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The Radioecology Education and Training Platform

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STAR STRATEGY FOR ALLIED RADIOECOLOGY

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Executive Summary

The Radioecology Education and Training Platform (E&T platform) is a website focal point for students and professionals interested in radioecology. The platform presents an overview of education and training course modules within radioecology/environmental radioactivity presently offered by the STAR consortium. Information on course curriculums and learning outcomes are provided, with recommended pathways to obtained academic merited education (MSc, PhD). The Radioecology E&T platform also provides links to other E&T platforms, such as those within Radiochemistry, Radiobiology and Radiation Protection. This is an important outreach mechanism for the Radioecology E&T platform, as – for example – many of the basic course modules within radioecology are also relevant for other nuclear science students, and vice versa.

The E&T platform contains a number of distinct items.

- The EU MSc in Radioecology – this is a tailored two year MSc programme, Bologna accredited, consisting of obligatory and voluntary stand-alone course modules. As for any EU MSc, students are free to make up credits by taking European Credit Transfer and Accumulation System (ECTS) accredited courses at other institutions and collaborating universities (e.g. Aix-Marseille).
- Radioecology MSc Course Modules – descriptions of the modules currently offered as part of the EU MSc, including the STAR flagship course Experimental Radioecology. These modules are open to MSc students from other programmes.
- Other MSc courses available from STAR partners – this covers relevant courses that are not currently part of the official Radioecology MSc Programme, but that might be relevant to any radioecology student.
- PhD courses – ECTS courses aimed primarily at PhD students. Most European PhD students are expected to take some accredited courses as part of their PhD training. These courses are often relevant and attractive for professional training.
- The Radioecology Research School – this is a networking forum aimed primarily at PhD students in radioecology and other relevant nuclear sciences.
- Training courses – courses aimed primarily at professionals. These do not give ECTS, but can be relevant for both workers and students. Vocational credits can be implemented.
- Links to e-learning tools – useful teaching aids for students and professionals
- Links to the STAR Virtual Laboratory

The present deliverable report details the background and strategy behind the development of the E&T platform, and its various components. The actual E&T website development and production, and release of the final E&T platform will be carried out within STAR WP7.

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1. Introduction

The Radioecology Education and Training Platform (E&T platform) is a website focal point for students and professionals interested in radioecology. The platform presents an overview of education and training course modules within radioecology/environmental radioactivity presently offered by the STAR consortium. Information on course curriculums and learning outcomes are provided, with recommended pathways to obtained academic merited education (MSc, PhD) or relevant competence building and training for professionals. The platform also contains links to other E&T platforms that offer course modules of relevance to radioecology candidates.

The E&T platform contains a number of distinct items. These are described in more detail in the following sections, but are briefly defined as follows.

- The MSc in Radioecology – this is a tailored two year MSc programme, Bologna accredited (120 ECTS[1]), consisting of obligatory and voluntary stand-alone course modules. At present the only MSc in Radioecology in Europe is hosted at the Norwegian University of Life Sciences (UMB), where students can take all necessary courses if they wish. But, as for any EU MSc, students are free to make up credits by taking ECTS accredited courses at other institutions and collaborating universities (e.g. Aix-Marseille).
- Radioecology MSc Course Modules – descriptions of the modules currently offered as part of the EU MSc. These modules are open to MSc students from other programmes.
- The EU STAR supported course: Experimental Radioecology represents a flagship of the STAR E&T effort and is an integral part of the MSc in Radioecology
- Other MSc courses available from STAR partners – this covers relevant courses that are not currently part of the official Radioecology MSc Programme, but that might be relevant to any radioecology student.
- PhD courses – ECTS courses aimed primarily at PhD students. Most European PhD students are expected to take some accredited courses as part of their PhD training. These courses are often relevant and attractive for professional training.
- The Radioecology Research School – this is a networking forum aimed primarily at PhD students in radioecology and other relevant nuclear sciences.
- Training courses – courses aimed primarily at professionals. These do not give ECTS, but can be relevant for both workers and students. Vocational credits can be implemented.
- Links to e-learning tools – useful teaching aids for students and professionals
- Links to the STAR Virtual Laboratory

The Radioecology E&T platform also provides links to other E&T platforms, such as those within Radiochemistry, Radiobiology and Radiation Protection. This is an important outreach mechanism for the Radioecology E&T platform, as – for example – many of the basic course

[1] The European Credit Transfer and Accumulation System (ECTS) under The Bologna Process (ministerial agreements between European countries) designed to ensure comparability in the standards and quality of higher education qualifications. ECTS makes teaching and learning in higher education more transparent across Europe and facilitates the recognition of all studies. The system allows for the transfer of learning experiences between different institutions, greater student mobility and more flexible routes to gain degrees. It also aids curriculum design and quality assurance.

modules within radioecology are also relevant for other nuclear science students, and vice versa.

The present deliverable report details the background and strategy behind the development of the E&T platform, and its various components. The actual E&T website development and production, and release of the final E&T platform will be carried out within STAR WP7.

1.1. Overview of the Deliverable

The deliverable report provides information on the present content and development of the E&T platform within the STAR project. The following section presents the background to the E&T platform, including the present Radioecology MSc, including current status and syllabus revisions. Section 3 outlines plans regarding the development of the E&T website (in collaboration with WP7). Section 4 gives more dertailed information on the current Radioecology MSc, including short summaries of the available course modules, details of the two academic courses held within the STAR project and proposals for new course modules. This includes revisions resulting from proposals forwarded at the STAR E&T stakeholder meetings (see STAR deliverable 6.1) and other STAR project meetings. Section 5 presents a status update of the PhD research school. The final section presents the future timeline and further plans.

2. Background to the E&T Platform

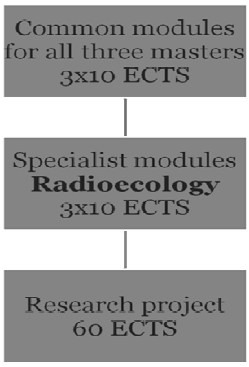
2.1. Background to the EU MSc programme

Already in 2000, the OECD/Nuclear Energy Agency's report: "Nuclear Education and Training: Cause for Concern?" demonstrated that many nations probably were training too few scientists to meet the needs of their current and future nuclear industries. Additional studies undertaken by different European projects (EURAC, ENEN-II, FUTURA) and international organisations (IUR) confirmed the OECD/NEA findings; decreasing student interest, decreasing course numbers, ageing faculty members and ageing facilities. Consequently, the European educational skill base has become fragmented to a point where universities in most countries lack sufficient staff and equipment to provide education in all, but a few, nuclear areas. Of particular concern to the stakeholders (EU Commission, authorities, industry and professionals) are the significant and persistent needs for post-graduates with skills in radiochemistry, radioecology including environmental modelling, and radiation protection including radiobiology and dosimetry.

Given this spectrum of requirements, it was suggested (EURAC, ENEN-II) that the needs identified would be most efficiently met by developing new MSc degree programmes with course modules open to BSc, MSc and PhD students, sharing teaching expertise and, facilities. As a start, three MSc programmes were identified:

- European MSc Radiation Protection
- European MSc Analytical Radiochemistry
- European MSc Radioecology

During the EURAC and ENEN-II projects educational plans were developed for all the above MSc degrees (Fig 1). These plans envisaged that each degree would comprise of three modules that are common to all the degrees (3 x 10 ECTS credits), three specialist modules (3 x 10 ECTS credits) and a research project (1 x 60 ECTS credits), in accordance with the Bologna convention. The lecturing should be shared among specialist scientists within a network of collaborating universities, institutes and stakeholders. As part of the above ENEN-II project, the European MSc in Radioecology was established in 2008, and a European MSc in Radiochemistry will be developed within the EU CINCH-II project (2013 – 2016). Work within the STAR project has included evolving the Radioecology MSc and expanding links with other E&T initiatives.



The MSc courses should be aimed, not only to fill the identified European postgraduate education gap in radiological sciences, but also to provide a modular structure that is easily accessed by stakeholders for professional development training. It was anticipated that the European Masters should meet the academic training requirements of "qualified experts", as defined by the European Commission and the IAEA.

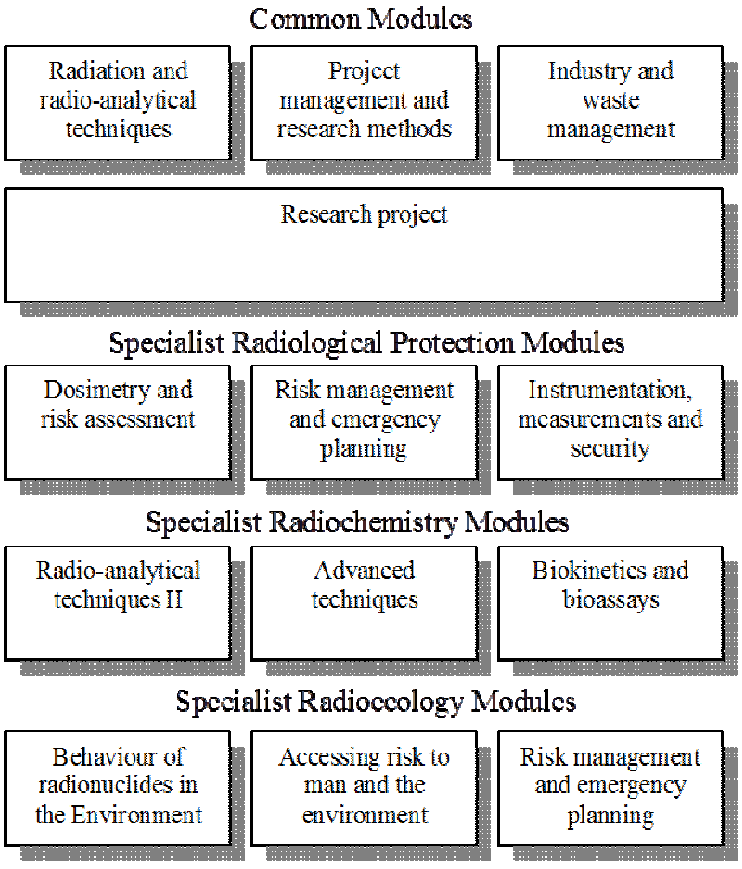


Figure 1. Course module structure for European MSc programs in Radiological Sciences.

2.2. The Radioecology MSc Programme

The only MSc in Radioecology in Europe has been established at the Norwegian University of Life Sciences (UMB). Students from within Europe and outside have attended individual course modules or the whole MSc program. Expert teachers are also from institutions from different countries in Europe and in North America. Initiatives have been taken to establish Joint MSc degree between universities in Europe.

In short, the EU MSc in Radioecology is a tailored two year, Bologna accredited (120 ECTS) MSc programme consisting of obligatory and voluntary stand-alone course modules. At present the MSc is hosted at the Norwegian University of Life Sciences, where students can take all necessary courses if they wish. But, as for any EU MSc, students are free to obtain credits by taking ECTS accredited courses at other institutions and collaborating universities (e.g. Aix-Marseille).

2.3. Student access to other courses and links to other programmes,

The courses provided by STAR, as well as courses available in the STAR consortium (see section 4), give the students access to more specialized courses to choose from, building their specialized Radioecology MSc. In the future, it would be beneficial to have a signed Memorandum of Understanding between the involved Universities, to facilitate student access to the courses. To be able to build an MSc in Radioecology, if and when course modules follow the Bologna convention standards, a joint degree between collaborating universities would boost the EU MSc program and student access throughout Europe. Examples of some of the courses available within the STAR consortium are given in Appendix 1.

Already today some courses in the MSc in Radioecology are linked to other EU education and training initiatives like CINCH-II (Nuclear chemistry) and DoReMi (Radiobiology). Attending the courses in these platforms can further expand the possible courses the students can take as part of their degree. This enables a more cost effective use of the resources already invested in on-going courses and facilities in Europe.

3. Realisation of the E&T Website Platform

The Education and Training pages on the Radioecology Exchange website currently contain information on the further education and professional development courses developed by STAR (Fig. 2). These courses have expanded the portfolio of those available within radioecology, giving students and trainees more courses to choose from to build their expertise. In the future, either a dedicated website will be created or the current wiki pages (Fig. 2) will be developed. The webpages will summarise the information on, and provide hyperlinks to, the courses available, not only in radioecology, but also those on radiochemistry, radiobiology and the radiation protection given by CINCH-II, DoReMi, etc. (Fig. 3)

When entering the Education and Training platform, students will be able to access information on relevant courses available under all the different areas of nuclear and radiation protection science. The MSc and PhD courses selected will need to give credits according to the Bologna model, while training courses need to have implemented vocational training credits. At some universities (e.g. UMB), the MSc/PhD courses are already open to professionals and there is a potential to open for giving both ECTS and vocational training credits.

Figure 2. The current Education and Training webpages

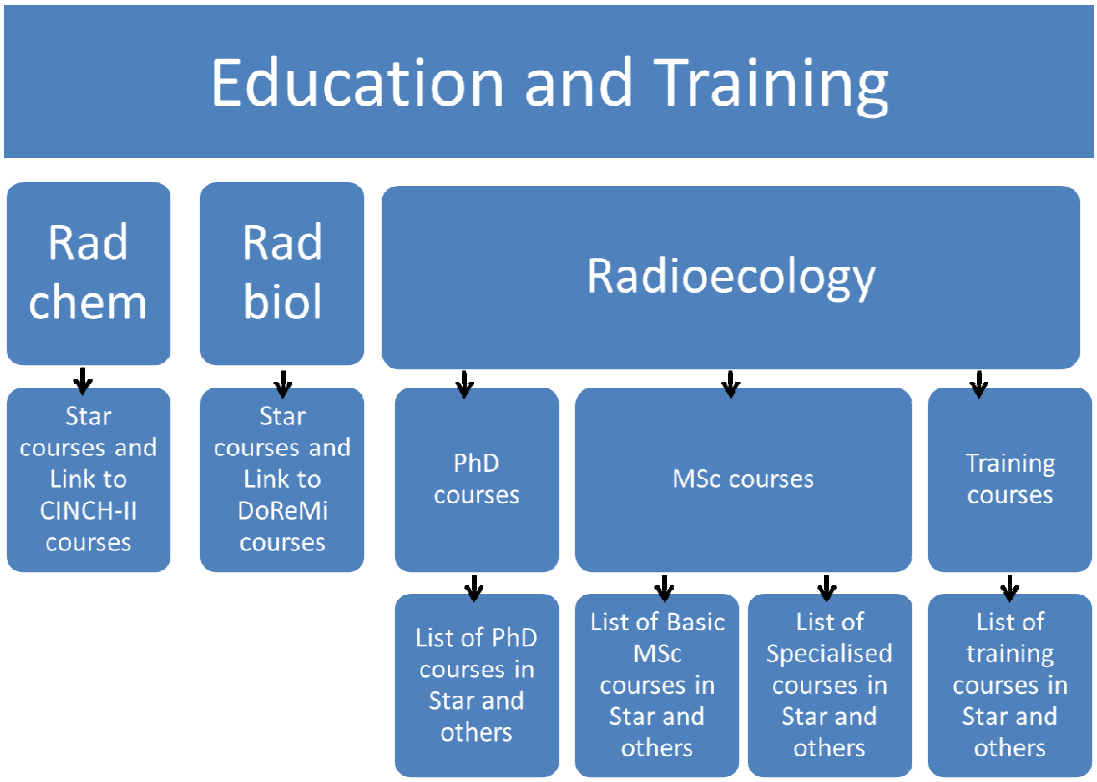


Figure 3. How the planned Education and Training Platform will look

The first step will be to set the platform up for radioecology and radiobiology courses, conducted as part of STAR and DoReMi. The next step will be to include courses on radio- and nuclear chemistry and radiation protection and provide hyperlinks to those organised by CINCH-II and other training courses offered in NERIS and PREPARE.

As well as information on training courses (Fig. 4) the Training and Education platform will include some interactive tools for student interaction and learning. Examples of possible e-learning and student interaction tools include:

- Training videos and lectures from the STAR course in Environmental Radiobiology
- Presentations and summary notes from the ERICA-Tool training course
- Other presentations and summary notes – as from PhD, MSc and other courses.
- Whiteboard presentations (clickable/with voice over)
- Lectures (streamed live or recorded)
- Interviews (streamed live or recorded)
- Audio visual demonstrations
- Mini films/podcasts etc. (see YouTube, or www.microdocs.org)
- Powerpoint presentations (clickable/with voice over)
- Interactive tools (e.g. virtual reality simulations (e.g. walking through a contaminated area)
- Animated tools; interactive equipment e.g. http://www2.plymouth.ac.uk/science/radiationexperiments/radiationsimulations.swf

- Dynamic visual models showing radionuclide movement through the environment (e.g. comparison of I and Cs)
- Websites related to training activities

Hyperlinks will also be provided to other websites which contain information relevant to radioecology/radiochemistry students; currently these include:

- www.nucleonica.com (interactive periodic table, periodic table type publications/add-ons (e.g. element or nuclide specific information such as K_d, environmental half life, transfer factors, important foodstuffs, dose conversion factors, source terms, etc.)
- www.periodictable.com
- www.webelements.com
- www.periodicvideos.com/

4. Radioecology MSc Programme - Course Structure and Modules

At present in the MSc in Radioecology, four of the originally planned MSc courses are held in Norway, while two of the planned courses are held in University Aix-Marseille. In addition, the students can choose other modules relevant for their future interest of work. A Memorandum of Understanding (MoU) expressing the aim to establish Joint MSc degree has been signed between Norwegian University of Life Science and University Aix-Marseille, and a similar MoU agreement will be signed between Norwegian University of Life Science and the Moscow State University.

4.1. Learning Goals and Structure

The overall learning goals for the Radioecology MSc program are as follows:

- The students will be trained in radioecology and be able to conduct experimental radioecological studies. The students will have knowledge on radioactive sources and understand the transport and spreading of radioactive substances in various ecosystems.
- Through laboratory exercises, the students will have the necessary experience to be able to conduct radioecological studies using tracer techniques and radiochemical separation techniques, as well as have an introduction to the basics and theory on advanced measurement methods.
- The students will understand the basis for assessing environmental impact and risks, from radioactive contamination and be able to evaluate alternative countermeasures and clean-up strategies, and thereby contribute to national preparedness associated with nuclear accidents and contamination of different ecosystems
- The courses will provide the students with working permission related to the use of open, ionizing radiation sources in their future work.

In a diverse learning process, the students will gain knowledge about radioecology (i.e. source terms, ecosystem transfer and behaviour of radionuclides in the environment), as well as

biological effects, impact and risk assessment based on radiochemistry and radiation protection. Case studies include NORM, accidental situations, the nuclear industry and waste management. The course module on project management and research methods forms the basis for the research projects.

4.2. Radioecology Course Modules

The learning is based on several intensive course modules, laboratory work, group work, real-life case studies and a thematic thesis with an interdisciplinary approach, and through reflection on links between real-life situations and theory. Giving most of the course modules as intensive blocks makes the courses easily accessible for training needs. In this way, the courses are open for PhD students, MSc students and trainees from all over Europe. An example of the course curriculum is given for some of the courses in Table 1. A list of other STAR courses relevant for the MSc is given in the following section.

Table 1: The Radioecology MSc Programme - Examples of the six course modules available, brief syllabus and specific learning outcome.

Obligatory* courses for all Radioecology MSc students

1) Radiation and radioanalytical techniques (10 credits)	***2) Project management and research methods (10 Credits)***	***3) Experimental Radioecology (5/10 Credits)***
Syllabus:	***Syllabus:***	***Syllabus:***
Basic principles/: The nucleus, stability/instability, Disintegration, T1/2, statistics, mass and energy, α- β- and γ-radiation, spontaneous fission, induced fission, cluster decay, mother/daughter relationship and decay chains,	**Research methods:** Statistics and data handling, database and literature resources, critical analysis of publications, efficient scientific writing	**Environmental behaviour of RN:** Dispersion and transfer of radionuclides in the atmosphere, dispersion and transfer of RN in terrestrial, freshwater and marine ecosystems –from the nuclear fuel cycle.
Interaction with matter: Interaction mechanisms of radiation in matter, including shielding (density, absorbtion) and in active materials (detectors). Overview of radiation protection	**Project management:** Design, implementation and management of projects. Introduction to generic management tools.	**Radiobiology and Radiation Protection Aspects** Biological effects on humans and non-humans, Risk Assessment. Emergency Preparedness
Radioanalytical techniques: Environmental sampling and sample handling / processing techniques, Source preparation, yield, γ- and α-spec, β-scint, γ-spectra, α-spectra, β-spectra, Geometry, quenching, efficiency, calibration, interferences, Good laboratory practice, Quality Assurance/Quality Control, clean room practice.	**Scientific writing and presentation:** How to write scientific papers and make poster. Plagiarism. Ethics in Science, Validation of methods, Oral presentation of scientific results.	**Modelling:** Notion of models, definition of models, databases, etc
Learning outcome:	***Learning outcome:***	***Learning outcome:***
The students will understand radiation and principles of interaction with matter. They will be able to work safely with radiation sources and to be able to apply their	The students will be competent in designing research projects, analysing and evaluate data using appropriate	The students are to have an overview over radioecology and be able to conduct experimental radioecological studies. The course gives a thorough introduction to radioactive sources of contamination and

knowledge to detection of radiation and radionuclides. Gives permission to work with radiation sources and will be provided with a certificate of competence.	statistical techniques. They will be able to make oral and written presentations	the course also focuses on species (speciation), transport, spreading, mobility, biological uptake, modelling and the effect of radioactive radiation as well as environmental impact assessment.
Laboratory practice	Case studies	Laboratory practise

*While these courses are all available at UMB, it is possible for students to replace these courses with comparable ECTS courses (e.g. courses in radioanalytical techniques radiobiology and radiation protection are widely available at other European Universities).

Examples of Radioecology specialized courses

4) Radiation protection and waste management (10 Credits)	***5) Accessing risk to humans and the environment (10 Credits)***	***6) Risk management and emergency planning (10 Credits)***
Syllabus:	***Syllabus:***	***Syllabus:***
Industry and Waste management: Radioactive waste associated with nuclear fuel cycle; mining, types of reactors, reprocessing, waste management, decommissioning, transportation, handling and storage, Low, medium and high radioactive waste.	**Risk Assessment:** Environmental, Human and Ecological risk assessment (chemicals and radionuclides), Epidemiology	**Risk management:** Problem formulation, hazard identification, risk characterization. Countermeasures in different ecological systems and reduction in doses to man. Emergency preparedness. Modelling. Post accidental management.
Legislation, Regulations: At European and national level, release of RN, authorization, safety issues. Quantities and Units, ICRP, ICRU, UNSCEAR Regulatory issues including waste handling and disposal of waste.	**Effects of radionuclides on man and the environment:** Biological effects, doses, dose-models, biological endpoints, cancer, RBE, radiation ecotoxicology, dose to biota, etc	**Source terms:** Great accidental releases of RN in the environment / Sources; Hiroshima/Nagasaki, Chernobyl, Three Mile Island, Mayak, etc
Radiation Protection: Biological effects, doses, dose-models, biological endpoints, cancer, RBE, Dose-effect-risk relationship, ALARA Shielding, distance, time.	**Modelling training** ERICA tool, dose-response modelling (in R), SSD calculations (all with 1-2 days hands on modelling tool training)	**Case study:** Nuclear accidents, dirty bombs etc. Emergency strategy and countermeasures. Modelling.
Learning outcome:	***Learning outcome:***	***Learning outcome:***
The students will know the short long term biological effects from radiation. They will know how to handle low, medium and high level waste, and should be able to estimate risks and associated uncertainties.	Understand the basis for evaluations of environmental impact and become able to conduct basic risk assessments for humans or non-humans.	Have insight into evaluations of environmental impact and the use of effective actions. Competence building that can contribute to national preparedness when it comes to the radioactive pollution of various ecosystems.
Case study: transmutation versus deep storage	Exam: Risk assessment case study	Case study

A full report on the specific courses run as part of STAR WP6 (one MSc course, on PhD course and 2 training courses) will be provided in deliverable 6.3. However, since the restructuring and development of certain courses has been central to the development of the overall E&T training platform, and has greatly benefited from the input of the STAR E&T stakeholders, a brief status report is included in this section. This concerns only the academic MSc and PhD courses, but includes description of a potential new course module in modelling. Other courses available through STAR partners are given in Appendix 1.

4.3. STAR MSc course in Experimental Radioecology

The MSc course in Experimental Radioecology (KJM351/353) is the STAR "flagship" radioecology course intended to be accessible to students taking other environmental science and radiation related subjects, as well as to professionals wishing to build up their competence. At the present time, the course is held at UMB as part of the Radioecology MSc, but earlier versions of the course have been offered to UMB students since the early 1990s.

The main administrative changes made since the start of the STAR project include:

- Splitting into two course modules giving10 ECTS or 5 ECTS in order to better cover the needs of both students and professionals
- Restructuring to give intensive teaching over 2 weeks to allow participants from external universities and international professionals.
- Organization of exam at home university for external students

Although the course to be offered as part of the STAR project was scheduled for autumn 2013, based on input from the STAR E&T stakeholder workshops and STAR consortium discussions, some changes were already made to the course for 2012. This included addition of other international and STAR specialists from IRSN, McMaster University and NRPA The 2012 course attracted 10 students, of whom 6 followed the full 10 ECTS course and passed the exam. All the course students were recruited from the Consortium members, with local UMB students representing 50%. Feedback from the student course evaluation questionnaire, as well as direct response from students and the experience of the teachers, was positive. The only criticism was the high intensity of the lecturing hours, which might be hard to change given the short time frame for an intensive course. The feedback from students and teachers has as far as possible been taken into account for the 2013 course.

Further developments have been made for the 2013 course (to be held in October 2013). These include increased participation from STAR consortium members: SCK, CIEMAT, NRPA and IRSN. An overview of the various proposals received from stakeholders and STAR participants is given in Table 2, together with the proposed changes. The 2013 course lecture plan is provided in Appendix 2. So far 16 students have applied for registration for the 2013 course, of whom about half are from EC countries.

Table 2: Summary of proposed changes and revisions made (see STAR Deliverable 6.1 for more details of the proposals make at the STAR E&T Stakeholder Workshops).

Proposals based on 2011 course (see STAR D6.1, 2012)	**Revisions made to 2012 course**	**Revisions for 2013**
Need some more "catching" lecture titles: nuclear forensics, accidents, etc	Changed some titles	Continued …
The introduction needs to be more generally relevant	-	The curriculum has been changed to include – visually – and not just as sub-themes in lectures: 1) General Radioecology Introduction Lecture 2) General sources lecture 3) Stand alone Chernobyl and Fukushima lectures (these will make the lectures/course look really interesting)
Radiobiology is too heavy on non-human biota	Restructured to make the human/general radiobiology and non-biota parts clearer.	Lectures have been revised to coordinate better with the UMB Environmental Radiobiology course (MINA410)
Too much on NORM	Cut one lecture	-
Not enough modelling	One lecture included	An overview modelling lecture has been included
Transfer should be a lecture in itself. At the moment seems to address speciation only or spread over aquatic, terrestrial, etc lectures.	Will be integrated in lectures concerning all ecosystems	A standalone lecture on transfer has been included
Too much with two tracer experiments	One more lab experiment has been introduced, demonstrating speciation, transfer to biota, and the usefulness of tracer techniques	Revisions have continued highlighting the different techniques.
Need for experience on RN analytical techniques (e.g. Sr/Pu)	-	Separation techniques are already included in the Radiochemistry course module. Thus is it difficult to include time consuming Sr/Pu separation techniques in the limited lab experiment time for the course. However a lecture on techniques has been added.
Need more on waste disposal/management (high EU relevance for nuclear power countries)	Covered in detail in the Aix-Marseille course; and mentioned in source lecture	The possibility for a stand alone lecture has been discussed, the decision was to await feedback on the French course.
Radon measurement as a	Is discussed together with the	A practical has been included.

practical	Rn dose calculation during the NORM lecture	
Include a visit from NRPA mobile whole body monitoring unit	-	This is now included in the 2013 course

4.4. Environmental Radiobiology PhD course

The Environmental Radiobiology course (MINA 410) was the test PhD course run during the STAR project. The aim of the course was to give students an overview of the fundamental principles of radiobiology, but within the context of effects on non-human biota. The course covered both the history and the state-of-the-art of our knowledge on the biological effects of radiation on humans, including how recent studies are challenging established paradigms, but concentrated specifically on those issues and applications of most relevance for other organisms (See Appendix 3). This included effects and endpoints significant for non-human organisms, ways in which radiobiology methods and biomarkers are being applied in ecological research, factors influencing radiosensitivity in different organisms, and ecological risk assessment. Case studies included ecological research in Chernobyl and Fukushima, and laboratory work on biomarker analysis in model organisms. The lecture plan is provided in the Appendix.

In a development from the original STAR workplan, we made a successful application for additional funding from DoReMi for this course, primarily to foster exchange of students between the two disciplines, and also to strengthen links with the radiobiology community. The rational was that the course would provide the opportunity to get a better understanding of the fundamentals of radiobiology for students of radioecology; and that for radiation biology students it would offer the chance to see how radiobiology concepts and tools are applied in other areas of radiation research, thus gaining a more in depth understanding of the subject. Teachers were from Norway, Canada and Sweden and 28 students took the course with a split of 20 PhD and MSc students and 8 “professionals”; of whom 8 were from Norway, 15 EU and 5 non-EU (USA, Argentina, Russia).

As part of the dissemination work to be carried out in collaboration with WP7, the intention is that selected powerpoint presentations from the course will be made available on the E&T platform, together with discussion case studies (e.g. fieldwork challenges, “the linear-no-threshold (LNT) court case”). A number of suggestions for the development of e-learning tools were also proposed, that could be taken forward with WP7. These included micronuclei scoring exercises, ecosystem response, a “RAP-App”, field site maps, etc. But these ideas need further discussions with WP7 to decide what is practicable.

4.5. Environmental Radioactivity Modelling Module

A clear recommendation from the E&T stakeholder workshops was the need for modelling competence. There was strong consensus from STAR partners that this is an important area of expertise, and one that is highly sought after in stakeholders and employers. Funding and resources to set up a whole new module has not been included in the STAR budget, but it was

agreed that efforts should be made to start the process to “fill the hole”, with a view to looking at eventual financing and feasibility, and possibilities for follow up. Thus CIEMAT and SCK have started to put together a module outline, and there is positive feedback that such a module could be offered at the University of Madrid.

Briefly, this is a module that would attract professionals as well as students and also lends itself well to distance and e-learning. It should be relatively cheap compared to laboratory courses. Learning goals would include that students would be able to use simple assessment models (via hands on training in some models), that they would be able to understand the applications, assumptions and limitations of models, and that the course would provide the basic competence to go on to take a PhD in modelling (i.e., the aim is NOT to produce fully fledged modellers in two weeks).

Potential funding opportunities were also discussed, including the possibility of links with DoReMi or NERIS training courses, as well as an Alliance sponsored professor at the host university. These will be discussed further in Deliverable 6.4.

5. The Radioecology Research School

The STAR PhD research school is a virtual forum intended to increase networking and interaction between students working within radioecology. The school was formally launched in 2012, with a dedicated STAR website (Figure 4) and at present 19 PhD students and 9 ex-students are registered, with a further 11 under registration as a result of the STAR PhD course.

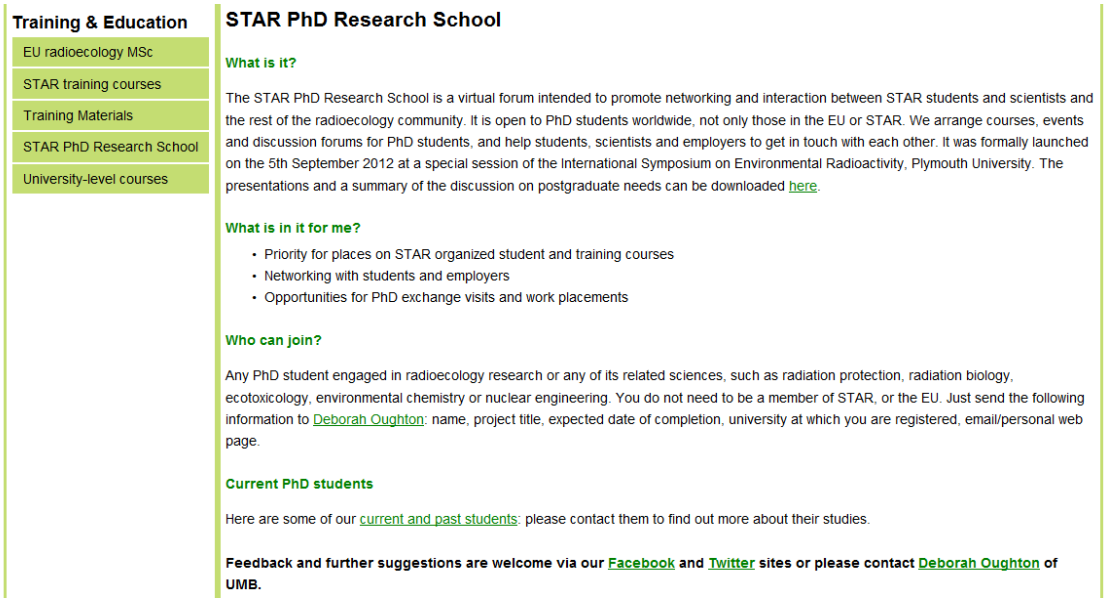


Figure 4: Screenshot of the present STAR PhD Research School webpage.

The research school is open to PhD students worldwide, and the intention is to extend to MSc students within the next year. Benefits for research school students include priority for places on STAR organized student and training courses; and opportunities for PhD exchange visits and work placements.

The plans are to continue the PhD Research School within the Education & Training Platform, with dedicated activities related to forthcoming conferences, and student travel grants/awards for best posters and presentations at conferences (e.g. the ICRER conference in Barcelona, 2014).

6. Future Plans

Discussions with WP7 on the structure of the E&T website platform are ongoing and revisions are expected before the end of 2013. Links with the virtual laboratory will be facilitated at that time.

As to the future of both the platform and the MSc in Radioecology, the main challenge in maintaining such a joint MSc program is sustainable funding. Both the EU and stakeholders need to find a way to help students pay their student fees, keeping in mind the notorious heterogeneity between the different EU universities concerning these fees (for instance between Germany and the United Kingdom). Provisions should be carried out to cover the cost of staff movements. These issues will be addressed in greater detail in the final WP6 Deliverable: 6.4. Funding and Sustainability.

Mutual acceptance of course modules utilized within radioecology, radiochemistry, radiobiology and radiation protection is needed. Hopefully this work can be taken further as part of the COMET and OPERRA projects. The training and education collaboration between universities and institutes should be confirmed by Memorandum of Understanding and possible Joint degrees.

References

Skipperud, L., Salbu, B., Priest, N. D., Garelick, H., Tamponnet, C., Abbott, A. & Mitchell, P. (2011). European MSc programs in nuclear sciences: to meet the need of stakeholders. *Nuclear Engineering and Design*, 241 (4): 1013-1017.

Appendix1: STAR consortium course modules – platform

Courses available in STAR	Courses relevant for EU MSc in Radioecology	Available as Training Courses	Comments
Environmental Radiobiology (5 ECTS), UMB, Norway	Yes	Yes	PhD course
Ecotoxicology (10/15 ECTS), UMB, Norway	Yes	Yes for the short course	PhD relevant
Radiological Protection of the Environment, UK, NERC		Yes	No ECTS
Radiation Biology (15 ECTS) SU, Sweden	Yes	Linked courses are offered as part of DoReMi	
DNA Damage: Signalling and Repair (15 ECTS), SU, Sweden	Yes		PhD relevant
Cancer Biology (15 ECTS) SU, Sweden	Yes		PhD relevant
Ecotoxicology (15 ECTS) SU, Sweden	Yes		PhD relevant
Applied Environmental Modelling I and II (15 ECTS each), SU, Sweden	Yes		PhD relevant

Programme for KJM351 Experimental Radioecology 2013

KJM351 Eksperimentell Radioøkologi — 10 studiepoeng
KJM351 Experimental Radioecology — 10 ECTS points

Lab exercises at the Isotope laboratory
Lunch break usually between 1200-1315 (see detailed programme)

The module comprises the following:
Ca. 38 hours lectures, 4 hours case study
Laboratory practice (ca. 25 hours) and submission of laboratory journal (counts ¼ of the grade).
Submission of term paper (counts ¼ of the grade).
Written exam in December (counts $^1/_2$ of the grade).

Week	Date	Time	Room	Subject	Lecturer/supervisor
40	Monday 7.10	08:15-10:00 10:15-11:00 11:15-12:00 13:15-14:00 14:15-16:00	SKP	Introduction: Speciation of radionuclides in the environment, radioecological aspects Introduction to laboratory exercise Radiochemical separation techniques Radiochemical separation techniques cont. Advanced methods	Brit Salbu Marit N. Pettersen Lindis Skipperud Ole Christian Lind
	Tuesday 8.10	08:15-10:00	LAB	Start experiment: Kinetics, CF, Kd. Size- and charge fractionation	Marit Nandrup Pettersen/Merethe Kleiven/Tove Loftaas
		10:15-12:00	PL203	Sources; Past, present and future sources of radionuclides in the environment	Ole Christian Lind/Brit Salbu
		13:15-15:00	LAB	Kinetics, CF, Kd: 3-4 hrs measurement Size- and charge fractionation continue	M. N. Pettersen/M. Kleiven/T. Loftaas
		15:15-16:45 16:45-17:15 17:15-18:00	PL203	NORM and dose calculations Food and Refreshment break Demonstration of radon measurements	Peter Stegnar Peter Stegnar
	Wednesday 9.10	08:15–12:00	LAB	Sequential extractions, step 1-4 Kinetics, CF, Kd: ~24 hrs measurement	M. N. Pettersen/M. Kleiven/T. Loftaas
		13:15-14:00 14:15-15:00	J106	Demonstration of the NRPA preparedness mobile laboratory The Chernobyl nuclear accident	Per Strand/Bjørn Lind Per Strand
		15:15-16:00	LAB	Sequential extractions, end step 4	M. N. Pettersen/M. Kleiven/T. Loftaas

	Thursday 10.10	08:15–12:00	LAB	Sequential extractions, step 5-6	M. N. Pettersen/M. Kleiven/T. Loftaas
		13:15-16:00 16:00:-16:30 16:30-17:15	SU113	Modeling within radioecology (**NB! students need laptop pc**) Food and Refreshment break Modeling within radioecology	Juan Carlos Mora Canadas Juan Carlos Mora Canadas
	Friday 11.10	08:15-11:00	LAB	End kinetics, BC, Kd, ~70 hrs measurement Autoradiography Start depuration	M. N. Pettersen/M. Kleiven/T. Loftaas
		12:00-14:00 14:15-15:45	Curie room/Image centre	Radioactive particles/Speciation Electron microscopy/Particle identification and characterization (demonstration)	Ole Christian Lind Ole Christian Lind/Cato Wendel
	Saturday or Sunday	To be decided		Joint tour to the Bygdøy museums, Oslo (Kon-Tiki, Fram, Viking ships)	Ole Christian Lind
41	Monday 14.10	09:15–11:30 12:15-15:00	LAB	End depuration. Size- and charge fractionations, ~96 hrs Autoradiography (read-out)	M. N. Pettersen/M. Kleiven/T. Loftaas /O. C. Lind
		15:15-16:00 16:15-17:00 17:00-17:30 17:30-18:15	J106	Biological effects of ionizing radiation Uptake of radionuclides in plants Food and Refreshment break, Isotope laboratory Biological effects of ionizing radiation in plants	Deborah Oughton Hildegarde Vandenhove Hildegarde Vandenhove
	Tuesday 15.10	09:15–10:00 10:15-12:00 13:15-15:00 15:15-16:00 16:00-16:30 16:30-17:15	SKP	The Fukushima accident Freshwater radioecology including modeling Assessing impacts of ionizing radiation to man and non-human biota (principles, mechanisms, biomarkers) Radioecology principles and challenges, including multiple stressors Food and Refreshment break Radioecology principles and challenges, including multiple stressors	Hildegarde Vandenhove John Brittain Deborah Oughton Tom Hinton Tom Hinton
	Wednesday 16.10	09:15-11:00 11:15–12:00 13:15–15:00	SKP	Radioecology principles and challenges, including multiple stressors cont. Radionuclides in the marine environment Radionuclides in the marine environment cont.	Tom Hinton Luis León Vintró Luis León Vintró
		15:15-16:00	DEMO	Visit to FIGARO “Facility for Low Dose-Rate Gamma Irradiation”	Ole Christian Lind
	Thursday 17.10	09:15–12:00 13:15-15:00	PL203	Terrestrial radioecology, transfer and countermeasures Preparedness, Environmental security	Justin Brown Brit Salbu

	Friday 18.10	09:15-12:00 13:15-14:00 14:15-15:00	PL203	Case study: Nuclear preparedness Summary of case study Summary of KJM351	Per Strand/Ole C. Lind Per Strand/Ole C. Lind Brit Salbu/Ole C. Lind

Deadline for term paper will be 1 week before the written exam (date to be decided).

Important dates

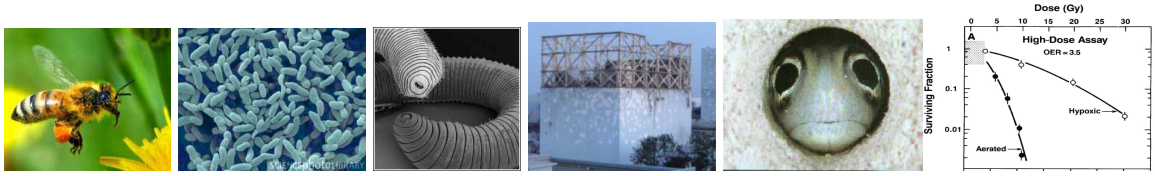
Friday 12.10	DELIVERABLE	KJM351 Students obliged to present a title for their term paper (own choice or from list of suggested titles)	Ole Christian Lind Submission on Fronter/by e-mail
Date to be decided	DELIVERABLE	KJM351 Students obliged to report an elaborated outline including suggested main literature for their term paper	Ole Christian Lind Submission on Fronter/by e-mail
November 15th	DELIVERABLE	Deadline for submitting laboratory report	Ole Christian Lind Submission on Fronter/by e-mail
December 1st	DELIVERABLE	Deadline for submitting term paper	Ole Christian Lind Submission on Fronter/by e-mail
December 12th *14:00-17:30*	EXAM		

Ole Christian Lind
Associate Professor

Environmental Radiobiology

24-28th June 2013, UMB, Norway

5 ECTS MSc/PhD Course organised by the Norwegian University of Life Sciences (UMB) and Stockholm University, supported by DoReMi and STAR



Lecture Plan

All lectures will be held in the SKP Auditorium (Building 61). Lunch will be organised at the SKP canteen or garden.

Overview

The course is mainly lecture based, with one afternoon of laboratory practicals and demonstrations linked to the preparation and analysis of samples for biomarker assessment following in vivo irradiation of whole organisms (fish and earthworms). In general, the days are split into lectures on radiobiology (Seymour and Wojcik) and ecotoxicology (Mothersill, Bradshaw and Oughton).

Monday 24th

0830-0900: Registration and coffee
0900-0920: Welcome from Professor Brit Salbu, Head of the Centre for Environmental Radioactivity (CERAD), UMB
Radiobiology refresher
0920-1030: DNA damage and repair: mechanisms and assays (PFGE, comet assay, focus assay) (Andrzej Wojcik)
1100-1215: Cell death mechanisms (mitotic death, apoptosis, autophagy) and biophysical models based on clonogenic cell survival (Colin Seymour)
Lunch and student registration for those taking the ECTS course
Assessing the Impacts of Ionising Radiation on Non-human biota
1315-1430 History, concepts and differences between approaches for non-human species and humans (Deborah Oughton)
1500-1615 Impact of Ionising Radiation on Non-human biota – challenges from endpoint and effects analysis (Carmel Mothersill)

1700: Social Event: Pizza and beer/soda get-together (Bioteknologibygningen Library, Building 44)

Tuesday 25th
Factors influencing cell radiosensitivity
0915-1030: Common factors influencing cell radiosensitivity - focus on oxygen status, cell cycle, chromatin, etc. (Colin Seymour)
1100-1215: Mechanisms of extreme radioresistance of selected non-human species (rotifers, taridgrades, insects, bacteria) (Andrzej Wojcik)
Lunch
1315-1615: Radiosensitivity and radioresistance in non-human species, intra and interspecies differences, life history stages. (Carmel Mothersill)

Wednesday 26th
Biomarker tools and endpoint assessments, applications in non-human biota
0915-1215; Introduction to biomarkers of exposure – what can they tell us Cytogenetic damage (chromosomal aberrations and micronuclei) – the most common biomarkers of exposure (Andrzej Wojcik) immunohistochemical and bystander assay (Carmel Mothersill)
Lunch
1315-1615: Visit to the UMB low dose irradiation facility, FIGARO. Laboratory work: organism dissection, cell cultures, harvesting for bystander analysis, comet assay, micronuclei assay. Demonstrations and hands on exercises

1800: Social Event: Tai Chi session followed by "Midsummer" Barbeque (location dependent on the weather!)

Thursday 27th
0915-1215: RBE and weighting factors: comparison of human and non-human approaches; Non-targeted effects and new paradigms in radiation biology (Carmel Mothersill and Colin Seymour)
Lunch
1315-1500: Systems Ecology, Ecosystem Approach and Radiation Ecology (Clare Bradshaw)
1515-1600: Introduction to field studies (Deborah Oughton)

Friday 28th
0915-1100: Field studies of radiation ecological effects: Cases: Chernobyl, Mayak, Fukushima, mining, waste disposal (Clare Bradshaw and Carmel Mothersill)
1115-1200: Group discussions on interpreting field study cases
1200-1215: Feedback and summary session
Lunch
1315-1415: Environmental Risk Assessment and Regulation of Effects on Non-human Species (Deborah Oughton)
1430-1530: Follow up on laboratory sample preparation(Carmel Mothersill)

Examination
The exam is a course assignment to produce a detailed experimental description and plan for testing a specific hypothesis (topics to be chosen by the students and can be related to their own research projects). In addition to the one week intensive teaching,

students are expected to spend one week on research and assignment, and will be given tutoring (distance) by the course teachers during this time.

Coffee, Lunch and Social Events
Coffee/tea and a simple lunch will be provided free of charge by UMB. Refreshments at the social events on Monday and Wednesday will be provided by the STAR/UMB Research School.

Teaching Material
Course teaching material in the form of powerpoint presentations and background literature will be provided as pdf files by the organisers.