Report on the PIANOFORTE training course “BIODORA“ – 2023

Content, organisation and participants

From 26 June to 14 July, the PIANOFORTE training course "BIODORA" ("Application of Biological Dosimetry in Radiation Protection & Radiation Research") was organised by the Federal Office for Radiation Protection (BfS) with the aim of maintaining and sharing knowledge in the field of biological dosimetry.

The course gave the participants an insight into the different methods of biological dosimetry that can be used in individual dose reconstruction, emergency response or radiation protection (see timetable). In the frame of methodological lectures and laboratory sessions the advantages, limitations and special features of the individual methods were explained and demonstrated. Thus, the participants were not only taught how to apply the methods, but were also encouraged to critically review the research results. Additional keynote lectures addressed associated topics or interdisciplinary topics closely linked to biological dosimetry. This demonstrated the possibilities to integrate the methods of biological dosimetry into radiation protection and radiation research, especially into the research fields identified in PIANOFORTE (Figure 1A). While the lectures were held in an online format, the participants were able to deepen their knowledge by working in the laboratories of the section "Biological Dosimetry" at the BfS in Munich over a period of 5 days.

A total of 12 doctoral students, post-docs and scientists from eight European countries participated both in the lecture and laboratory sessions (Figure 1B). In addition, 13 participants attended the lecture session only, from countries such as Spain, Egypt and Indonesia (Table 1). Due to the online format of the lectures 25 participants could be accepted for the training course in total. In the laboratory part the number of participants has to be restricted to 12 persons due to the limited space in the rooms. Due to the limited space in the laboratory, only.

The lectures and the laboratory sessions were held in cooperation with international and European experts, most of them are active in the RENEB network (Figure 2): Bundeswehr Institute for Radiobiology (Germany), Ghent University (Belgium), Health Canada (Canada), IRSN (France), National Center for Scientific Research „Demokritos“ (Greece), Stockholm University (Sweden), Universitat Autònoma de Barcelona (Spain) und UK Health Security Agency (United Kingdom). The Bundeswehr Institute for Radiobiology additionally hosted a laboratory day dealing with the topic “gene expression” in their own laboratories.

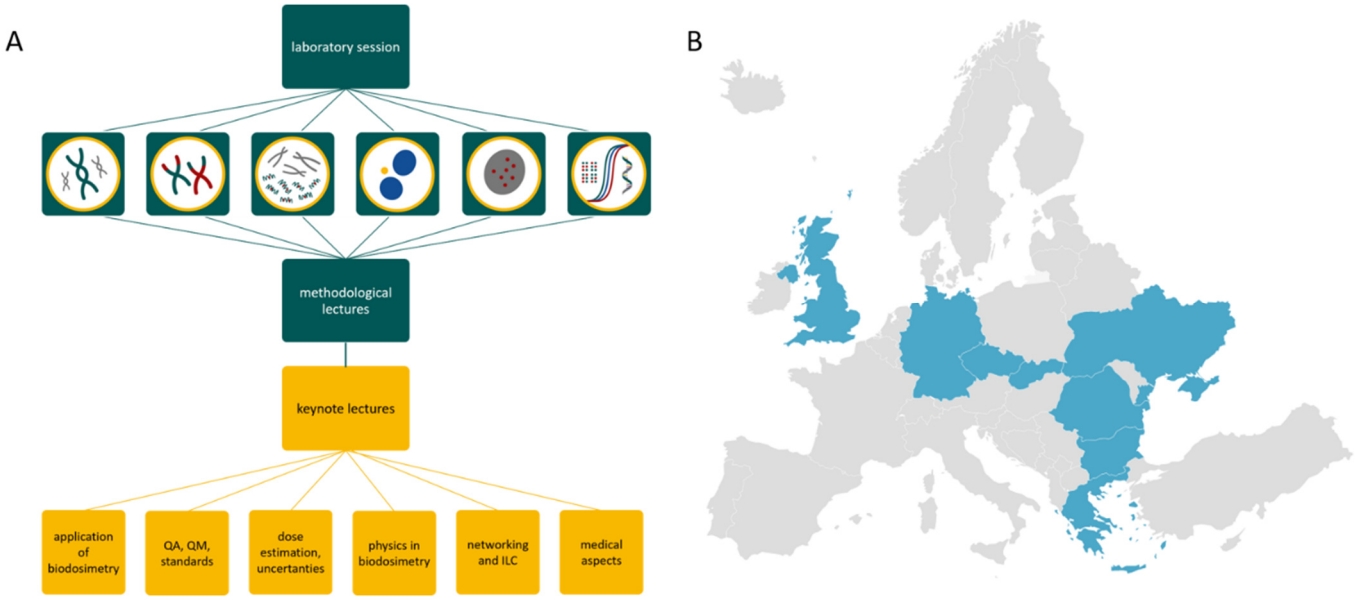


Figure 1: **A** Content of the BIODORA training course. **B** The 12 participants who participated in the lecture and laboratory sessions came from Bulgaria, Czech Republic, Germany, Greece, Romania, Slovakia, Ukraine, and United Kingdom.

Table 1: Gender, country of origin, education level and background of the participants.

participant data		number of participants	
		lecture & laboratory session	only lecture session
gender	female	9	9
	male	3	4
country of origin	Bulgaria	2	1
	Czech Republic	2	
	Egypt		1
	Germany	1	1
	Greece	1	
	Indonesia		6
	Romania	2	
	Slovakia	2	2
	Spain		1
	Ukraine	1	
	United Kingdom	1	
education level	MSc student	0	3
	MSc	3	3
	PhD student	5	2
	Postdoc	4	4
	Senior researcher	0	1
background	biological dosimetry	7	
	radiobiology	13	
	physics	3	
	radiochemistry	1	
	epidemiology	1	

Bundesamt für Strahlenschutz	Martin Bucher	Organisator, dicentric chromosome assay
	Ursula Oestreicher	Ko-Organisator, dicentric chromosome assay
	David Endesfelder	Statistics
	Daniela Hladik-Klenner	dicentric chromosome assay
	Augusto Guissani	Physical aspects in biological dosimetry
	Ute Rößler	γH2AX assay
	Clemens Woda	Physical retrospective dosimetry
Bundeswehr Institute of Radiobiology (BIR)	Michael Abend	Genexpression assay
	Matthias Port	Medical aspects in biological dosimetry
GHENT UNIVERSITY	Anne Vral	Micronucleus assay
Health Canada	Ruth Wilkins	Standardization of methods and protocols
IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE	Juan Martinez	Quality assurance and quality management
National Centre for Scientific Research "Demokritos"	Georgia Terzoudi	Fusion PCC assay
Stockholms universitet	Andrzej Wojcik	Biological dosimetry in radiation protection and radiation research
UAB	Joan Barquinero	FISH assay
UK Health Security Agency	Stephen Barnard	γH2AX assay
	Mingzhu Sun	Chemical-induced PCC

Figure 2: Participating institutions and lecturers.

Feedback of the participants

The format and contents of the course also resulted in a positive feedback from the participants, (see Annex I: citation box 1 & 2 and evaluation). However, to get more information a detailed survey was performed in addition (see Annex II: questionnaire). In this survey, 24 of 25 participants took part in the period from 17 to 31 July. The results of this are listed separately in the appendix. It should be mentioned that in some cases more than the 12 participants of the laboratory session gave feedback for questions concerning only the laboratory part.

From the participants' feedback, the following conclusions could be drawn on the potential for improvement for future courses:

- Introduction lecture on the radiobiological basics that are essential for the biomarkers of biological dosimetry.
- More information on new, emerging methods in biological dosimetry and their potential application.
- A very short review (0.5h) of the theoretical background of the method prior to the practical laboratory sections of the individual methods.
- The proportion of own practical work in the laboratory should be further increased.
- In the practical laboratory session and in the cytogenetic methods, some topics (Giemsa staining, preparation of slides) could be combined.
- The laboratory part with the content on fusion PCC and chemical-induced PCC should be reduced and more time should be given to gene expression, in order to provide more information to the participants on this method.

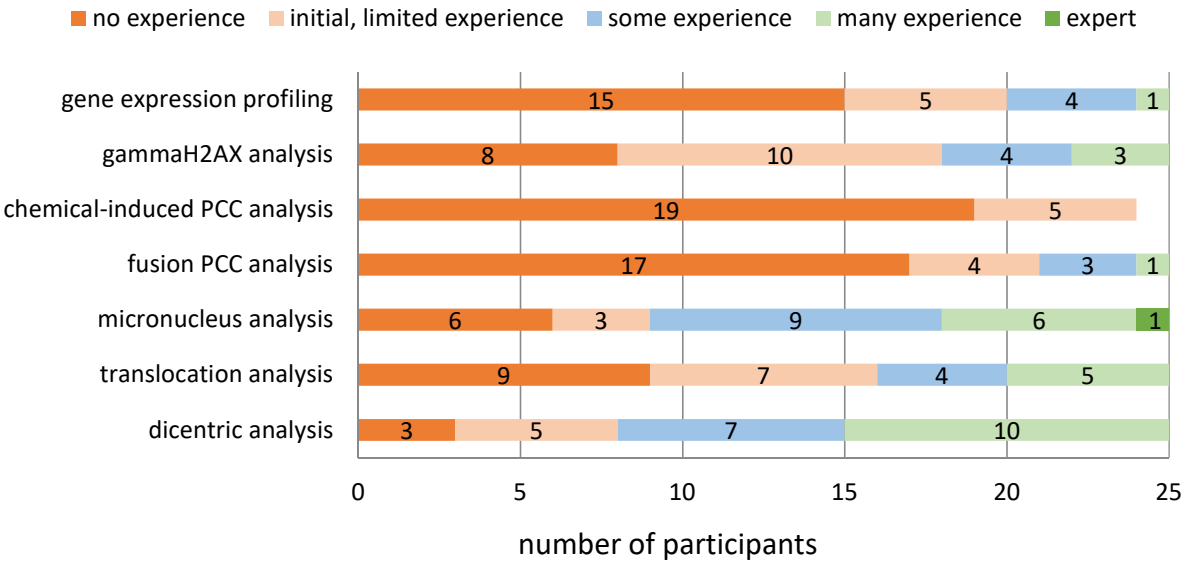
Conclusion

In summary, this course was very successful. The participants rated the overall quality of the lectures and the laboratory session and the organisation of the course as very good to good for most parts. All topics of the course were relevant and the participants did not wish for a thematic extension. In addition, the course was a very good opportunity for the participants to make new contacts and to network. The evaluation identified some valuable suggestions for improvement, which will be implemented in future courses. The success of the course was based especially on the involvement of experts from the networks of biological dosimetry in the lectures and in the laboratory session. This ensured the very high quality of the course. It is recommended that the course should be repeated periodically every 2 years in the future, as it was very useful for the participants. The participants would also like to use the methods of biological dosimetry in the future and integrate them into their own work. In this way, the maintenance of competence in the field of biological dosimetry and in radiation research can be ensured.

"The course on biological dosimetry was excellently organised and gave me, as a PhD student in the field of medical physics, valuable insights into various methods. The direct exchange with experts was very valuable. The course exceeded my expectations and gave me a good insight into Biological Dosimetry." Johanna Pehlivan, PhD student, Karlsruhe Institute of Technology (Germany).

"The theoretical part provided all the necessary information for introducing the participants to the field of radiation protection and biological dosimetry. The principles of each method, the pros and cons along with the research topics that each technique can be applied were explained in detail. The laboratory session provided hands on training and experience to all the techniques, analysis of the results and dose estimation, which was really fantastic! Both on line and on-site sessions were carried out by the experts in the field, who not only explained and demonstrated the techniques but were also willing to answer all the questions raised by the participants. After the BIODORA course I feel I have all the knowledge needed and the confidence to apply most of the biological dosimetry methods in my Lab."
Sotiria Triantopoulou, researcher, National Center for Scientific Research „Demokritos" (Greece)

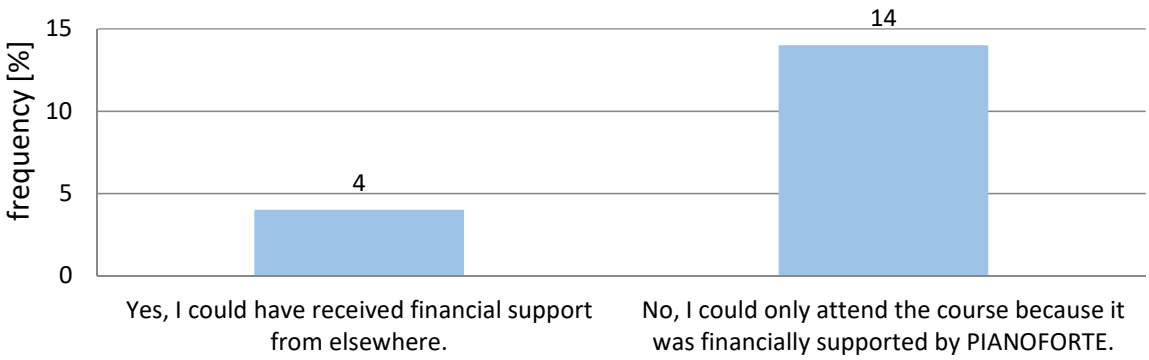
Did you have any experience in biological dosimetry before this course?



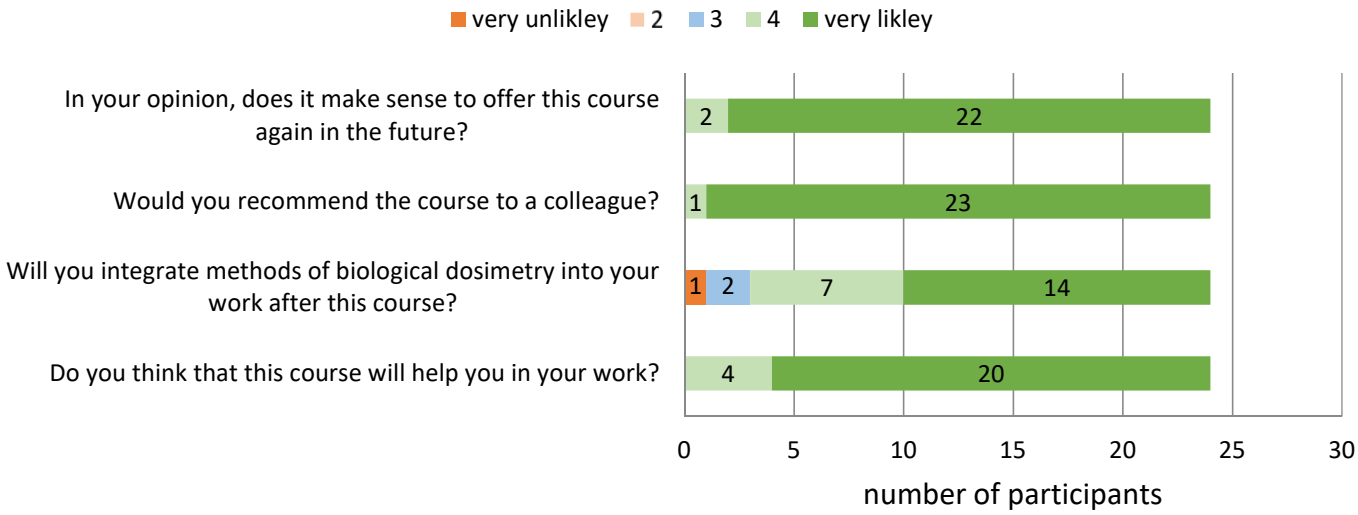
Why did you do this course? (comments)

- Since it fits in with my PhD topic and I don't have any knowledge in this area yet and also have no possibility of getting it from my present workplace.
- To provide me with invaluable (radio-)biological knowledge from the lectures and practical skills that will be directly relevant and applicable to the project I am undertaking for my PhD. My project is focusing on researching biomarkers in the context of conventional, FLASH, and proton irradiation. This will be done by collecting whole blood samples from healthy and patient volunteers and irradiating the blood in vitro. Following this, I will be performing various biological assays, RNA sequencing, and gene expression signatures (with the flexibility to perform other techniques that may be of interest). From this, I hope to identify, evaluate, and validate potential biomarkers and hopefully define biomarkers that could be potentially implemented in clinical settings. The project focuses on performing the biological analysis at defined time points post-radiation. With all of this information, the focus is to gain valuable insight into these topics with an outcome of being able to look further into an individual's response allowing patient stratification and a move to clinically tailor each therapy to an individual.
- To learn and to put into practice new techniques.
- To increase practical experiences in DCA and CBMN assays. To see and learn other approaches and methods practically. To meet with experts in biological dosimetry and radiation biology.
- Our institute intends to carry out the biological dosimetry of the personnel professionally exposed to ionizing radiation, so I considered it necessary to know the newest methods of analysis, considering that I have not worked in this field for over 10 years.
- To update my knowledge in radiobiology and biodosimetry.
- Because I want to know more about biological dosimetry and apply it my work.
- I want to expand the knowledge of radiation protection of biological dosimetry aspect.
- The course was very useful for me to increase my experience and knowledge in different methods as well as to learn new methods.
- I wanted to learn about the different techniques that aren't established in my lab with the hopes of acquiring a base knowledge to implement them. This would allow our lab to respond to a wider variety of overexposure scenarios that could take place in an emergency situation. I also wanted to deepen my knowledge of the techniques I was already familiar with.
- Despite all my experience in dicentric analysis, micronuclei analysis and FISH analysis I still felt like a beginner in these methods, and the BIODORA helped me improve my expertise. In the future, I would also like to analyze the changes in expression of various genes after long-term exposure to low-dose IR.
- Because it provided me training to all the methodologies used in Biodosimetry for Radiation Protection purposes and I acquired the skills to apply them in Radiation Protection Practice as well as in the Research of the Laboratory.
- To learn from experts in the field of biological dosimetry to help me and my lab partners to perform our experiments on a high standard comparable to the best teams in Europe. Also I wanted to learn about gene expression to kick-start this method in our laboratory. And finally, I wanted to personally meet the people I will potentially be working with in the future.
- To enrich my experience, increasing the knowledge, and capability, especially in the application of biological dosimetry in radiation protection research.
- Because I want to learn and apply the methods at work.
- I would like to improve my knowledge and experience in biodosimetry methods.
- It will very helpful in research and development or innovation in biodosimetry system in Indonesia and take a big opportunity to get brief discussion, as well as collaboration with the experts around the world.
- I wanted to have a basis of the techniques that aren't established in my lab, so that we could implement them in the future. I also wanted to expand my knowledge of the ones I already utilize or have received some formation about.
- To increase the knowledge in biodosimetry.
- To study the modern implementation of biological dosimetry techniques and improve my skills.

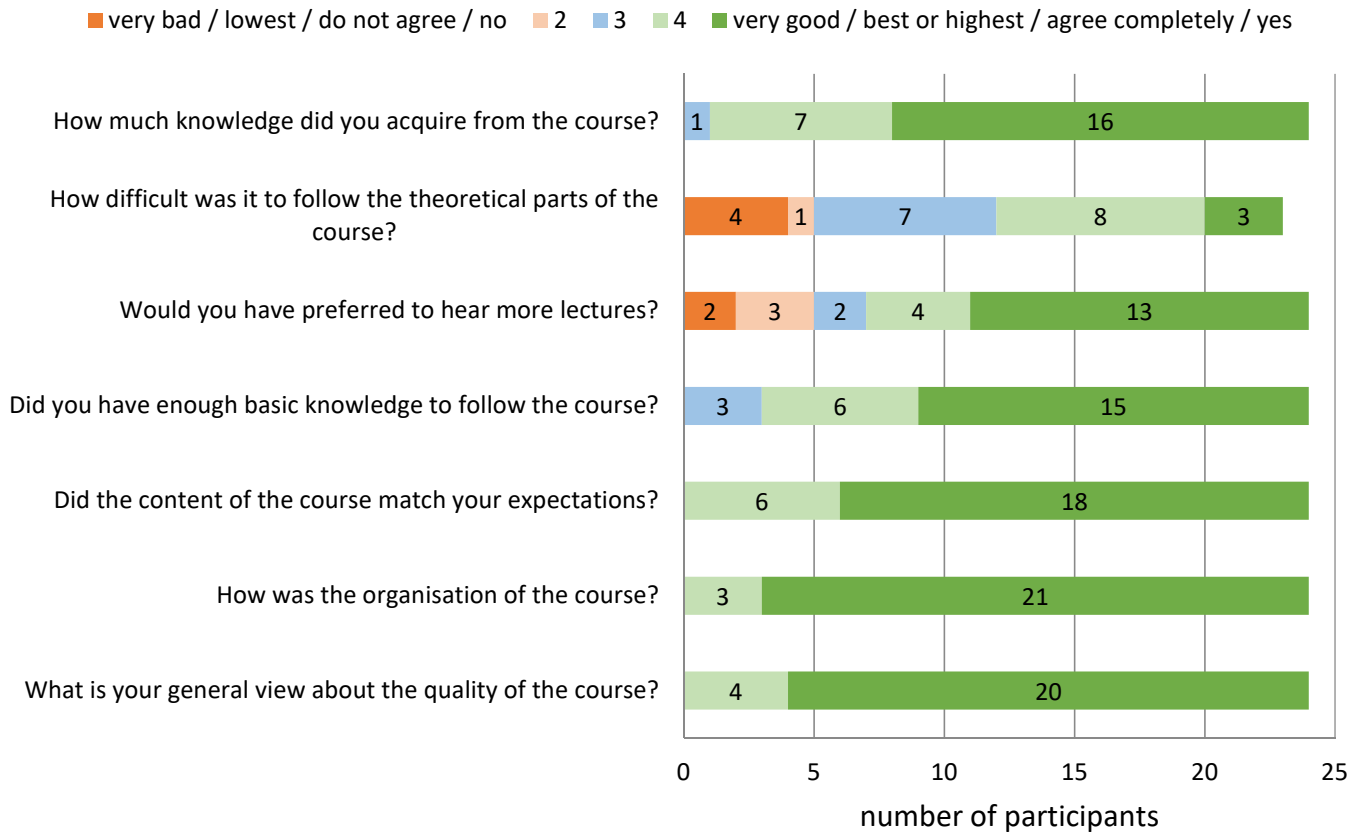
Would you have been able to do this course if it had not been sponsored (only for participants of the lab session)?



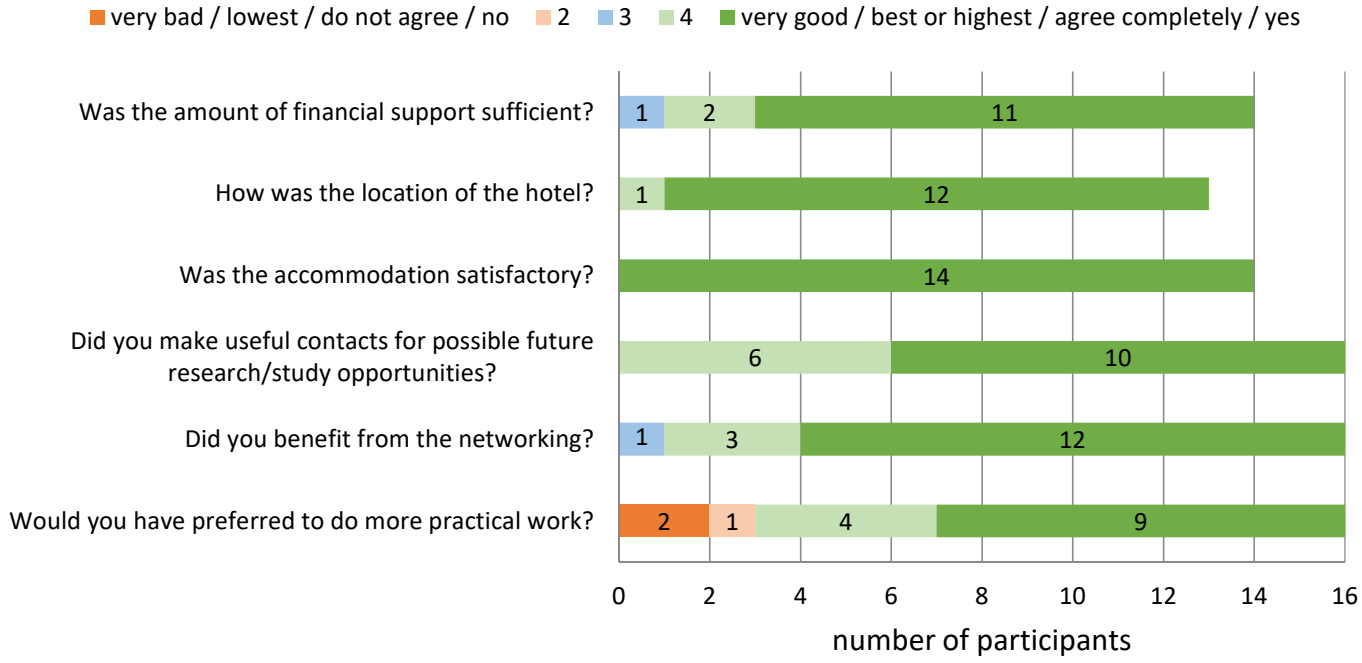
We would like to know what impact the course contributes to the maintenance of knowledge in the future.



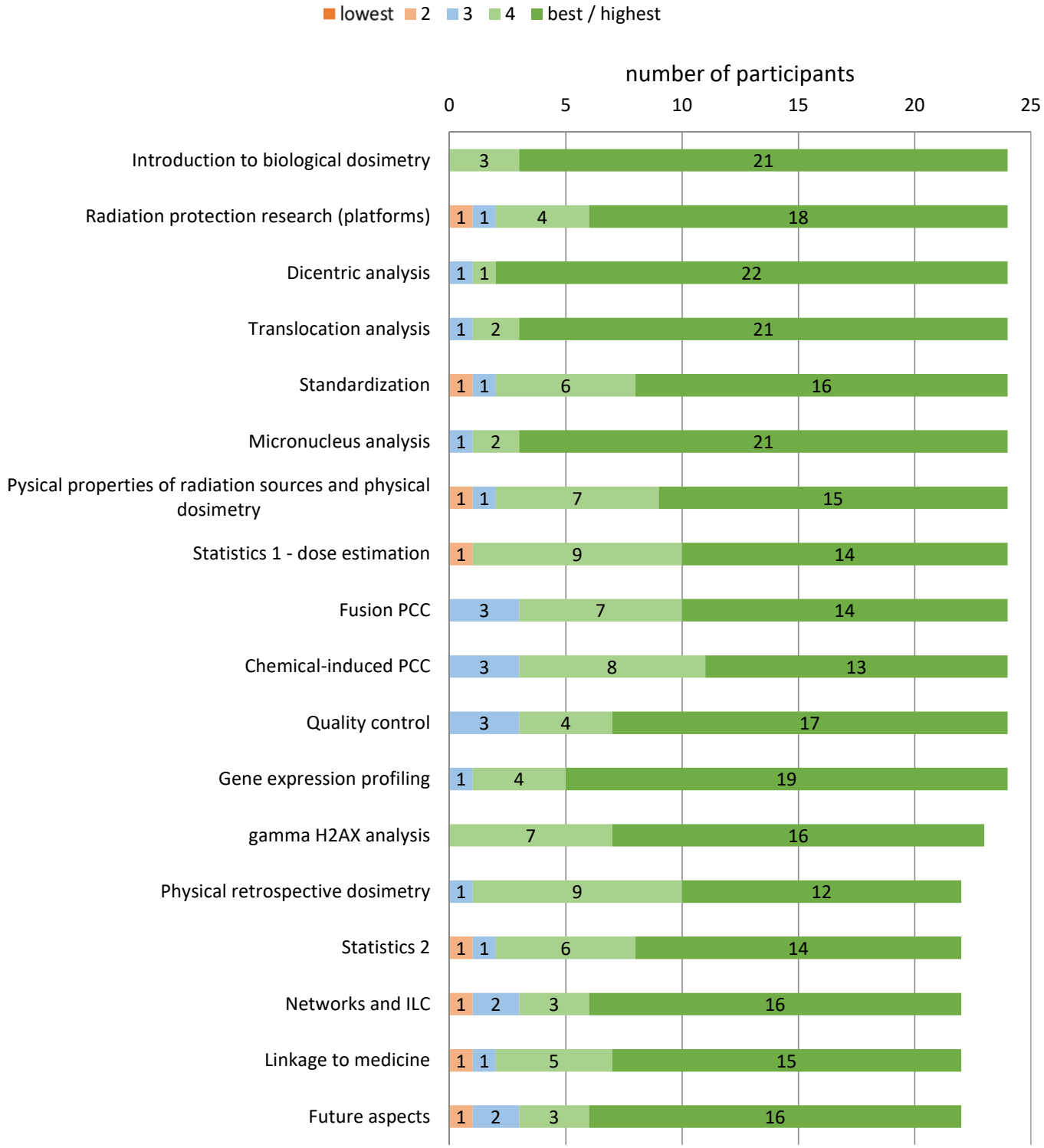
Please rate some general aspects of the course.



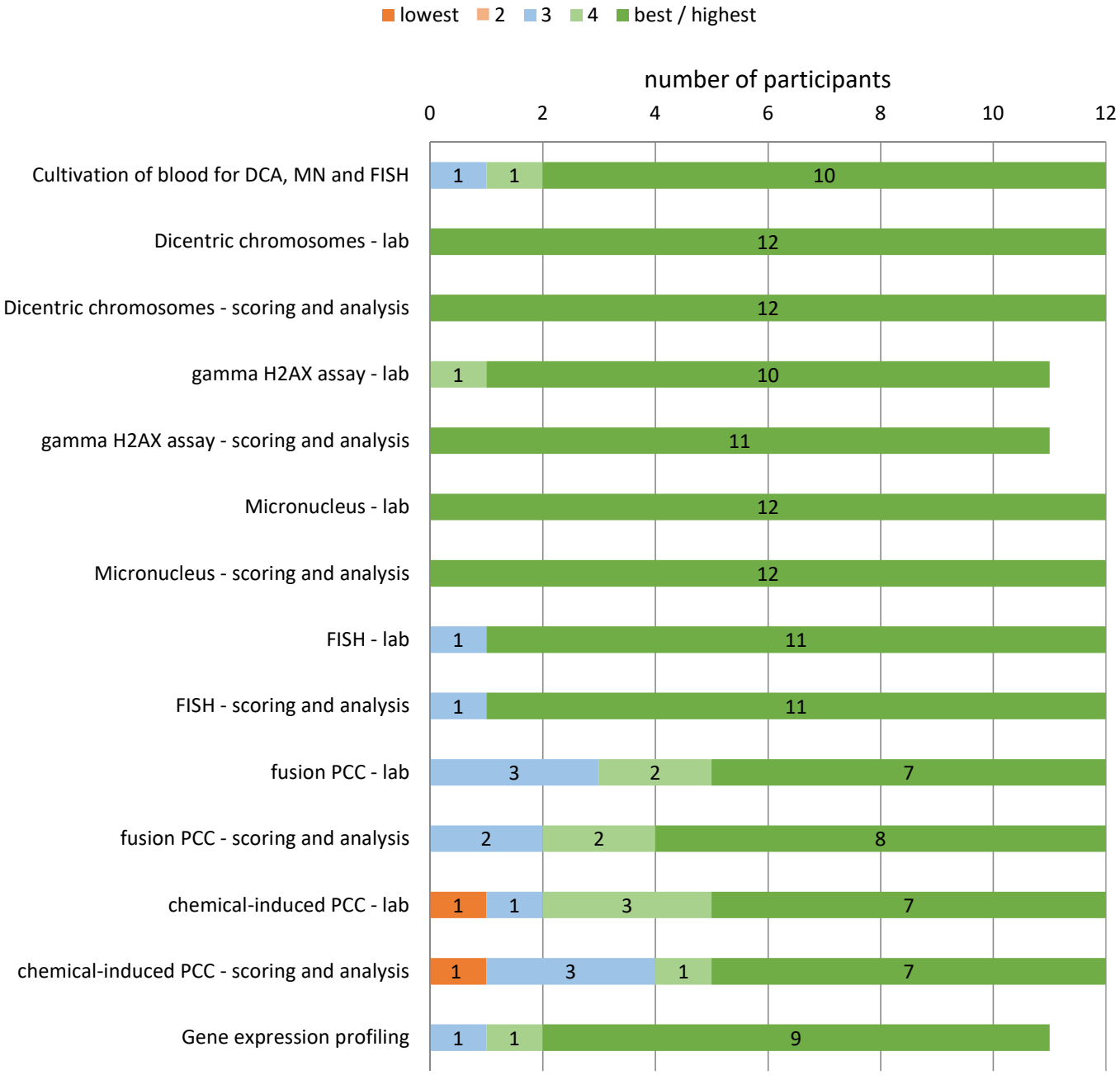
Please rate some aspects of the course that are related to the on-site lab session (only participants of the lab session).



Please rate the following LECTURES in terms of content and usefulness (listed in chronological order).



Please rate the following LAB SESSIONS in terms of content and usefulness (only participants of the lab session).



Did you miss certain subjects that you think would have been relevant? (comments)

- Maybe a theoretical background on some of the more promising methods of biological dosimetry that are in research and are currently developed.
- Maybe a different approach at the last lecture about Future outlooks of biological dosimetry. I expected a focus on new investigation lines, techniques in the development... Information regarding what the future of biological dosimetry techniques, platforms, etc... could be. Also maybe some information about apoptosis assays and their possible applications to biological dosimetry would have been nice.
- Biodosimetry or radiobiology of targeted radionuclide therapy.

Were there any topics that you felt were unnecessary? (comments)

- If I could change anything, I would trade the duration of the PCC analysis (which was too long for me) for gene expression (which was too short for me).

Do you have any other comments? (comments)

- The lectures were around an hour and a half long... even longer at some points when people ran over. Which left us with only 5-10 mins of break. This was not long enough to go to the toilet, get a drink, and recharge in between such long lectures. Which meant it was hard to get the most out of each lecture as your attention span just deteriorates. The practical sessions on the other hand were incredible! I learned so, so much valuable information, practical skills, and knowledge from experienced experts. The practical skills were invaluable. I would 100% recommend this course to someone else. This course went above and beyond my expectations and I am so grateful to have been a part of it - thank you.
- Lecture session should also be face to face inspite of online.
- The organization was perfect in every detail and we met some very kind and friendly people.
- I am very sorry I did not have grant to attend Lab Session
- thank you for the opportunity to attend this training course. I hope I could integrate the methods for my research in the future.
- It was really amazing opportunity. Thank you very much.
- Top quality course with excellent organization!
- The course overall was very good, with excellent organization, planning, and informative content. However, there were a few areas that could be improved to enhance the experience for all participants. One minor issue I noticed was the repetition during the practical sessions, such as Giemsa staining or slide preparation. While this might not be applicable to all participants, it could be worth considering streamlining these sessions to keep them engaging for everyone and save some time in the process. The main concern for me was the gene expression session. Although it was well-organized and carefully put together, it lacked essential information about the methodology. Specifically, crucial details like primer design, thermocycler protocol, efficiency information, working concentrations of chemistry, and templates were completely omitted. Having access to this vital information is crucial for a comprehensive understanding of the topic. In comparison, the cytogenetical methods part of the course was more open and transparent, providing participants with all the necessary information and detailed protocols. However, during the gene expression session, it felt like important details were kept undisclosed. I found some of this vital information in publications from prof. Abends team, but definitely not all. No protocols were provided. I must acknowledge that this viewpoint might be influenced by my particular focus on the gene expression aspect of the course. Nevertheless, addressing these issues would undoubtedly enhance the overall inclusivity of the program. Maintaining the same level of openness across all sessions would ensure a valuable and enriching learning experience for all participants. Thank you for all the hard work with the course, overall it was very well done. I am looking forward to working with you in the future! Best regards, Johana
- I look forward to taking this course. And hopes can contribute to the intercomparison moment especially for Disentric and micronuclei biomarkers

- I like a lot the whole course and I am thankful to be a part of it. It is quite useful for me and my current and future work.
- Very useful lecture and experience.
- The course was organized and conducted at the highest level.
- I just want to say, the FISH lab was incredible. The expert who ran the lab was hilarious! And he went above and beyond making sure we really understood every aspect. He even gave us a little classroom lesson after the practical side which really helped consolidate our learning. Thank you to every single person that made this course possible! Especially to Martin for the outstanding organisation. Thank you all.
- Please open this platform for collaboration of young researcher to already established laboratory and provide some position to doctorate students for continuity their research in radiation biology.
- Thank you, you give me opportunity to join online course eventhough I late to register
- It would be wonderful to have more time for laboratory classes. The lectures were very interesting and informative, but practice helps a lot in consolidating knowledge.