

# MEET-CINCH

(Project Number: 754 972)

## DELIVERABLE D1.1

**A report of training needs in radiopharmaceutical chemistry**

Lead Beneficiary: UH

Due date: 31/05/2018

Released on: 11/07/2018

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Start date of project: **01/06/2017**

Duration: **36 Months**

Project Coordinator:

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Project Coordinator Organisation:

LUH

VERSION: 1.2

**Project co-funded by the European Commission under the Euratom Research and Training Programme  
on Nuclear Energy within the Horizon 2020 Programme**

**Dissemination Level**

<b>PU</b>	Public	<b>X</b>
<b>RE</b>	Restricted to a group specified by the Beneficiaries of the MEET-CINCH	
<b>CO</b>	Confidential, only for Beneficiaries of the MEET-CINCH project	

## Version control table

Version number	Date of issue	Author(s)	Brief description of changes made
1.0	31/05/2018	Teija Koivula	1 <sup>st</sup> draft
1.1	11/06/2018	Mario Mariani	WP leader revision
1.2	11/07/2018	Clemens Walther	Co-ordinator check and final approval

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## Project information

Project full title:	A Modular European Education and Training Concept In Nuclear and RadioChemistry
Acronym:	MEET-CINCH
Funding scheme:	Coordination Action
ECGA number:	754972
Programme and call	H2020 EURATOM, Euratom Fission 2016-2017, NFRP-12
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Start date – End date:	01/06/17 – 31/05/20 i.e. 36 months
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*“This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 754 972.”*

## **EXECUTIVE SUMMARY**

**Deliverable 1.1 covers a summary report on the current training needs in radiopharmaceutical chemistry in Europe. It is based on a survey that was conducted in the MEET-CINCH project during the first year (2017-2018). The work was carried out mainly by personal contacts to various end-users in the field and by sending an invitation to fill in an on-line questionnaire on the topic. The survey was also advertised on the project web page. Detailed information on the current offer and future needs for Vocational Education and Training (VET) and Continuous Professional Development (CPD) in radiopharmaceutical chemistry, as well as employment of the (radio)chemists and other occupational groups as potential target groups for training was collected. The results were analysed with respect to the type of organization and the importance of radiopharmaceutical chemistry within the organization. Furthermore, the overall results will be considered in the development of specific training materials in radiopharmaceutical chemistry during the next phase of the project. The questionnaire consisted of 15 various type of questions and it is attached in this report as an Annex 1.**

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# 1 INTRODUCTION

The MEET-CINCH project aims at developing and performing nuclear and radiochemistry (NRC) teaching and training according to the needs of research institutions, industry, hospitals, and other end-users in the field. The growing need of radiopharmaceuticals both for diagnostic and therapeutic use, as well as for drug development makes radiopharmaceutical chemistry one of the largest growing fields in nuclear and radiochemistry. Therefore, the objective of this study was to collect detailed information on current training needs from the end-users in the field. The target group was specified to include both industry and research units developing radiolabelled compounds as well as hospitals and institutes that utilize them in clinical work or in biomedical or drug research. Some universities having research in the field or doing collaboration with the nuclear medicine departments or preclinical imaging units were also contacted but typically these units offer education in the field themselves and may not be relevant as potential users for the training materials of MEET-CINCH project.

Direct contact to representatives of each target group was sought by already existing personal contacts among the radiopharmaceutical industry, research institutes and imaging centres. In addition, new contacts were formed, e.g., by exploring the web pages and scientific publications of the above-mentioned institutions and by personal discussion during the nuclear medicine congress (EANM2017). All contact persons were kindly asked to fill in an on-line questionnaire “Survey on education and training needs in radio/radiopharmaceutical chemistry”.

The questionnaire was modified from the form that was used in the CINCH-II project to survey the current and future requirements for Vocational Education and Training (VET) in nuclear chemistry (D2.1-2.2), i.e., except for nuclear medicine. The questionnaire consisted of 15, mainly multiple-choice questions: The first two questions specified home country and type of organization. Five questions dealt with the importance of radio/radiopharmaceutical chemistry in the daily work and what other occupational groups are involved in the work in addition to (radio)chemists. In two questions respondents were asked to describe their future plans to recruit more people. Five following questions were focused on current offer and future needs in VET or CPD (Continuous Professional Development); the type of training and delivery as well as preferred subjects were asked. Finally, the respondent had to describe the most important target group for training in radiopharmaceutical chemistry. The responses could be given anonymously or by including information of the organization, contact person and his/her role in the organization.

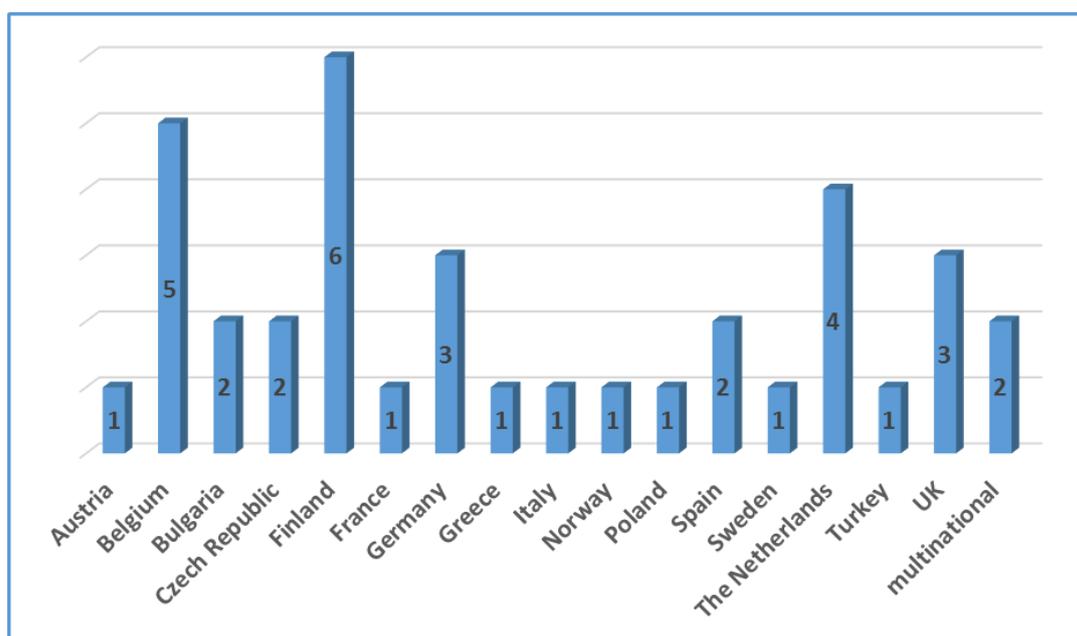
The questionnaire was created by Google forms and the overall form is attached in this report as an Appendix 1.

## 2 RESULTS AND DISCUSSION

### 2.1 Respondents

#### 2.1.1 Countries

Invitation to fill in the questionnaire on the training needs was given/sent to at least 88 contact persons of which 37, i.e. 42% responded. The respondents came from 16 different countries and also from multinational companies that have their headquarters in the USA but act also in Europe, as illustrated in Fig. 1. The majority of the respondents, 73%, gave also personal information of the company/institute, however, as notified in the questionnaire the information was only used to help analyse the results and it is not published here.



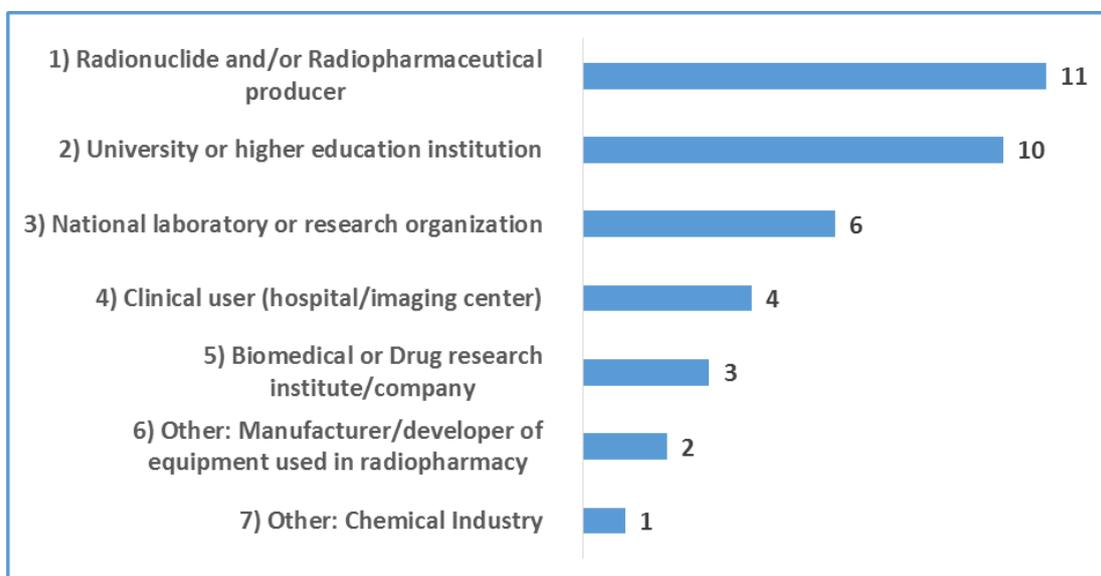
**Figure 1. List of respondent countries and number of responses in the survey.**

#### 2.1.2 Type of organization

In question number two the respondent was asked to choose the description that best fits his/her organization or if “Other” was chosen, there was a requirement to describe the field. Results are depicted in Fig. 2. In general, responses were received from all of the major target groups (1-5) and also some additional groups that are related to radiopharmaceutical chemistry.

Two groups gave the majority of the responses, nearly 60%: “Radionuclide/ radiopharmaceutical producer” and “Higher education institution”. The former group included companies, typically medium-size, that have either some or several of the following activities in the field of radiopharmaceutical chemistry: production of bulk radioisotopes, radionuclide generators, radiopharmaceutical precursor solutions, other radiochemicals, radiopharmaceuticals for various molecular imaging or nuclear medicine applications, as well as related equipment for the synthesis and analysis of the labelled compounds. The majority of the universities had similar activities in the development and production of radiolabelled compounds. The difference between the next biggest group, “National laboratory or research organization”, was also rather small, since this group typically includes institutes that develop and produce radiopharmaceuticals both for research and clinical use but have reached a national status. Group 4, clinical users, had typically also in-house production of radiopharmaceuticals. Biomedical/drug research representatives were companies that use radiolabelled compounds for biological evaluation of various target systems (disease models, drug

effects) or develop materials for this type of studies. The last two remaining groups were important industry related to radiopharmaceuticals, i.e. companies that, e.g., develop/produce synthesis units or radio-analytical equipment (group 6) or manufacture materials that can be utilized in the purification of the starting materials or radiolabelled compounds.

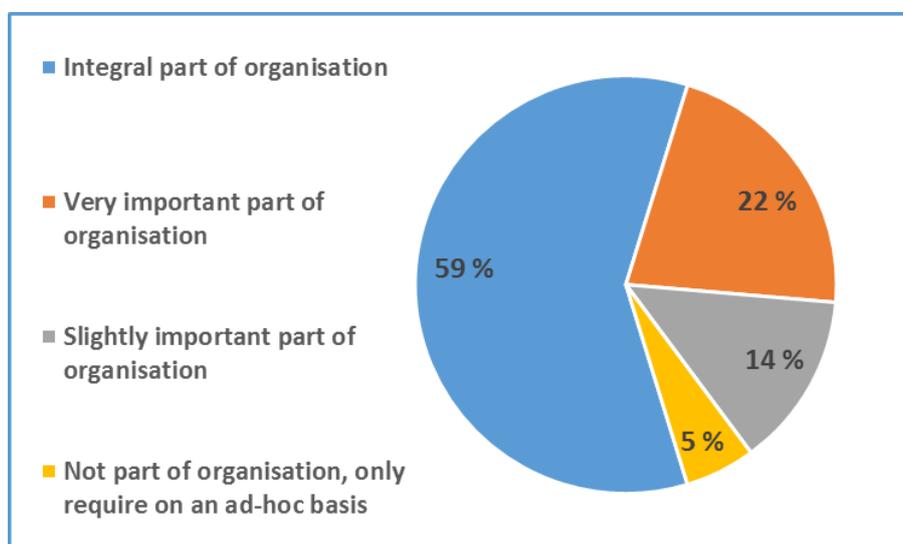


**Figure 2. Type of respondent organizations and number of responses in survey.**

## 2.2 The status of chemistry in the organization

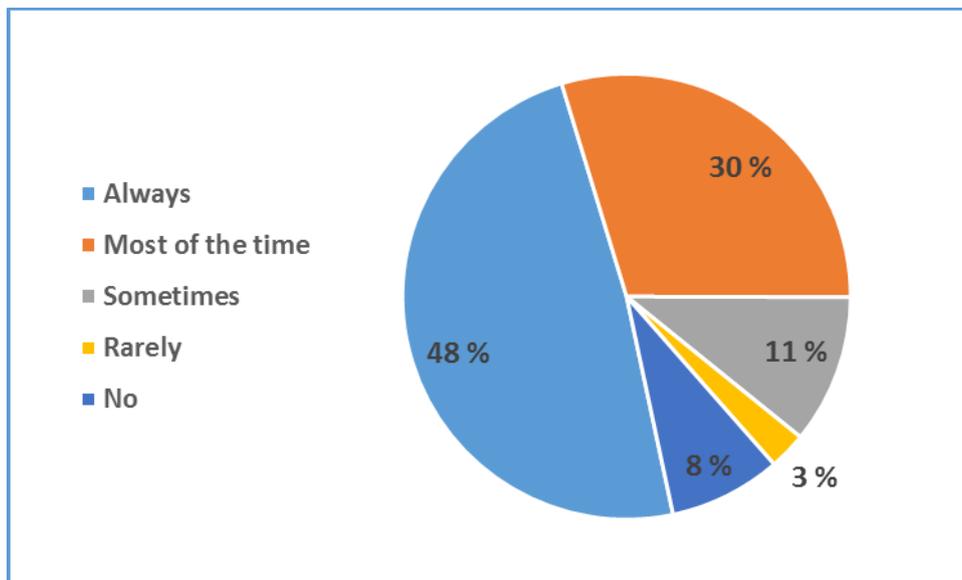
### 2.2.1 Importance of radio/radiopharmaceutical chemistry in the organization

Responses to question number three showed that the target groups were chosen rather well, *i.e.* over 80% of the respondents considered radiopharmaceutical chemistry integral or very important part of their organization, Fig. 3. For the rest of the respondents the importance was slight (14%). Both of these proportions included organizations from all groups, reflecting that radiopharmaceutical chemistry is indeed needed in various type of organisations/work. In two organizations radiopharmaceutical chemistry was required only on ad-hoc basis (5%).



**Figure 3. Importance of radio/radiopharmaceutical chemistry in the respondent organizations.**

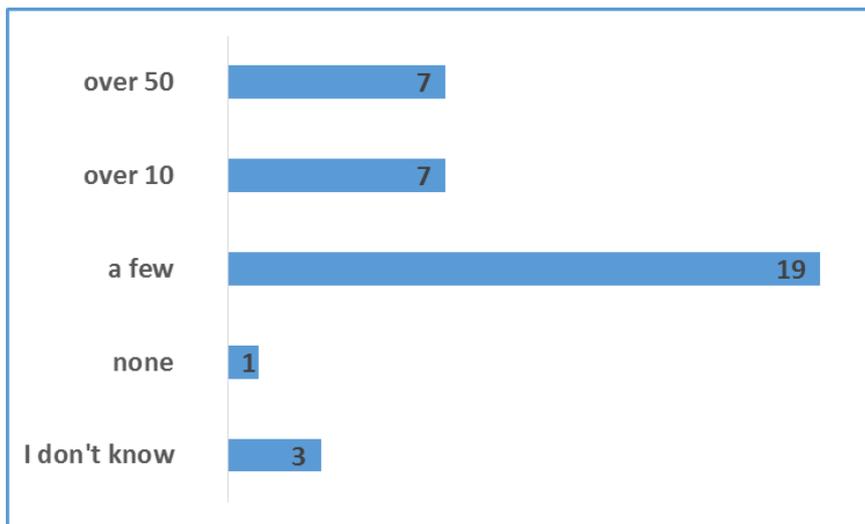
Correspondingly, there was need for people with radiopharmaceutical chemistry skills always or most of the time in nearly 80% of the respondent organizations, Fig.4. However, detailed analysis of the results showed that all organizations that had a minor proportion of radiopharmaceutical chemistry (slight importance) still had need for people with radiopharmaceutical skills always or most of the time; and some of the organisations that considered radio- or radiopharmaceutical chemistry as an integral or very important part of organization responded that they do not have need for people with these skills or it happens only sometimes. Examples of these type of respondents were higher education institutions and biomedical/drug research companies.



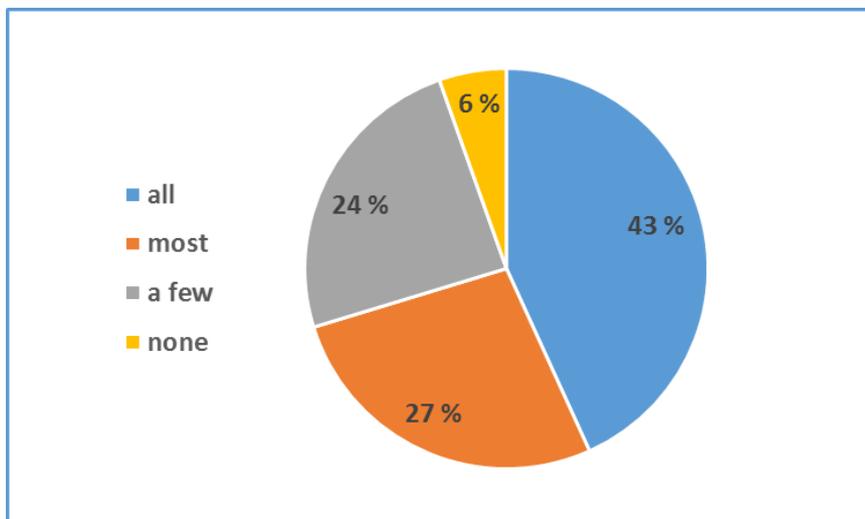
**Figure 4. Need for people with radio/radiopharmaceutical chemistry skills in the respondent organizations.**

### 2.2.2 Employment of post-graduate chemists and other occupational groups

The questions number four and five surveyed the current number of chemists working in the organizations and what proportion of this group is involved in radio/radiopharmaceutical chemistry work. The majority of the respondents, over 70%, employed only a few post-graduate chemists, considerably less employed over ten or even over fifty, see Fig. 5. Furthermore, all or at least most of them are or have been involved in work with radiopharmaceuticals. Three larger organizations could not specify their current number of post-graduate chemists and a company that was involved in biomedical research and thus considered radiopharmaceutical chemistry as a very important part of organization did not employ any chemists at all. About 20% of the responses were given by larger research organisations and university institutions that are currently employing over 50 post-graduate chemists. However, typically only a few of them were working with radiopharmaceuticals, except for the two national research organisations that were strongly involved in production of radionuclides and radiotracers and have most of the chemists also working in the field. Overall responses to the question four are depicted in Fig. 6

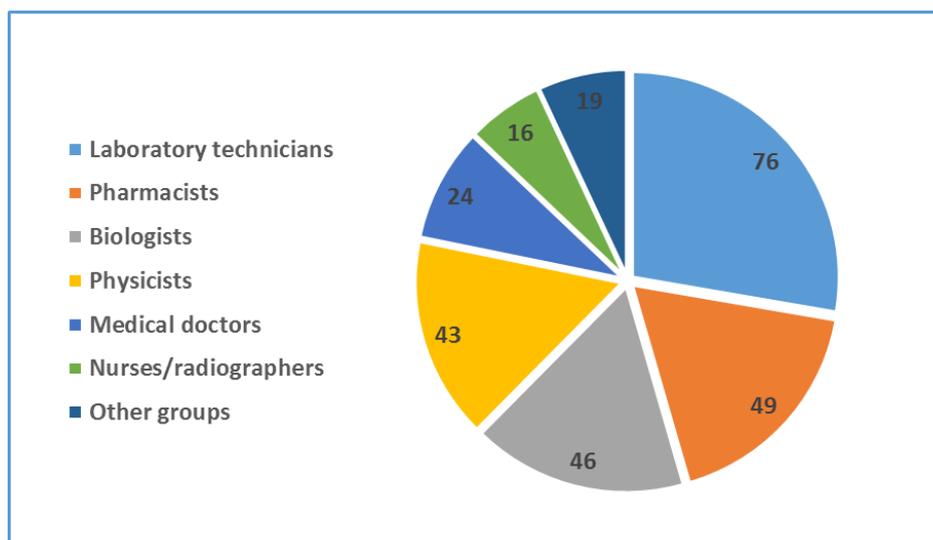


**Figure 5. Number of post-graduate chemists employed by the respondent organizations. Blue bars represent number of responses in each category.**



**Figure 6. Proportion of the employed post-graduate chemists working with radiopharmaceuticals (currently/past) in the respondent organizations.**

The following question surveyed what other occupational groups are working with radiopharmaceutical chemistry in addition to nuclear/radiochemists. The respondent organizations could choose the most typical groups from a list or name additional groups, the responses are summarized in Figure 7. Over 75% of the organizations were employing also laboratory technicians, the next largest groups were pharmacists (49%) and biologists (46%). Other individual groups that were listed by the respondents were designers, engineers, logisticians, graduate students, diploma workers, PhD and biotechnologists.



**Figure 7. Occupational groups involved in working with radiopharmaceutical chemistry in addition to nuclear/radiochemists. Results are represented as percentage of the category from the total 37 respondent organizations.**

Laboratory technicians were typically employed as an individual group or together with pharmacists or biologists. The overall combination of other occupational groups was naturally reflecting the scope of the work related to radiopharmaceutical chemistry, i.e. nurses/radiographers and medical doctors are involved in clinical use and physicists and biologists more in research and development of equipment. Some examples of responses about occupational groups and their typical employers are presented in Table 1.

**Table 1. Examples of other occupational groups involved in working with radiopharmaceutical chemistry (in addition to nuclear/radiochemists) and their most typical employer.**

Occupational groups	Responses [% of total]	The most typical employing organization(s)
Laboratory technicians	14	Radionuclide/radiopharmaceutical producer
Laboratory technicians, Pharmacists	11	Radionuclide/radiopharmaceutical producer
Laboratory technicians, Nurses/radiographers, Pharmacists, Physicists, Biologists, Medical doctors	11	University (development and production of radiopharmaceuticals)
Laboratory technicians, Biologists	8	Developer of equipment used in radiopharmacy; Research organization
Laboratory technicians, Pharmacists, Biologists	5	Radionuclide/radiopharmaceutical producer
Laboratory technicians, Physicists, Biologists	5	National laboratory; Biomedical research company
Physicists, Biologists	5	University
Nurses/radiographers, Pharmacists, Physicists, Medical doctors	5	Clinical user (hospital/imaging center)

### 2.2.3 Future plans for recruitment

Nearly 20% of the respondents could say already now that they will recruit post-graduate chemists within the next or next 5 years, and additional 30% saw that possible, Table 2. Even higher need within the next 5 years was seen for nuclear/radiochemists. Organizations that did not have future plans to recruit nuclear/radiochemists, i.e. answered that it is unlikely or very unlikely, typically

represented institutes in which radiopharmaceutical chemistry is only required on ad-hoc basis and/or other occupational groups are more strongly involved with the work.

**Table 2. Summary of recruitment plans for post-graduate (PG) chemists and nuclear and/or radiochemists (NRC) in the future.**

Response	PG chemists [number of responses, %]	PG NRC chemists [number of responses, %]
Yes, within the next year	7 [19]	5 [14]
Yes, within the next 5 years	11 [30]	16 [43]
Possibly, within the next 5 years	12 [32]	12 [32]
Unlikely, within the next 5 years	6 [16]	3 [8]
Very unlikely, within the next 5 years	1 [3]	1 [3]

## 2.3 VET/CPD in the organizations

### 2.3.1 Current opportunities for VET/CPD within the organization

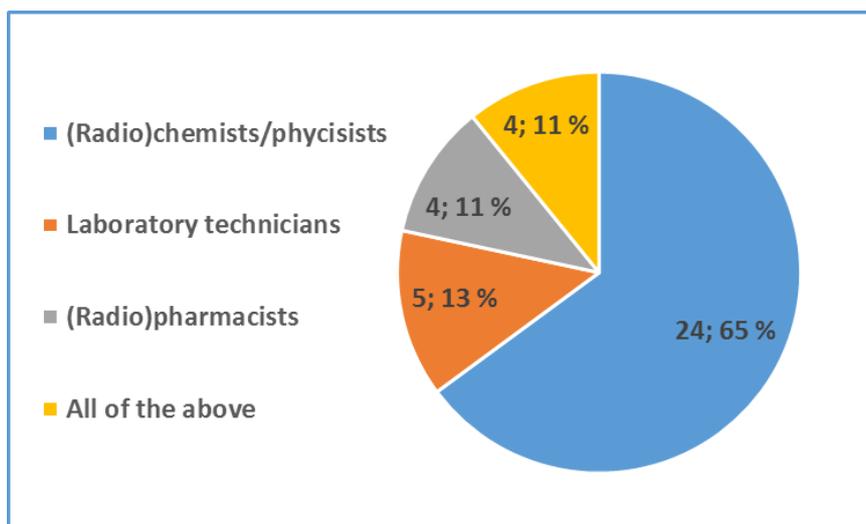
Questions 10 and 11 surveyed the current offer for Vocational Education and Training (VET) and Continuous Professional Development (CPD) among the participated organizations. Only about 40% of the respondents answered that the organization offers this type of training frequently (always or often). VET/CPD in radio/radiopharmaceutical chemistry was offered even less. Typically, the organizations were not offering VET/CPD at all, or there was both general and radiopharmaceutical training to some extent. Four of the overall 37 respondents (11%) answered that although radiopharmaceutical chemistry has high relevance to their work, there is only some general training and no VET/CPD in the specific topic. These organizations represented both clinical and research applications of radiopharmaceuticals. Overall responses to the questions are summarized in Table 3.

**Table 3. Summary of current opportunities for VET/CPD in general and in radio/radiopharmaceutical chemistry (RPC).**

Response	General VET/CPD [number of responses, %]	VET/CPD in RPC [number of responses, %]
Always	7 [19]	6 [16]
Often	8 [22]	7 [19]
Sometimes	15 [41]	11 [30]
Rarely	6 [16]	9 [24]
Never	1 [3]	4 [11]

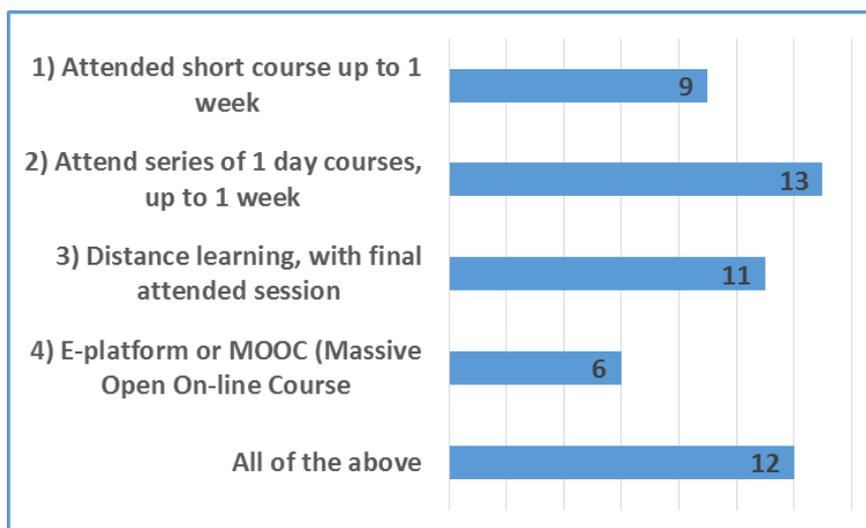
### 2.3.2 Future needs for VET/CPD

Nearly 65% of the respondents named radiochemists/physicists as the main target group for future VET/CPD in radiopharmaceutical chemistry; additional 10% chose radiopharmacists. In practical work, like in hospitals, the duties of radiopharmacists and radiochemists are most likely very similar, but the difference is arising from different educational systems, e.g. whether you have graduated from the radiochemistry programmes or have a degree/postgraduate certificate in radiopharmacy. Third largest group named for the VET/CPD was the laboratory technicians. The rest of the respondents did not specify the group, instead, they thought that VET/CPD in radiopharmaceutical chemistry would be useful to all of the listed groups, see Figure 8.



**Figure 8. Main target groups for future VET/CPD in radiopharmaceutical chemistry within the respondent organizations. Results are presented as a number and percentage of responses in each category.**

The most preferred **types of delivery** for VET/CPD were “Attend series of 1 day courses up to 1 week” and “Distance learning with final attended session”, as depicted in Figure 9. Organizations could choose the preferred options from a list and in total ten different combination of responses were received. More detailed analyses of the results are depicted in Table 4. Twelve organizations (32%) chose all types (“All of the above”) and nine organizations (24%) preferred the series of 1-day courses alone or combined with distance/e-learning options. Distance learning including final attended session was supported by a large part of the organizations, e.g. combined with the “Attended short course up to 1-week”. Option number 4, “E-platform or MOOC” was the only type of delivery that was not chosen alone but only combined with other methods. Two companies responded that they are not interested in VET/CPD at all although they saw radiopharmaceutical chemistry as an important part of the organisation and one organization had missed the question.



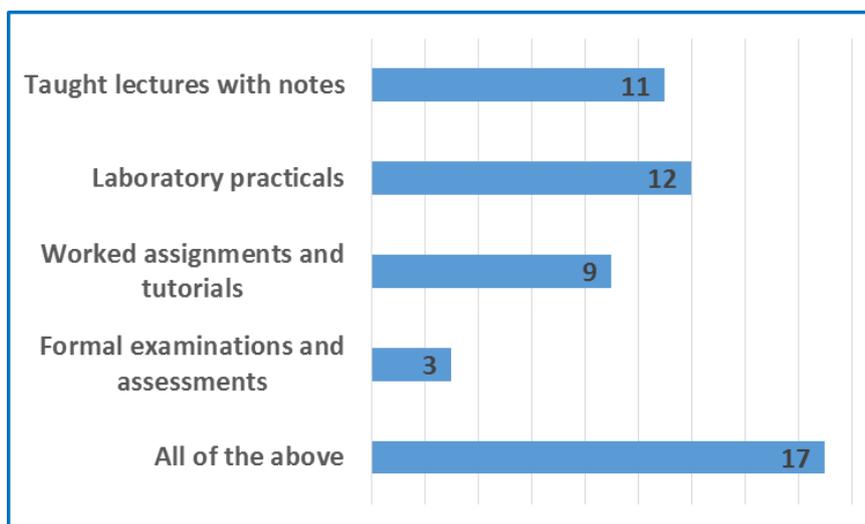
**Figure 9. Preferred type of delivery for VET/CPD in radiopharmaceutical chemistry. Blue bars represent the number of responses in each category.**

The responses were also analysed with respect to the various respondent groups, however, there was no clear correlation between the preferred type of delivery and the type of organization.

**Table 4. A summary of responses for the preferred type of delivery for VET/CPD in radiopharmaceutical chemistry.**

Preferred type of delivery	Responses [number]	Responses [% of the 37 respondents]
Attended short course up to 1 week		
alone	2	5.4
<i>combined with other types</i>	7	
Attend series of 1 day courses, up to 1 week		
alone	5	14
<i>combined with other types</i>	8	
Distance learning, with final attended session		
alone	4	11
<i>combined with other types</i>	7	
E-platform or MOOC		
alone	-	
<i>combined with other types</i>	6	
All of the above	12	32
Not interested in radio/nuclear chemistry VET	2	5.4
No response to the question	1	2.7

Participants were also asked for their opinions on the preferred **type of training** for VET/CPD. The two organizations that were not interested in VET/CPD did not specify their general preference, other responses are compiled in Figure 10. Nearly half of the respondents (17) answered that all type of training would be suitable for them, however, the result may also arise from the fact that the option (“All of the above”) was the easiest to choose. From the rest 18 respondents, twelve organizations included “laboratory practicals” in their preferred training types and eleven organizations chose “taught lectures with notes”. The majority of these organizations chose combination of two or three types of trainings, such as “taught lectures with notes and Laboratory practicals” (4 responses) and “laboratory practicals and worked assignments and tutorials” (3 responses). Much less support was given to the traditional type of education and training, namely “formal examinations and assessments”: only three organizations had included this choice in their preferences, together with some other type of training.



**Figure 10. Preferred type of training in radiopharmaceutical chemistry. Blue bars represent number of responses in each category.**

For specification of the training needs, organizations could choose **preferred topics** from a list, see Table 5., or suggest additional topics. The majority of the respondent organizations, in total 17 (46%), stated that “All” subjects in the list would be useful in their organization and “radioanalytical methods” and “labelling techniques” were as highly preferred from the individual topics that the rest 18 organizations were specified. Only one respondent, a clinical user, suggested “waste management” as an additional topic for VET/CPD.

**Table 5. Summary of preferred subjects for future VET/CPD in radiopharmaceutical chemistry. The results are presented as a number of selected subjects and percentage of the overall 83 responses.**

Subjects	Responses [number]	Responses [%]
Fundamentals of radio/nuclear chemistry	8	9.6
Production and separation methods of radionuclides	7	8.4
Radiopharmaceutical chemistry, labelling techniques	14	17
Radioanalytical methods	15	18
Radiation detection and protection, dosimetry	9	11
Radiopharmaceutical regulatory affairs	10	12
All of the above	17	21
Other:		
In addition to all of the above, waste management	1	1.2
<i>Not interested in NRC VET</i>	2	2.4

As in the earlier multiple-choice questions, the majority of the respondents could not choose a single preferred option; instead, a combination of at least three subjects were listed. There was only one exception, namely “radiopharmaceutical regulatory affairs” that one “radionuclide and/or

radiopharmaceutical producer” chose as the only preferred topic and responded that VET/CPD would be aimed at laboratory technicians in their organization.

In general, all preferred topics were also analysed with respect to the type of organization and what was their main target group for VET/CPD in radiopharmaceutical chemistry. The majority of the respondents had named radiochemists/physicists as their main training group and there weren't clear differences between the subjects that were chosen for this group, or for the radiopharmacists. With laboratory technicians as the target group, the list of topics may be a little shorter, such as “fundamentals of radio/nuclear chemistry, radioanalytical methods and radiation detection and protection, dosimetry”. However, there was some correlation between the type of organization and the preferred subjects: for example, “production and separation methods of radionuclides” were mainly chosen by the organizations that are producing radionuclides either for their own use or for customers.

### 3 CONCLUSIONS

In this study, the specific training needs in the field of radiopharmaceutical chemistry were surveyed mainly by an on-line questionnaire under the topic. Although the number of received responses to the questionnaire was only satisfactory, in total 37, the respondents represented very well the diversity of the fields in which radiopharmaceutical chemistry and people with these skills are needed and the results are therefore applicable to larger scale. Responses were received from industrial radionuclide/radiopharmaceutical producers, institutes where these compounds are produced in-house either for clinical or research purposes, as well as from organizations in which radio(pharmaceutical) chemists are working with technology development or use labelled compounds for biomedical or drug research.

The majority of the respondents, representing every target group, felt that radiopharmaceutical chemistry is an integral or very important part of the organization. These organisations were typically employing only a few post-graduate chemists but had already plans of recruiting more chemists/radiochemists within the next five years. This is a promising result since it indicates both the increasing need for chemists and for VET if people with general chemistry background are trained at work for tasks requiring skills in radio/radiopharmaceutical chemistry. Furthermore, 95% of the respondents indicated that they are interested in VET/CPD in the radiopharmaceutical chemistry but only about 40% of the organizations offered some training in the field or VET/CPD in general. This result suggests that there is a clear need for radiopharmaceutical chemistry training at the European level.

The most favoured type of delivery was “attended series of 1-day courses up to 1 week”, however, “distance learning with final attended session” was almost as popular. All types of training were welcome; support for individual methods, such as “laboratory practicals” or “taught lectures with notes” was almost equal. “Formal examinations and assessment” as a type of training received much less support. **These findings suggest that the MEET-CINCH objectives for development of video-lectures and conceptual training events supported by the produced material in WP3 is aiming at the right direction.**

Although the majority of the respondents named radiochemists/physicists as the main target group for VET/CPD in radiopharmaceutical chemistry, we should keep in mind that there is a number of other occupational groups involved in the work and therefore potential participants for training, such as laboratory technicians. Moreover, the preferred subjects for VET/CPD reflects the type of organization and their scope in radiopharmaceutical chemistry. **Based on this survey we can thus say that there is need for a variety of training subjects, but “radioanalytical methods” and “radiopharmaceutical chemistry, labelling techniques” are the most potential topics for wider target groups.**

In overall, this survey gave the MEET-CINCH project a lot of valuable information on the training needs in radiopharmaceutical chemistry and that information can be utilized in the development of specific training materials.

## 4 ANNEXES

### 4.1 Annex 1: Questionnaire Survey on education and training needs in radio/radiopharmaceutical chemistry

The objective of this survey is to identify specific education/training needs in radiopharmaceutical chemistry and related fields within Europe. It forms a part of the MEET-CINCH EU-project (A Modular European Education and Training Concept In Nuclear and RadioCHEmistry) which e.g. aims to enhance people's general awareness to needed and beneficial use of nuclear and radiochemistry techniques and methods, as well as to attract new talents in the field.

The results of this survey will be summarized in a report and utilized in designing education/training events and teaching materials that meet the requirements of the various stakeholders in the field. Information on the project outcomes will be available via the project web page (<https://www.cinch-project.eu/>).

1. 1) In which country do you work?

\_\_\_\_\_

2. 2) What description best fits your organization? (Select one option.)

*Mark only one oval.*

- University or higher education institution
- National laboratory or research organization
- Radionuclide and/or Radiopharmaceutical producer
- Biomedical or Drug research institute/company
- Clinical user (hospital/imaging center)
- Other: \_\_\_\_\_

3. 3) How important does your organization view radio/radiopharmaceutical chemistry? (Select one option.)

*Mark only one oval.*

- Integral part of organisation
- Very important part of organisation
- Slightly important part of organisation
- Not part of organisation, only require on an ad-hoc basis
- Not part of organisation

4. 4) Does your organization have any need for people with radio/radiopharmaceutical chemistry skills? (Select one option.)

*Mark only one oval.*

- Always
- Most of the time
- Sometimes
- Rarely
- No

5. 5) How many post-graduate chemists are currently employed within your organization?

(Select one option.)

Mark only one oval.

- over 50
- over 10
- A few
- None
- I don't know

6. 6) What proportion of these chemists are or have been involved in work related to radio/radiopharmaceutical chemistry? (Select one option.)

Mark only one oval.

- All
- Most
- A few
- None
- Don't have any post-graduate chemists

7. 7) What other occupational groups are currently involved in work related to radio/radiopharmaceutical chemistry within your organization?

Tick all that apply.

- Laboratory technicians
- Nurses/radiographers
- Pharmacists
- Physicists
- Biologists
- Medical doctors
- Other: \_\_\_\_\_

8. 8) Does your organization have any plans to recruit post-graduate radio/nuclear chemists? (Select one option.)

Mark only one oval.

- Yes, within the next 5 years
- Yes, within the next year
- Possibly, within the next 5 years
- Unlikely, within the next 5 years
- Very unlikely, within the next 5 years

9. 9) Does your organization have any plans to recruit post-graduate chemists? (Select one option.)

*Mark only one oval.*

- Yes, within the next 5 years
- Yes, within the next year
- Possibly, within the next 5 years
- Unlikely, within the next 5 years
- Very unlikely, within the next 5 years

10. 10) Does your organization offer opportunities for VET (Vocational Education and Training) or CPD (Continuous Professional Development)? (Select one option.)

*Mark only one oval.*

- Always
- Often
- Sometimes
- Rarely
- Never

11. 11) Does your organization offer opportunities for VET/CPD in radio/radiopharmaceutical chemistry? (Select one option.)

*Mark only one oval.*

- Always
- Often
- Sometimes
- Rarely
- Never

12. 12) What TYPE of DELIVERY for VET/CPD would your organization prefer for training in radio/radiopharmaceutical chemistry?

*Tick all that apply.*

- Attended short course up to 1 week
- Attend series of 1 day courses, up to 1 week
- Distance learning, with final attended session
- E-platform or MOOC (Massive Open On-line Course)
- All of the above
- Not interested in radio/nuclear chemistry VET

13. 13) What TYPE of TRAINING for VET/CPD would your organization prefer for training in radio/radiopharmaceutical chemistry?

*Tick all that apply.*

- Taught lectures with notes
- Laboratory practicals
- Worked assignments and tutorials
- Formal examinations and assessments
- All of the above
- Not interested in radio/nuclear chemistry VET

14. 14) What SUBJECTS would your organization prefer to have included into a VET/CPD package on radio/radiopharmaceutical chemistry?

*Tick all that apply.*

- Fundamentals of radio/nuclear chemistry
- Production and separation methods of radionuclides
- Radiopharmaceutical chemistry, labelling techniques
- Radioanalytical methods
- Radiation detection and protection, dosimetry
- Radiopharmaceutical regulatory affairs
- All of the above
- Not interested in radio/nuclear chemistry VET
- Other: \_\_\_\_\_

15. 15) What would be the main target group for VET/CPD in radio/radiopharmaceutical chemistry in your organization (Select one option.)

*Mark only one oval.*

- Laboratory technicians
- (Radio)pharmacists
- Nurses/radiographers
- (Radio)chemists/physicists
- Medical doctors
- All of the above
- Other: \_\_\_\_\_