



Radiation tolerant Extremophiles

Dr. S. Subramani

- Extremophiles are organisms that have adapted to survive in extreme conditions
- Extremophiles that have the ability to survive in high doses of ionizing radiation are known as radio-resistant or radiation-resistant extremophiles.
- Radiations are designated as ionizing radiations, If their interaction with matter produces unstable ions and free radicals – that interact with living matter, in a destructive manner.
- Ionizing radiations are emitted by unstable atoms. These unstable atoms, try to stabilize, by giving off excess energy. This energy is known as radiation, which is harmful to many organisms.
- Radiation, damage cells, by causing mutations in DNA. These mutations break the bacterial cell's DNA. Low level irradiation causes mutation, while high exposure doses destroy nucleic acids, enzymes and kill microorganisms.

- But, radioresistant extremophiles, have repair mechanisms, to correct the damage – induced by radiations.
- They have enzyme systems – which repair broken DNA fragments, creating new sequences. This mechanism of radio tolerance is noted in *Deinococcus radiodurans* – the second most radio-resistant organism known.
- A radiation unit of 4-10Gray, can kill a human. *Deinococcus radiodurans* can survive upto 15,000Gray.
- The most radio-resistant organism known to man – *Thermococcus gammatolerance* can withstand radiations upto 30,000Gray – two times that of *Deinococcus radiodurans*.

- Bacterial members belonging to the genera *Hymenobacter*, *Rubrobacter*, *Methylobacterium* and *Geodermatophilus*, were isolated from desert soils, which exhibited radiation-resistant survival from 17-25kGy.
- Hyperthermophilic Euryarchael members of the genera *Thermococcus* and *Pyrococcus* showed lower levels of radiation resistance.

Adaptive mechanisms:

Radio-resistant organisms adopt an array of adaptive mechanisms – which are suggested to have evolved – not to counteract radiations, but to compensate desiccation - a naturally occurring stress, that generates a pattern of DNA damage, similar to those produced by ionizing radiations.

(i) BER enzymes:

Both *Deinococcus radiodurans* and *Thermococcus gammatolerance*, use several BER (Base Excision Repair) enzymes – that efficiently repair DNA damage caused by radiations.

(ii) Extremolytes:

Extremolytes are organic compounds found in extremophiles. They are primary or secondary metabolites. Examples include Scytonemin, Mycosporin-like amino acids, Shinorine, Biopterin, Phlorotannin, etc.. These compounds absorb high radiations, protecting the DNA, from damage by radiations.

(iii) Repair mechanisms by Rec.A:

Rec.A is a 38kDa protein, that repairs DNA. High doses of radiations can induce >100 dsbs (double-stranded breaks) per chromosome. *D. radiodurans* carries out extensive recombination repair, using Rec.A protein, to repair the DNA damage.

(iv) Pigments:

A highly gamma radiation resistant bacterium – *Hymenobacter xinjiangensis* – has been isolated from a desert in China. It is a pink-pigmented bacterium – which can tolerate 8K Gy of radiations.

The Cyanobacterial members *Tolypothrix* and *Chroococcidiopsis*, produce Scytonemin – which make them radio-resistant.