Intention for launching Radioecology research working group *(January 2015)*

Title and acronym: **Transgenerational Effects and Species radioSensitivity (TESS)**

Note: will be split into two separate WGs in the future

Leadership

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Topical area (ca. 10-line description)

The issue of biological effects of low doses of ionising radiation is of major concern for both human and environmental radiation protection. This has been recently highlighted after the Fukushima accident, especially with respect to the quantification (and reduction if needed) of the magnitude of risk to individual (human) and population (human and biota) health at low doses/dose rates. Gaining knowledge on low dose effects and explaining clearly important and relevant results obtained to the public is needed to give people the power of informed choice. Being able to clearly demonstrate the role of ionising radiation in comparison with other environmental stressors is a must for this task to be successful.

Understanding the role of primary mechanisms at the cellular and sub-cellular level when organisms are exposed to low dose radiation will help to explain the potential consequences on physiological functions and health at the individual and population level. Of equal importance to studying the immediate effects of exposure to low dose radiation is the need to understand a number of related issues such as: the possible induction of long-term or transgenerational effects and the capacity of organisms to adapt to stress, by elucidating the roles of genetic and epigenetic factors; understanding of the differences of radiation sensitivity across species.

This includes the understanding of the role epigenetics in genomic instability, inheritance and adaptation of organisms under conditions of a pressure selection. In perfect complementarity, mutation rates and types are to be assessed and quantified in parallel. This will enable distinguishing between epigenetic and genetic induced changes. Another important improvement will be achieved by a better understanding of differences of radiation sensitivity across species and phyla, which have important implications for understanding the overall effects of radiation and for radiation protection: sensitive species may require special attention in monitoring and radiation protection; and differences in sensitivity between species also lie behind overall effects at higher levels (community, ecosystem), since interactions between species will be altered.

Broad Objectives (up to 5 lines)

1. To improve our mechanistic understanding of the concepts and drivers governing changes in biological responses of organisms exposed to low-doses of ionising radiation. This includes analyzing data in a novel way (e.g. best use of databases, mathematical and computational approaches).

2. To develop research to characterize molecular or cellular changes driving transgenerational effects and inter- and intra-species differences (between different life-stages within a species)
3. To identify molecular fingerprints that possibly can be used (i) to demonstrate minimal impacts on the environment (e.g. biomarkers of ionizing radiation exposure), (ii) to give an indication of potential impact (e.g. biomarkers of ionizing radiation effects, possibly related to transgenerational effects) or (iii) to inform understanding (e.g. biomarkers of radiosensitivity)
4. To develop lines of communication with advisory and regulatory bodies to evaluate how the new knowledge being acquired should influence radiation protection standards and criteria.

Within COMET WP4, the IRA is focused on the investigation of the role of (epi)genetic changes in transgenerational effects, in vertebrates (fish and amphibians), invertebrates (worms) and plants. These studies are conducted under laboratory controlled conditions (external gamma irradiation) or in the field (Chernobyl, Fukushima). Within STAR WP5, the omics approach is used to understand the different modes of action of alpha vs gamma radiation in exposed fish. This roadmap is based on activities initiated within STAR and COMET.

Justification based on answers to the criteria for prioritization of research, question(s) to be addressed **(up to 20 lines)**

The activities of this WG should contribute and/ or allow to:

- Publish common technical guidance, ensuring research results will be of comparable quality and that the knowledge capitalization will allow powerful meta-analyses to be conducted. Such guidance could relate to data acquisition (approved techniques and procedures), data analysis (mathematical and computational approaches), data interpretation and presentation, data archiving (database development, accessibility and usability), and results communication.
- Acquire (epi)genomic, transcriptomic, proteomic and/or metabolomic data on the transgenerational effects and radiosensitivity of a sufficient number of different species to allow for in a comparative approach and as such in order to implement a powerful meta-analysis among species, among exposure conditions that will lead to a better understanding of molecular or cellular mechanisms leading to inter- and intra-species sensitivity. Phenotype anchoring and top-down approaches must be used. A holistic systems biology will further enable to identify functional and regulatory networks.
- Identify specific molecular or cellular fingerprints to be used as biomarkers of epigenetic changes, adverse hereditary or adaptive effects, radiosensitivity.
- Share information and exchange ideas and approaches with researchers studying the same topics with low levels of “conventional” chemical exposure to provide a cross comparison to ionizing radiation exposures.
- Improve the number and quality of reliable protection criteria for ecosystems and their sub-organisational levels with respect to exposure to radioactive substances. These criteria are needed to support emerging policy in the field of radioprotection of the environment *per se*

as this is now explicitly mentioned in both the International Basic Safety Standards (BSS) from IAEA, and the updated EURATOM BSS

Related challenge(s) and research line(s) in the Radioecology SRA

The research to be done in this WG falls within Challenge 2 of the SRA (*To Determine Ecological Consequences under Realistic Exposure Conditions).* The research to be done in this WG falls within the research line (RL4) (*Identify the mechanisms underlying multigenerational responses to long term ecologically relevant exposures: maternal effects, hereditary effects, adaptive responses, genomic instability, and epigenetic changes/transformations/processes*), but could also contribute to (RL2) '*to understand what causes intra- and inter -species differences in radiosensitivity (e.g. among cell types, tissues, life stages, life histories, ecological characteristics*), RL3 (*Understand the interactions between ionising radiation effects and other co-stressors),* (RL4) '*mechanistically understand how processes link radiation induced effects in wildlife from molecular to individual levels of biological complexity*' and RL5 *(Understand how radiation effects combine in a broader ecological context at higher levels of biological organisation (population dynamics, trophic interactions, indirect effects at the community level, and consequences for ecosystem functioning))* (COMET D2.1).

The research done by this WG could contribute to the MELODI community by delivering fundamental research using the most recent technological developments. The high priority issues MELODI has identified include: the sensitivity of different cell types, redox profiles, genetic and epigenetic profiles and DNA repair capacity (COMET D2.1).