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Introduction

The EIRENE Research Infrastructure (RI) demands skilled and competent personnel and therefore will also require properly assess and address the training and education needs. A training strategy for the RI is crucial to ensure that scientists, administrators, managers, and others possess and practice the specific skills directly linked to the services the RI is committed to provide, by effectively utilizing the resources, tools, and state of the art science available. A well-thought-out training strategy can enhance productivity, promote best practices, ensure efficient management, and foster innovation within the RI community. The training strategy should promote collaborative efforts where knowledge-sharing is encouraged and valued. A recent article by Raess et al (<https://open-research-europe.ec.europa.eu/articles/4-152/v1>) addresses requirements, issues and presents recommendations related to the development of European research infrastructures that is of interest for the development of EIRENE RI training needs and offerings.

Overarching and specialized workshops, training courses, secondments, and twinning activities will build the competencies within the EIRENE RI consortium and increase the value and quality of services provided to the user community. The training strategy will aim at establishing an EIRENE training network (ETN) as a tool for the education and training of a new generation of RI operators and technicians. The RI consortium already provides training within its core subjects. It is important to get an overview of the current training offerings as these will connect to the training initiatives.

The aim of the education and training and strategy is to identify appropriate tools to maintain and enhance the skills of the EIRENE RI staff and, with the current training offerings, prepare the establishment of an EIRENE training network, to increase the value and quality of the services provided.

Notable, specific support and training needs of the EIRENE RI user community, the stakeholders, is not included herein but to be assessed separately within the PPP T6.3.

Assessment of training needs and offerings

Methodology

A survey was devised to assess the existing training needs and missing expertise, as well as which training is currently offered within EIRENE and to outline the envisioned requirements for the implementation phase of the RI. The initial stage of this survey involved identifying the training needs to support the fundamental services essential for the EIRENE RI, as detailed in Table 1. WP2 and WP6 in the EIRENE preparatory phase project agreed on their interdependence to identify and present a coordinated questionnaire on services, human resources, and training. Eight core services, denoted as (1-8), were formulated to encapsulate the objectives and mission of EIRENE. Responding partners were instructed to provide training needs to learn, enhance the personnel skills and keep up/improve their competence in the fields indicated, i.e. all related to the Exosome services in EIRENE. The question was an open question, for the partners to express with their own words the needs for education, training, and competence development, to be able to provide and improve the services they are offering. Since the format of the training could impact its usefulness and may vary depending on specific needs, the participants were asked to indicate whether they preferred academic courses (MSc or PhD), digital or

physical training courses, user meetings, summer schools, on-demand training, or other formats.

The EIRENE RI national node leaders were provided with summary statistics of their respective country's result and corrections and additions of missing data was allowed for a short period of time before the results were considered finalized.

Table 1. Identified core services for the mission of EIRENE RI

EIRENE SERVICES
1. Collecting and providing samples (including bio, environmental, and specimen banks) to determine exogenous substances
2. Access to cohort study or survey data on an individual level
3. Measurements of exogenous substances including target and nontargeted measurements of chemical mixtures (or other pollutants) as well as parent and transformation exposure markers in humans and the environment
4. Omics-based analysis of markers of biological response (separate: metabolomics, lipidomics, adductomics, (epi)genomics, metagenomics/microbiomics, transcriptomics, proteomics, phenomics)
5. Quantification/determination of toxicity (human- and ecological), pathways and modes of action (in-vivo, ex-vivo, in-vitro, in-silico)
6. Biostatistical and/or bioinformatics tools and platforms to investigate the exposome and human health interactions
7. Databases and exposure maps on environmental factors (e.g. pollutants, temperature, noise, socio-economic, lifestyle)
8. FAIR cataloging of exposome data (e.g. cohorts, algorithms)
9. Training offerings in the field of exposome research (e.g. academic courses and programs, summer schools, tailored trainings, workshops) and Training needs
10. Additional service(s)*

* Partners could add additional services for evaluation if they fit the EIRENE core mission

Results, interpretation and discussion of the survey

A total of 49 answers to question #9 training offerings and needs were reported by participants in the survey. In total 16 out of the invited 21 countries submitted information. The number of national partner institutions varied among the countries (institutions): Austria (AUT) 3, Belgium (BEL) 5, Cyprus (CYP) 1, Czech Republic (CZE) 1, Denmark (DEN) 1, Finland (FIN) 1, France (FRA) 1, Germany (GER) 1, Greece (GRE) 11, Italy (ITA) 3, Luxembourg (LUX) 4, Norway (NOR) 2, Slovakia (SVK) 2, Slovenia (SVN) 5, Sweden (SWE) 6, The Netherlands (NLD) 10. The open question allowed partners to freely describe their training needs, which resulted in a variety of answers related to one or several core services. The answers were therefore systematically classified into seven classes for further interpretation (Table 2). Two answers could not be classified as training needs due to lack of description (E) and were therefore omitted from further analysis. Several training needs covered general topics, often cross disciplinary, and not directly related to any of the core services but of relevance for EIRENE and therefore classified as general training (A) and training on health and environment (F).

Table 2. Answers on training needs classified based on relevance for EIRENE core services

Class	Description	No. of answers	Relevance to EIRENE services
A	General training supporting the core services	5	All core services
B	Providing samples and cohorts	2	Services 1, 2
C	Data generation	10	Services 3, 4, 5
D	Data handling and interpretation	11	Services 6, 7, 8
CD	Data generation and handling	8	Services 3, 4, 5, 6, 7, 8
E	Not classified as training/lack of description	5	No relevance
F	Miscellaneous training on health and environment	6	All core services

Most answers were directed to training needs for generating data (23%), data handling and interpretation (25%) or integrated issues of generating and handling data (18%). General training and training directed to health and the environment were 11% and 14% respectively of the training needs.

The preferred format for each training need (academic courses (MSc or PhD), digital or physical training courses, user meetings, summer schools, on-demand training, or other formats) indicated that a minor part of training needs required multiple formats or hands-on supervision (Figure 1). Most answers on training needs contained the formats summer schools, workshops and digital courses, with digital courses and workshops being the most frequent suggested formats. The training needs belonging to the class data handling were exclusively directed towards these formats. No academic courses were mentioned in the needs which might be explained by it requiring more administration and less flexibility in length and language, while it is easier to join digital courses or a summer school, for which the content can be more dynamic and up to date.

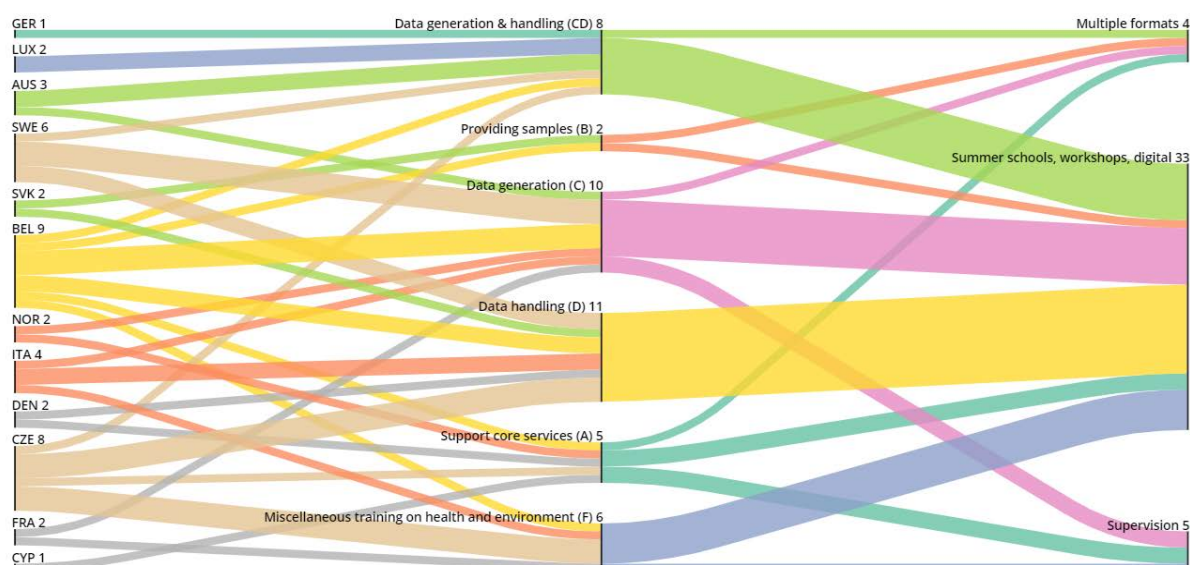


Figure 1. Training needs (left side), connected with preferred formats of the training (right side), as provided by partners from different countries participating in the survey. Country codes and number of partners providing answers are given on the left axis. The number of answers for each class of training needs (A-F) are given on the middle axis, and number of answers for each training format are on the right axis.

Training was offered by 29 institutions from 12 countries and a total of 48 individual training offerings were reported (Figure 2). Looking at the current available training by the EIRENE preparatory phase partners, there is an overlap between offerings and needs although the distribution of training offerings among core services does not match the training needs. For example, around half of the training provided as summer schools, workshops and digital courses are directed to data generation and handling and the other half is for support of core services and providing samples. The main self-assessed need by partners were for data generation and handling. The geographical distribution of training offers is good, covering 12 countries but it remains to be elucidated if the geographical distribution of on-site internships and workshops covers the needs and practical frames of the different EIRENE nodes.

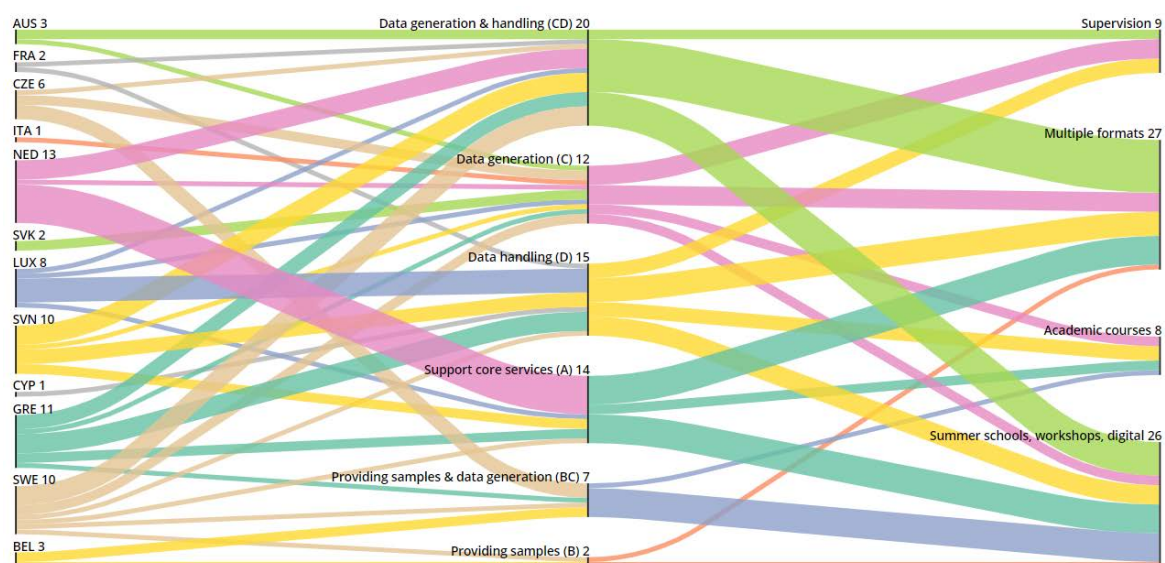


Figure 2. Training offerings (left side), connected with formats of the training (right side), as provided by partners from different countries participating in the survey. Country codes and number of partners providing answers are given on the left axis. The number of answers for each class of training offerings (A-F) are given on the middle axis, and number of answers for each training format are on the right axis.

Training strategy

Goals with the strategy

The training strategy will aim at establishing an EIRENE training network as a tool for the education and training of excellent scientists, a new generation of RI operators and technicians, as well as service managers. The ambition is to provide excellence in EIRENE but also extend to external networks and interested parties, as well as large scale projects both in Europe and globally.

Target groups

The primary target group for the training strategy is the **internal staff members**, that is EIRENE partners providing services in EIRENE. This target group is the core foundation of providing services and excellence in science and management to provide for the needs of stakeholders. The secondary target group is **external communities**, for which the EIRENE training network is made available to educate scientists outside EIRENE, stakeholders and the public in the art of the core services as well as knowledge on environmental and human health.

Tools and methods to enhance skills and professional development

Tools and methods directly linked to services. To establish a network of harmonized laboratories, databases, and data processing tools, it is crucial to prioritize workshops and internships where the EIRENE staff meet and share knowledge. These workshops should be designed specifically for internal purposes, rather than for external participants. Internships are particularly crucial—they are the first and most important step in building our internal capacity by letting early-career researchers work together across countries and disciplines, fostering collaboration and innovation in the lab. Summer schools, in collaboration with larger projects like PARC, are also part of the EIRENE strategy. The training efforts should first-hand take advantage of the institutional offerings and competencies for hosting the efforts. In order to promote the competence provision development academia should prepare an inventory of available study programs for EIRENE partner professionals. At a later stage, digital courses should be developed to further support learning and training.

Tools and methods for excellence in science and management. Research infrastructures exist to support excellent science, which requires ongoing investment in cutting-edge technologies. However, it is equally important to continuously educate the staff. Embedded continuous education needs to be included in the structure of each service and competence centres of EIRENE. Annual physical meetings among the different competence centres will promote teambuilding and competence exchange. This needs to be identified at the respective centres on a regular basis and includes ensuring that, alongside reinvestment plans for instruments, there is a Human Resources Development Plan for technicians and researchers. Equally important are the tools for enhancing management skills among research infrastructure managers such as the program in Milan is an Executive Masters (MBA) in Management of Research Infrastructures (<https://emmri.unimib.it/>). Education from other organisations may also be considered, e.g. the European Organization of Research Managers, and Open Access Managers.

Responsibility and management

Training should be coordinated at the central level in connection with the quality of the overall infrastructure. This means that the coordination of training activities will be one of the key services managed centrally by EIRENE. An operational committee or steering group, comprising representatives from various competence centres and services of EIRENE, will oversee these activities. Forming a competence centre on education and training should be considered. A clear description of how this effort will be organized, where it will fit within the coordination structure, how it will be implemented in the short term, who will be involved, and how it will be communicated, is to be performed by the EIRENE coordinator.

Requirements for the implementation phase

In the short term, the analysis of the needs assessment shows that data handling, closely linked to data generation, is the main training gap within EIRENE. This should be prioritized, and already existing training networks and university connections need to be identified by the EIRENE competence centre on data handling. It remains to be investigated which are the relevant staff groups that need to be addressed, for example technicians or data analysts. The most efficient way to determine where the training of internal staff members should be performed using existing training offerings needs to be elucidated. Critical trainings that are not in the existing EIRENE RI need to be identified, such as trainings in management of a research infrastructure.

Long term developments

In the long term, elements to develop and possibly offer as a paid service for external parties need to be identified as well as setting up a business model for the ETN. This could include offering online courses for free to generate greater societal impact, particularly for low-income countries. Additionally, minimize overlap with other infrastructures, organizations, and projects like PARC, by fostering cooperation and networking is needed. It is recognized that this effort is focused on building the EIRENE internal capacity for providing services and that the survey has garnered more responses from the scientific community than from the service providers since currently, only a small number of the EIRENE partners have Open Access facilities providing these services. Next step is to present the strategy to stakeholders and user community for input to verify that our training and development meets the expectation of the receivers of the EIRENE services.

Conclusions

The survey identified significant training needs, particularly in data generation and data handling, which together accounted for 66% of the reported needs. The results also highlighted that general training and training related to health and the environment were less prominent but still important. This suggests that EIRENE must prioritize training in these critical areas to address the identified gaps. The most preferred training formats identified were digital courses, workshops, and summer schools. These formats are favoured due to their flexibility and dynamic content, which contrasts with the lack of interest in more rigid academic courses like MSc or PhD programs. This indicates a need for more accessible and adaptable training opportunities within EIRENE. Although there is some overlap between

the current training offerings and the identified needs, there is an indication that a better alignment between what is offered and what is needed, is required.

The EIRENE training strategy emphasizes building internal capacity, particularly through workshops, internships, and continuous education tailored for EIRENE staff. This includes developing a harmonized network of laboratories and databases through EIRENE competence centres. In the long term, EIRENE aims to extend its training offerings to external participants and possibly monetize some services, while also ensuring cooperation with international projects and infrastructures, thus minimizing overlaps.

APPENDIX 1. EIRENE Questionnaire, the questions related to training offerings and needs

EIRENE Questionnaire - EIRENE Europe

Dear colleagues, please find a word version of the questionnaire to use in your Universities and Institutes. You may use it for working together on the questionnaire before entering the answers in the digital survey.

Introduction	11
Basic Information	15
Selection of Services	Error! Bookmark not defined.
Service 1 Collecting and providing samples	Error! Bookmark not defined.
Human resources for Service 1	Error! Bookmark not defined.
Service 2 Access to human health and/or exposure data	Error! Bookmark not defined.
Human Resources for Service 2	Error! Bookmark not defined.
Service 3 Measurements of exogenous substances	Error! Bookmark not defined.
Human Resources for Service 3	Error! Bookmark not defined.
Service 4 Omics-based analysis of markers of biological response	Error! Bookmark not defined.
Human Resources for Service 4	Error! Bookmark not defined.
Service 5 Quantification/determination of toxicity	Error! Bookmark not defined.
Human Resources for Service 5	Error! Bookmark not defined.
Service 6 Biostatistical and/or bioinformatics tools and platforms	Error! Bookmark not defined.
Human Resources for Service 6	Error! Bookmark not defined.
Service 7 Databases and exposure maps on environmental factors ...	Error! Bookmark not defined.
Human Resources for Service 7	Error! Bookmark not defined.
Service 8 FAIR cataloging of exposome data	Error! Bookmark not defined.
Human Resources for Service 8	Error! Bookmark not defined.
Service 9 Training offerings	17
Human Resources of service 9	21
Training needs	24
Service 10 Additional service(s)	Error! Bookmark not defined.
Human Resources for Service 10	Error! Bookmark not defined.
PILOT	Error! Bookmark not defined.
Warning/End of Questionnaire	Error! Bookmark not defined.

Introduction

Welcome to the EIRENE questionnaire

What is EIRENE? Environmental Exposure Assessment Research Infrastructure (EIRENE) aims to build a Europe wide infrastructure for exposome research. It is an EU funded project in the preparatory phase.

Note: Be aware that EIRENE RI is an infrastructure, and as such it will support and contribute to research projects, including monitoring efforts, not pursuing research projects in itself.

Mission EIRENE The EIRENE RI mission is to establish a sustainable research infrastructure enabling the advancement of exposome research in Europe by bringing together complementary capacities available in the member states, harmonizing them and upgrading to address current scientific and societal challenges in the areas of exposures and population health.

Vision EIRENE The EIRENE RI Vision is to mediate an open access to the infrastructures supporting a world-class research expanding the scientific knowledge in the area of human exposome, supporting the development of new technologies and translation of the research results to the daily lives of citizens via public-private (industry, spin-offs) or public-public (policy-making) partnerships in order to tackle a problem of non- genetic factors behind the development of chronic conditions and to improve the population health.

Why this questionnaire? To make an inventory which exposome services are present in Europe today and which human resources are available for these services.

To whom will this questionnaire be send? This survey will be distributed to all 17 national EIRENE PPP partners and all the national hub participants listed.

Which **type of Exposome Services** are in scope for the inventory?

01. Collecting and providing samples (including bio, environmental, and specimen banks) to determine exogenous substances
02. Access to cohort study or survey data on an individual level
03. Measurements of exogenous substances including target and nontargeted measurements of chemical mixtures (or other pollutants) as well as parent and transformation exposure markers in humans and the environment
04. Omics-based analysis of markers of biological response (separate: metabolomics, lipidomics, adductomics, (epi)genomics, metagenomics/microbiomics, transcriptomics, proteomics, phenomics)
05. Quantification/determination of toxicity (human- and ecological), pathways and modes of action (in-vivo, ex-vivo, in-vitro, in-silico)
06. Biostatistical and/or bioinformatics tools and platforms to investigate the exposome and human health interactions
07. Databases and exposure maps on environmental factors (e.g. pollutants, temperature, noise, socio-economic, life style)
08. FAIR cataloging of exposome data (e.g. cohorts, algorithms)
09. Training offerings in the field of exposome research and Training needs
10. Additional service(s)

Human Resources

EIRENE aims to build a Europe wide infrastructure for exposome research. Information about current and future staffing (human resources) is needed to estimate the economic impact of setting up and maintaining this Research Infrastructure, especially in the implementational phase.

Therefore, the current resources of the specific service of your institute are requested here. We ask you to please provide in full time equivalents (FTE) the human resources (personnel) identified by their skills and expertise, currently available and connected to the service in question. How resources develop in future you can indicate by selecting decrease, no change, or increase in type of personnel.

Training needs

Training needs is focused on the needs from the partners to learn, enhance the personnel skills and keep up/improve their competence in the fields indicated, i.e. all related to the Exposome

services in EIRENE.

Instructions for the questionnaire

Only fill in services your institute/university can promise to offer to the EIRENE Research Infrastructure that are available today and are sustainable. Per service you can indicate your expectations for how the service will change in the coming 5 years.

Services can be described on a department or on an institutional/university level.

Read the 10 sections/categories of exposome services.

Select the services your department or institute/university would like to offer to the infrastructure.

Describe the exposome services of your department or institute/university.

If the service you would like to offer is not in the list 1-9, please add it under “10. Additional service(s)”.

For each section/category a number of questions are asked, including keywords that describe your selected services best, as well as human resources and staff specifics.

Questions or requests for clarifications

Please contact:

Laurien Ulfman l.h.ulfman@uu.nl (exposome services)
and/or

Anna Kärman anna.karrman@oru.se (human resources)

Basic Information

Name

Profession

Department and unit (if applicable)

University/Institute

I fill in this questionnaire on behalf of the

☐ Department

☐ University / Institute

Address of university/institute

Country

Email address on which you can be reached:

Service 9 Training offerings

Explanation Training offerings are training/education modules that you can offer to the EIRENE Infrastructure. These are focused on, or highly related to, the services you filled in this survey thus far. Also, they can be diverse e.g., academic courses and programmes, summer schools, tailored trainings, workshops.

Please describe the trainings your institute provides in relation to Exposome Research. You can think of e.g. courses, workshops, online modules, summer schools.

- ☐ Training type 1 _____
- ☐ Training type 2 _____
- ☐ Training type 3 _____
- ☐ Training type 4 _____
- ☐ Training type 5 _____

In the questionnaire you get the possibility to answer the following question per type of training you selected.

Please describe the format and the level of training type ...

Which keywords would best describe training type .. (multiple answers possible)

☐

Workshops

☐

Online modules

☐

Summer schools

☐

Academic courses

☐

Supervision

☐

Other _____

☐

Other _____

☐

Other _____

Which keywords would best describe the accessibility of the training type ..?

- ☐ In loco
- ☐ Online
- ☐ On demand
- ☐ Language _____
- ☐ Basic requirements _____
- ☐ Free
- ☐ Paid
- ☐ Given on regular intervals

Do you expect changes in training type ... in the coming 5 years?

- ☐ Definitely not
 - ☐ Probably not
 - ☐ Might or might not
 - ☐ Probably yes
 - ☐ Definitely yes
-

Please describe the changes that might occur regarding training type ...

Describe the current capacity (e.g. number of people per year you can train for training type ...

Do you expect changes in the number of people that can be trained each year, in the coming 5 years for training type ..?

- ☐ Less people can be trained per year
- ☐ More people can be trained per year
- ☐ No changes
- ☐ There may be changes but it is unclear how they will impact our capacity

Human Resources of service 9

The next questions are about the human resources available for the service with regards to training offerings. This part can be filled for the sum of all trainings you have indicated above.

What personnel do you have currently available for the services with regards to training and education. Please select the personnel depicted. Is the personnel not in the list? Tick the "other" text field and enter description.

☐

Administrative staff

☐

Data manager

☐

IT support

☐

Lab assistant / technical staff

☐

Scientist

☐

Other _____

In the questionnaire you get the possibility to answer the following question per type of personnel you selected. For the question on FTE please fill in a number (1 decimal allowed)

Describe the expertise field/skills for the position of

What is the level of education for the position of ...

- ☐ PhD (Professor)
- ☐ PhD (Senior Researcher)
- ☐ PhD (Researcher)
- ☐ PhD
- ☐ MSc
- ☐ BSc
- ☐ Technician/Engineer
- ☐ Lab Assistant
- ☐ Other _____

Indicate the FTE available for the position of to provide service 9.

Do you expect changes for the position of in the coming 5 years in:

	Decrease	Stay the same	Increase
Available skills/expertise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Level of education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
FTE	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Training needs

Training needs

Training needs is focused on the needs from the partners to learn, enhance the personnel skills and keep up/improve their competence in the fields indicated, i.e. all related to the Exposome services in EIRENE.

What are your needs for education, training, and competence development to be able to provide and improve the services you selected?

☐

Need 1 _____

☐

Need 2 _____

☐

Need 3 _____

☐

Need 4 _____

☐

Need 5 _____

In the questionnaire you get the possibility to answer the following question per type of need you entered

What forms of training do you need for Need 1?

- ☐ MSc/PhD courses
- ☐ Digital courses
- ☐ Physical training courses
- ☐ User meetings/courses
- ☐ Summer schools
- ☐ On demand training/tutorials
- ☐ Other _____
- ☐ Other _____
- ☐ Other _____