RadoNorm
Managing risks from radon and NORM

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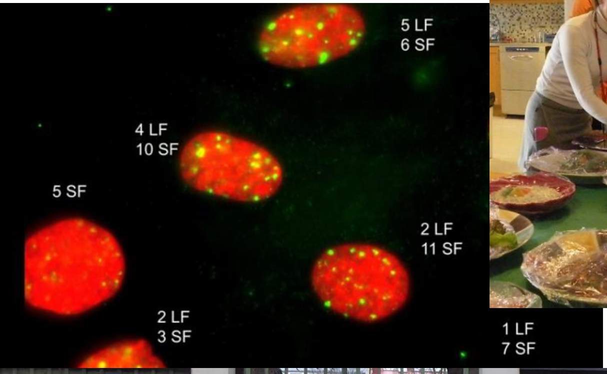
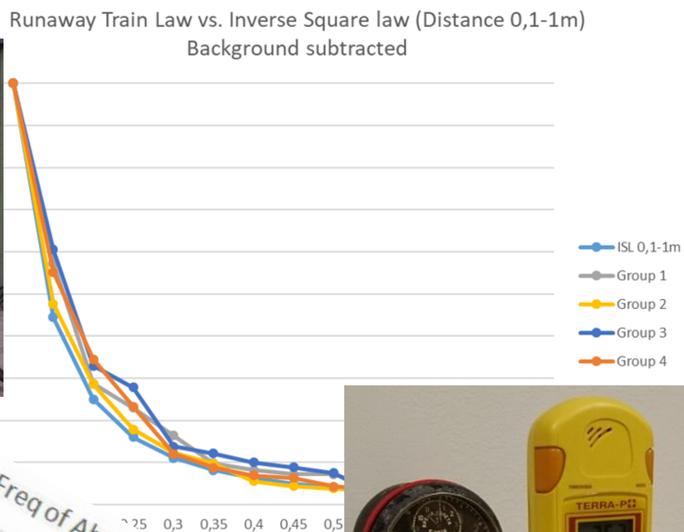
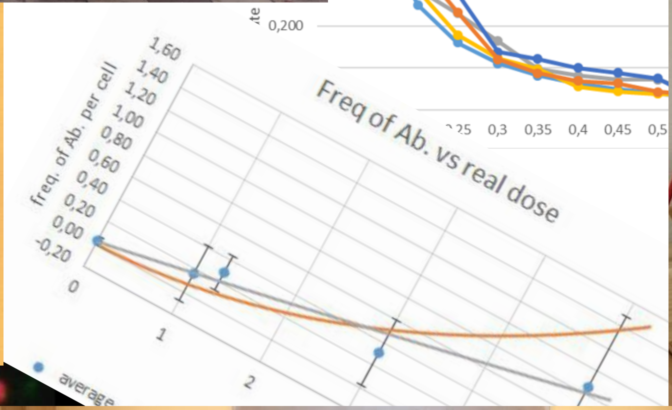
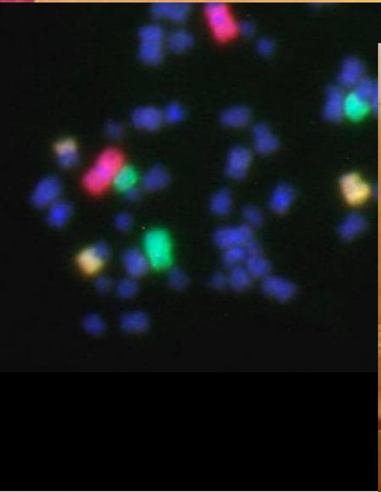
A RadoNorm short course entitled:
CELET: Cellular and genotoxic effects of high and low LET ionising radiation – introduction to radiation biology

Stockholm University, Sweden
14.11.2022 – 25.11.2022









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Version 1 – 2022 03 02

Aim of the course

The aim of the course is to acquaint students with techniques of studying genotoxic effects of ionising radiation which are of relevance for RadoNorm and the broad field of radiation research. The target group are students and young researchers with various backgrounds who want to get a basic introduction to biological effects of radiation. The course will contain both lectures and practical laboratory work. The lectures will focus on various aspects of biological effects of low and high LET ionising radiation as well as on techniques to detect them using cytogenetics and immunogenetics.
The practical part will focus on teaching laboratory techniques used to study genotoxic radiation effects on cells: 1) harvesting cells and analysing chromosomal aberrations and micronuclei by the Giemsa method; 2) in situ hybridization with whole chromosome probes and analysis of translocations; 3) gamma H2AX focus assay; 4) basics of high and low LET radiation detection and dosimetry.
The course will last 2 weeks and will be nested in a 10 week "introduction to radiobiology and cellular toxicology" course held at the Stockholm University (SU). The regular SU course is held for a maximum of 16 students. CELET will harbour a maximum of 12 students, bringing the total number of participants to 28.

Information for applicants: The course is open to any postgraduate student or researcher working in an EU academic institution, aged 35 years or below. There is no course fee and every student will receive a financial support equivalent to 50 Euro per day to cover the costs of logging. The University has no logging possibilities so logging will be offered in a youth hostel. Alternatively, the applicant can find her/his own logging but the sum of financial support will remain 50 Euro per night. No other financial support will be provided.

People wishing to apply should submit by mail the following documents to Andrzej Wojcik at andrzej.wojcik@su.se:
1. A letter of application
2. A CV with a description of the scientific career
3. A supporting letter from the supervisor/head of laboratory

The **deadline for applications is September 12th 2022**. Information confirming the acceptance will be sent by Friday 16th September 2022. A diploma, equivalent to 3 ECTS points, will be issued to each participant after the course.

Course description

To facilitate work in the lab the students will be divided into 4 groups with 7 people per group. Each group will carry out one experiment with different endpoints. At the end of the course students will present and discuss their results.

The course lectures will be held in the morning hours during week one. Practical work will be carried out in the afternoon hours of week 1 and during the whole days of week 2. The practical work will be divided into a "lab-teaching" part and a "results-analysis" part. Each group will learn techniques 1-4 (see above). Hence, each student will spend 4 time-blocks in the lab, where she/he will carry out the steps associated with a technique. The rest of the practical time will be devoted to learning how to analyse cells on microscopic slides/images. The rationale for dividing the students into small groups is that it will allow them to really perform the work and not only watch a demonstration. Each group will be supervised by an experienced employee of the SU.

Each group will also learn how to irradiate cells using the exposure facilities at SU: low-dose rate ^{137}Cs exposure facility, high dose-rate ^{137}Cs exposure facility, X-ray facility and ^{241}Am alpha-exposure facility. Although students will learn how to generate microscopic slides/images that can be used for analysing the results, the scoring part of the curse will be carried out using slides/images prepared beforehand by the SU employees. This strategy will guarantee high quality slides/images for scoring. At the end of the course the achieved results will be collated, statistically analysed and discussed.

Students will learn 4 techniques:

1. Basic dosimetric measurements and techniques of exposing cells to gamma rays and alpha particles. Students will use low activity gamma radiation sources to measure 1) dose rates in air as a function of distance from the source, 2) the energy spectrum of gamma radiation from ^{137}Cs and ^{133}Ba, 3) the effect of shielding. Dosimetric measurements of high activity ^{137}Cs sources will also be carried out. The nuclide content of a radioactive mineral will be determined by analysing its energy spectrum. Radon activities will be measured with an AlphaGuard meter in air drawn from an encapsulated ^{226}Ra source and in a basement room. Build-up of ^{222}Rn disintegration products will be demonstrated by measuring the increment of gamma radiation in a chamber filled with ^{222}Rn. Techniques of exposing cells to gamma radiation (^{137}Cs) and alpha radiation (^{243}Am) will be demonstrated.

2. Preparation of slides for analysis of chromosomal aberrations as well as microscopic analysis of chromosomal aberrations and micronuclei. A microscope will be available for each student. Slides will contain cells exposed to A) increasing doses of gamma radiation (demonstration of a dose response); B) a same dose of gamma radiation and alpha particles (demonstration of the concept of relative biological effectiveness), C) the same dose of gamma radiation delivered at high and low doserate (aim: demonstration of the dose rate effect), Each student will receive slides for analysis.

3. In situ hybridisation with whole chromosome probes (FISH) as well as image-based analysis of aberrations in painted chromosomes. Analysis will be done manually on digital images (aim: demonstration of stable and unstable-type aberrations).

4. Detecting gamma H2AX foci and image-based analysis of foci. Analysis will be done on digital images using the Image J software (aim: demonstration of analysis technique taking into account focus size as well as focus distribution).

Experiments will be carried out with AHH-1 and CHO cells (aberrations and micronuclei) and with VH10 cells (gamma H2AX). The cell lines/techniques are established and currently used in our laboratory.

A detailed description of the course is given below. Lectures/demonstrations start at 09:00. Afternoon demonstrations start at 13.30.

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Monday - day 1
Morning lecture: DNA damage and repair following irradiation of cells (1.5 h)
Morning lecture: Radiation-induced chromosomal aberrations (1.5 h)
Afternoon: Splitting of students into groups, introduction to practical work, distribution of literature for self-studies (1h)

Tuesday – day 2
Morning lecture: Introduction to cellular effects of high and low LET radiation and basic concepts in radiobiology (dose rate effect, LET, RBE) (1.5 h)
Morning lecture: The dose concept and Monte Carlo methods in radiation biology (1.5 h)
Afternoon: Group 1 learns dosimetry, Group 2 learns FISH Groups 3 and 4: analysis of experimental results

Wednesday – day 3
Morning lecture: Factors which influence cellular radiosensitivity (1.5 h)
Morning lecture: Bystander effects of radiation (1.5 h)
Afternoon: Group 3 learns gammaH2AX, Group 4 learns chromosomal aberrations Groups 1 and 2: analysis of experimental results

Thursday – day 4
Morning lecture: Radiation effects on the immune system and the use of radon to treat autoimmune diseases (1.5 h)
Morning lecture: Statistical analyses of experimental results from low and high throughput approaches in radiation research (1.5 h)
Afternoon: Group 1 learns chromosomal aberrations, Group 2 learns gammaH2AX Groups 3 and 4: analysis of experimental results

Friday – day 5
Morning lecture: Radiation-induced micronuclei (1.5 h)
Morning lecture: Radiation-induced gammaH2AX foci (1.5 h)
Afternoon: Group 3 learns dosimetry, Group 4 learns FISH Groups 1 and 2: analysis of experimental results

Saturday: a one day trip to Uppsala with a visit to scientific museums (Lineus and Karolina Rediviva) and an evening reception at the university will be organised

Monday – day 6

Morning: (3h) Group 1 learns the gamma-H2AX assay, group 2 learns chromosomal aberrations. Other groups analyse experimental results.
Afternoon: All groups learn to score gamma-H2AX foci (5h).

Tuesday – day 7

Morning: Group 3 learns chromosomal aberrations, group 4 learns gamma-H2AX (3h). Other groups ana-lyse experimental results.
Afternoon: All groups learn analyse experimental results (5h).

Wednesday – day 8

Morning: Group 1 learns FISH, group 2 learns dosimetry (3h). Other groups analyse experimental results.
Afternoon: All groups analyse experimental results (5h).

Thursday – day 9

Morning: Group 3 learns FISH, group 4 learns dosimetry (3h). Other groups collect results and prepare presentations.
Afternoon: All groups collect results and prepare presentations. (5h).

Friday – day 10

Morning: presentation of results, general discussion (3h)

A diagram illustrating the timing of CELET components is shown below. Blue: lectures/seminars, yellow: experimental work in the lab, green: scoring of slides/images.