of a damaged chromosome and stitches them together with other unharmed segments to build a new fully-operational **chromosome**. In addition, this bacterium displays an exceptional ability to withstand long exposure to oxygen, which normally is very harmful to DNA.

(1) The microbiologist John Battista, the discoverer of *Deinococcus radiodurans*, believes that very early in the Earth's history the bacterium developed this system to repair the damage caused by dehydration, which is very similar to that due to radiation.

Biodegrading qualities

The nuclear industry is naturally keen to put these findings to good use. An American team led by C. C. Lange is using the properties of *Deinococcus radiodurans* in the treatment of radioactive waste containing toxic organic or chlorinated solvents. The bacterium will degrade chlorobenzene, which it uses as a carbon and energy source, for more than 30 hours in a medium in which the radiation **dose rate** is about 60 Gy/h - unlike *Escherichia coli*, which will not grow in these conditions.

It is not meaningful to talk about absolute resistance or sensitivity of bacteria to radiation, e.g., to say simply that a bacteria is killed by a dose of 100 Gy or resists a dose of 10,000 Gy, without stating the dose rate. This is because the number of DNA **strand** lesions in a bacterial cell strongly increases with dose rate.

At CEA/Cadarache, a group at the Waste Behavior and Microbiology Laboratory has investigated the effect of low dose rates on bacterial behavior. The objective was to study the consequences of the presence of micro-organisms such as these bacteria, that might be able to grow in weakly or moderately **radioactive** waste placed in geological storage sites.

These experiments simulate different conditions of stress for the bacteria, in particular radiation at a dose rate close to the initial dose rate in low-to-moderate activity waste confined in bitumen. Micro-organisms that initially showed no special resistance to radiation had been growing for 500 days by the beginning of 2000 in the presence of the necessary nutrients, while exposed to radiation at a dose rate of 8 Gy/h, with a **cumulated dose** reaching 100,000 Gy.

Although the bacteria present in a geological storage site seem to become «hardened» to the effects of the radiation under these conditions, their **metabolism** does not appear to adversely affect the confinement of the radioactive waste. The Cadarache team has shown that on the contrary they can reduce the mobility of **radionuclides** by biodegrading the molecules with which they form chemical complexes.

Marie Libert
Department of Waste Disposal and Storage
Fuel Cycle Division
CEA/Cadarache