



# SURVEY REPORT

## PREWORKSHOP SURVEY

### “Overcoming barriers to cross-disciplinary research”

**Authors:** Paul Davies<sup>(1)</sup>, Matthew Elliot<sup>(1)</sup>, Ava Khamseh<sup>(2)</sup>, Frederic Lamoliatte<sup>(1)</sup>, Chris P. Ponting<sup>(2)</sup>, David Sims<sup>(3)</sup>, Duncan Sproul<sup>(2)</sup>, Cristina Vázquez-Martín<sup>(2)\*</sup> and Emily Woollen<sup>(4)</sup>

Affiliations: <sup>(1)</sup> MRC - PPU, University of Dundee, Dow St, Dundee DD1 5EH, Dundee, UK.

<sup>(2)</sup> MRC Human Genetics Unit, Institute of Genetics and Cancer, University of Edinburgh, Edinburgh EH4 2XU, UK.

<sup>(3)</sup> MRC WIMM Centre for Computational Biology, University of Oxford, Oxford OX3 9DS, UK.

<sup>(4)</sup> Institute for Academic Development, University of Edinburgh, Edinburgh, EH8 8FP, UK.

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\*Correspondence: [cristina.martin@ed.ac.uk](mailto:cristina.martin@ed.ac.uk)

@X-Net Twitter: [@AnonSciCar](https://twitter.com/AnonSciCar)

X-Net website: <https://x-net.bio>

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### 1. Introduction

Interdisciplinary research can create many scientific opportunities but may also face challenges and barriers. X-Net’s main objective is helping interdisciplinary scientists to overcome those barriers providing guidance and resources, particularly to early career researchers. We organised an online workshop “Overcoming barriers to cross-disciplinary research” (6<sup>th</sup> July, 2022) with the purpose of identifying the main obstacles of interdisciplinary research (IDR) in the UK.

The workshop incorporated a pre-workshop anonymous survey that allowed participants to identify and share some of their personal experiences of cross-disciplinary research. The workshop then used these experiences to find themes or challenges in common. It also allowed participants to consider, through action learning, what specific cross-disciplinary barrier(s) they sought advice on.

The survey questionnaire was designed to focus on the opinions of individual scientists regarding the barriers or incentives for interdisciplinary research and to receive diverse perspectives. Researchers with early or ongoing experience in interdisciplinarity entering biomedical sciences from STEM were approached for their opinions.

## 2. Survey design

The survey was planned using an online survey tool, provided under licence from JISC (formerly Bristol Online Survey (BOS)), accessible via the University of Edinburgh. This online system offered the platform required to create, run and analyse the survey. The questionnaire was designed using a variety of formats with closed and open-ended questions:

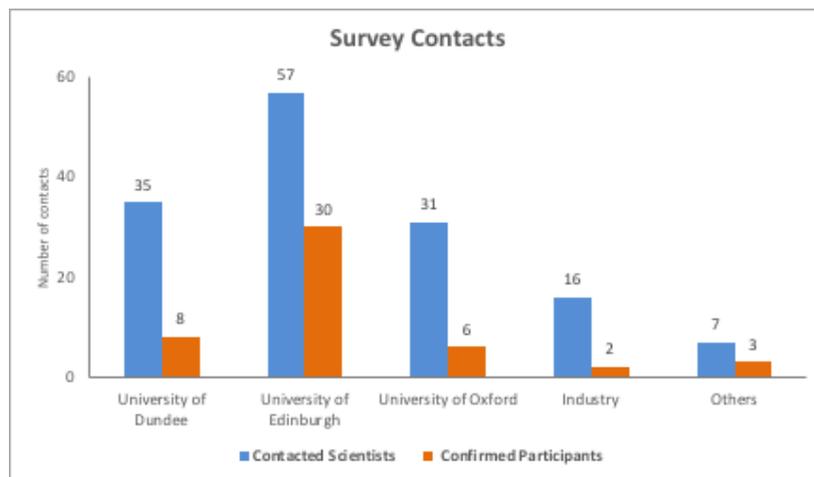
- **Closed-ended questions:** provided *quantitative data*. Survey respondents had to answer in a specific way giving a “yes” or “no” response, choosing from predetermined responses or selecting a rating. In this survey we used single choice, multiple choice, and scale/rank questions, measuring how the scientists participating in our study think or feel about a specific topic. Analysis of this type of data was achieved by charts or tables.
- **Open-ended questions:** provided *qualitative data*. Survey data were descriptive, word-based so that we identified trends and organised responses into groups and categories. Respondents could answer in the way they chose in their own words, not being limited to a predetermined set of possible answer choices. We collected a rich pool of genuine opinions from the participants on different topics. The analysis of raw qualitative survey data was achieved by sorting the responses into categories (coding) and creating visual representations (word clouds from terms that frequently appeared in responses).

The number of questions was 16, divided into five areas: personal details, interdisciplinary research barriers, career development, suggestions and additional reflections. 146 scientists related to interdisciplinary research were approached. Most of the connections were obtained based on the details provided by X-Net members while other contacts were found through specific searches on the Internet. The survey was sent to 49 interdisciplinarians who agreed to take part (the average response rate is shown in figure 1). There were large variations in the response rate between the University of Edinburgh and the Universities of Dundee and Oxford. The percentage of successful connections (scientists who agreed to collaborate out of the total approached) was 61% for the University of Edinburgh, 16% for the University of Dundee and 12% for the University of Oxford.

The respondents were at different career stages, from PhD students to well established independent researchers, and worked in the following institutions:

- **University of Edinburgh:** 30 researchers
- **University of Dundee:** 8 researchers
- **University of Oxford:** 6 researchers
- **Industry:** 2 researchers
- **Others (UK academia & research institutes):** 3 researchers

All participants were asked to re-distribute the survey among colleagues who could be interested in completing it. We initially sent the survey to the population of 49 researchers and the final number of responses used in this final analysis was 76. These comprehensive responses were obtained over a period of 2 months. The main advantage of the sampling approach employed is that all the participants approached to fill in the questionnaire were identified as interdisciplinarians and they all gave their consent to take part in it. They were also keen on re-distributing it to their colleagues. The main limitation of the approach is, however, that there was no control over the number of people who could complete the questionnaire or the number of times they did so.



*Figure 1.* Response rate in the survey: number of contacts initially approached in the different organizations (blue, n=149) and number of those approached contacts who agreed on completing the survey (orange, n=49).

The survey was launched on 18/06/2022 and distributed to our target audience on 19/06/2022 by sharing the public URL created by the platform (<https://edinburgh.onlinesurveys.ac.uk/x-net-survey-overcoming-barriers-to-interdisciplinarity>). The link was circulated by e-mail, posted in the X-Net website, slack channel and twitter account. The survey was also advertised in the X-Net article as part of the communications release for the X-Net presentation (01/07/2022) as well as specific intranets or twitter accounts in the Universities of Edinburgh, Dundee and Oxford.

### 3. GDPR: General Data Protection Regulation

**GDPR** came into play in May 2018 and it impacted the way organizations manage personal data in compliance with the mandates of the new privacy regulation. X-Net organised this online survey to collect feedback from interdisciplinarian researchers following rigorous GDPR guidelines, in order to promote transparency and trust. We did not collect any kind of personal data to avoid being in possession of information that required to be managed in a way that safeguarded the privacy of the individual.

The two parties involved in data collection - the data processor and the data controller - were GDPR compliant. The data controller (X-Net, the survey planner) established the intent and the method by which data was processed, while the data processor (JISC, our selected survey platform) processed the data on behalf of the controller.

We ensured that our survey remained completely anonymous by:

- not including any questions that asked respondents for identifying details.
- asking for consent before sending the survey.
- sending a survey link to all the participants independently, not using email distribution lists.
- being transparent about why we were collecting the data and how it will be used.
- making sure that respondents could opt-out from receiving our survey invitations.
- sending survey respondents an untraceable URL link with a dedicated webpage to complete the questionnaire without connection to a computer IP address.
- not sharing the data with third parties, belonging exclusively to the data controller (X-Net).
- adding a data protection disclaimer<sup>(\*)</sup> to the survey. This addition was not strictly required because the survey data could not be linked to the respondents in any way and it would not be possible to identify them (even indirectly). Data protection legislation does not apply to effectively anonymous data, only to personal data as it is reflected in the University of Edinburgh data protection website (<https://www.ed.ac.uk/data-protection/data-protection-guidance/definitions/definitions-personal-data>).

<sup>(\*)</sup> **Data protection disclaimer** (compulsory): Your participation in this research is completely anonymous. The following questions will be used for general analytical use only. Your specific responses will not be connected to you in any way. The URL link sent to you with a dedicated webpage to complete the questionnaire is untraceable, without connection to a computer IP address. Your individual responses will not be given to any third party whatsoever. Proceeding to the survey implies that you understand and agree to provisions in this disclaimer.

### 4. Data analysis

The survey was designed to deliver clear insights about the obstacles that scientists face when they approach interdisciplinary research. To achieve the optimal survey analysis and produce meaningful results we divided the analysis in two parts:

- **Analysis of numerical data - scores:** for the study of closed ended questions such as multiple choice, single choice or ranking questions where the respondent chose from a list of pre-selected options. The ranking or scale questions were established using a five points scale: strongly disagree – disagree – neither agree nor disagree – agree – strongly agree. This design creates data that are easily quantifiable so they are final in their nature. We could also categorize respondents into groups based on the options they selected.
- **Analysis of qualitative data - free text responses:** open-ended questions were designed to produce a meaningful answer and create rich, qualitative data using the subject's own knowledge and feelings. For these questions that allowed respondents to answer in their own words, text data was analysed by coding. The person who analysed the data read through all the answers several times, using personal judgement in order to identify some main categories. A code was associated to every category and the list of categories and their associated codes denoted the code frame. After reading all the responses, a value was assigned to each response, reflecting the code previously created. All variables were then analysed using frequency tables. In this way, we categorized the responses to provide not only a detailed picture of what people's opinions are in their own words, but also to know how many people feel that way. To visualize the qualitative data, we created **word clouds** using WordArt.com that show all the words in the text, packaged closely together, with the font size indicating the frequency with which words appear, with less interesting words automatically excluded.

## 5. Synthesis of findings

This synthesis of findings represents a summary of the survey analysis providing the bigger picture as communicated by the data in 76 responses. We used quantitative and qualitative research methods to collect the data and to analyse them providing different types of insights which are shown below. The quantitative analysis was carried out for questions 1 to 15 and the qualitative analysis for questions 16, 16a and 16b.

### QUANTITATIVE ANALYSIS

Taking into consideration the **personal information** offered by the respondents, the vast majority were working in the academic sector in UK and considered themselves as strongly interdisciplinarian, defining their research identity mainly as interdisciplinarian (50%) or differently, to different people (46%). The career stages of the participants were predominantly mid-level (35%) and senior (53%), capturing the views here of only a relatively small number of PhD students (12%). The most important potential benefit of IDR for them was helping to address their own research question (63%) or helping to define a new research direction (27%), not so much working to address other's research question (10%).

As regard to **barriers in IDR**, we found areas of agreement where researchers considered that the main obstacles were: too much jargon and/or domain-specific knowledge (17%), insufficient time to learn a new discipline (32%), little support from research environment including mentorship (23%) and others' pigeonholing one's skills, motivation or interest (26%). A large majority of respondents thought that communication is more challenging in IDR collaborations (84%), that researchers require to meet more frequently than working with single disciplines (64%), and that additional training is required (80%). We found that researchers have strong differences of opinion about how difficult it is to establish collaborations (34% disagreed and 41% strongly agreed). Career progression was thought more difficult in IDR for the 63% of respondents.

There were differences in views around the difficulty of getting interdisciplinary research published in major research journals and the scientists thought that single discipline research expertise was more highly valued in career evaluations than interdisciplinary expertise (56% vs 25%, whereas 18% neither agreed nor disagreed). Interdisciplinary researchers generally were more likely to agree that to have a strategy in place is important to pursue an interdisciplinary research career (85%), and to disagree that there is sufficient support, advice, and training available for interdisciplinary research (65%).

With respect to **Career Development** a large majority of respondents thought that the best time in a career to become an interdisciplinary researcher is at the PhD degree (45%) or postdoctoral levels (38%). The greatest scientific value for them was provided by working together with others from different disciplines each drawing on their own disciplinary knowledge (35%), integrating knowledge and methods from different disciplines, transferring methods from one discipline to another (38%) or when two or more discipline perspectives transcend each other to form a new holistic approach (21%). As expected, working within a single discipline was not considered very valuable scientifically by the interdisciplinarians (1%).

Diverse perspectives were found when researchers were asked if Interdisciplinary research provides better job opportunities: 41% neither agreed nor disagreed, 18% disagreed, 29% agreed and 10% strongly agreed. A similar range of opinions was seen when researchers were asked if interdisciplinary research is less likely to be funded than single disciplinary research: 34% neither agreed nor disagreed, 18% disagreed, 26% agreed and 13% strongly agreed. A majority of respondents felt that single disciplinarity is easier (45% agreed and 21% strongly agreed) and that peers in core disciplines often consider interdisciplinary research to be less rigorous (33% agreed and 24% strongly agreed). Most scientists disagreed with the idea that interdisciplinary research has usually less scientific depth (49% disagreed and 36% strongly disagreed).

In relation to the **suggestions from the respondents**, if asked how they would overcome any disconnection between disciplines the respondents had a variety of opinions equally distributed: greater general awareness of obstacles to inter- and cross-disciplinarity (32%), specific funding opportunities for inter- and cross-disciplinary researchers (37%) and specific training opportunities for inter- and cross-disciplinary researchers (30%). Almost none of the scientists thought that there is no disconnection between disciplines (1%).

According to the researchers in the study, the quality of interdisciplinary research should be best assessed by surveys (10%), publications and authorship order (18%), new metrics of the added value of cross- or interdisciplinarity (51%) or difficult or not possible for interdisciplinary research quality to be assessed well (21%).

## QUALITATIVE ANALYSIS

The survey participants were asked if they had experienced support or hostility to crossing disciplines or interdisciplinary research (question 16). We methodically characterized the respondents' answers in our qualitative data in order to find common themes and patterns, establishing different categories:

1. Hostility
2. Little support
3. Support
4. Support and hostility

Therefore, our raw data were structured into four themes for analysis, making it more systematic and rigorous. In this exploratory research we found insights that were truly representative of the data and the human stories behind them. *Inductive coding* was used, a ground-up approach where we derived our codes from the data, allowing the narrative to emerge from the raw data itself. We assigned four coloured number codes to the four recognised categories.

CATEGORY	CODE	NUMBER OF RESPONSES
Hostility	1	15 (26%)
Little support	2	21 (37%)
Support	3	14 (25%)
Support and hostility	4	7 (12%)
	<b>TOTAL</b>	<b>57 (100%)</b>

Table 1. Summary of the respondents' experiences of support or hostility working in interdisciplinary research: the number of responses was established by coding the answers. Percentages are shown in parenthesis (%).

The above findings show clear differences of personal experiences among the researchers, with 14 (25%) scientists having experienced support when doing interdisciplinary research whereas 15 (26%) experienced hostility. Most of the scientists felt little support: 21 (37%). **This means that 63% of the researchers found a negative environment when crossing disciplines at some point in their careers.** In the survey, only a minority of respondents sensed that interdisciplinary research presented support and hostility depending on the circumstances (12%).

To visualize the qualitative data we used text clouds, a cluster of words depicted in different sizes. The bigger and bolder the word appears, the more often it was mentioned within a given text and the more important it was. The word cloud generator used in this study was WordArt.com. As illustrated in figure 2, many of the scientists taking part in this survey perceived some kind of hostile environment working on interdisciplinary research, although support was also mentioned by some of them. Keywords like challenges or barriers with a negative implication and funding, collaboration, communication, training, values, lack of time were also mentioned by several respondents.



Figure 2. Text cloud: survey respondents experiences (support/hostility) working on interdisciplinary research.

Furthermore, participants were asked whether they, as interdisciplinarians, had access to specific training resources and if so, whether those resources were helpful (question 16a). The qualitative data obtained was again labelled in order to find common themes, establishing two preliminary different categories: **No** and **Yes**. A negative answer was coded as **1** (red) and a positive answer was coded as **2** (green). We determined subcategories describing the training help that interdisciplinary researchers received by inductive coding. Four sub-codes from those respondents who had some kind of training to do their interdisciplinary research were created:

- **2a: specific programmes (MSc/PhD/XDF)**
- **2b: Meetings/Conferences**
- **2c: Collaborators/Colleagues**
- **2d: Training material (books, online courses)**

The table below shows that 43% of survey respondents did not have special training doing interdisciplinary research whereas 57% had some sort of training. Among the scientists with specific training, some programmes like XDF (Cross-disciplinary fellowships from the University of Edinburgh) or MSc or PhDs (36%) and training material like books or online courses (32%) were the most helpful training resources. Collaborators/colleagues were helpful for the 29% of the respondents and only 3% considered meetings and conferences as beneficial.

CATEGORY	SUBCATEGORY	CODE	SUBCODE	NUMBER OF RESPONSES
Training Resources				
No		1		21 (43%)
Yes		2		28 (57%)
	Specific programmes (MSc/PhD/XDF)		2a	10 (36%)
	Meetings/Conferences		2b	1 (3%)
	Collaborators/Colleagues		2c	8 (29%)
	Training material (books, online)		2d	9 (32%)
			<b>TOTAL</b>	<b>49</b>

Table 2. Summary of the respondents' training resources in interdisciplinary research: the number of responses was established by coding and sub-coding the answers. Percentages are shown in parenthesis (%).

The final question in the study (number 16b) was an open-ended enquiry whose aim was determining which topics were the scientists interested in bringing to attention when discussing interdisciplinarity. We received 45 replies to this question with a wide variety of issues and topics to examine. Below it is shown the summarised list of the 17 topics collected:

- How to change the research culture to support interdisciplinary researchers.
- Lack of recognition: at a personal (i.e. colleagues) and institutional level (i.e. funding bodies).
- Lack of resources for interdisciplinarians i.e. training.
- Recognition of rewards and opportunities that IDR brings.
- More time and malleability required in interdisciplinary research.
- Career progression.
- Difficulties in getting funding for interdisciplinary research projects.
- High specialization in groups difficult to follow.
- Practical examples of IDR collaborations established by early career researchers.
- Reviewing of grants and fellowships by non-interdisciplinary professionals.
- Challenges of interdisciplinary research.
- How to work in a department which is not your core discipline.
- How to place value on making novel approaches that lead to new discoveries.
- Importance of communication, openness, and patience.
- How UKRI could better support interdisciplinary research.
- Difficulties in future prospect i.e. long-term collaborations.
- How to improve reviewing for IDR.

## 6. Survey results

Survey data were analysed as **general results** (section 6.1) from all the answers given by the participants responding to the questionnaire. The survey was divided in 5 sections:

- A. Personal details: 5 questions
- B. Interdisciplinary research barriers: 3 questions
- C. Career development: 3 questions
- D. Your suggestions: 2 questions
- E. Additional reflections: 1 question

Subsequent analysis on subgroups was made to get more detailed information. For this second part of the analysis, we wanted to capture the perspectives of specific groups. However, it is important having sufficient responses overall for our findings to be representative of the studied population, and not to be influenced excessively by chance. The groups of interest were:

- Working sector: academia (n=68) or industry (n=8).
- Working in UK (n=72) or abroad (n=4).
- Degree of interdisciplinarity involvement: strong (n=62), somewhat interdisciplinary (n=13) or monodisciplinary (n=1).
- Career stage: early (n=9), mid-level (n=27) or senior(n=40).

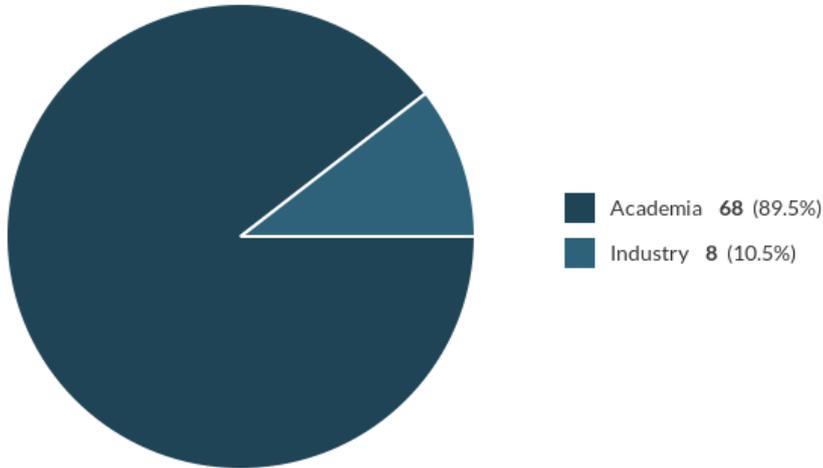
For the first three groups we did not have sufficient responses to conduct the analysis independently. We had significant data to do the analysis of the responses based on the career stage of the individuals. This report provided a side-by-side comparison of how different groups of respondents answered the survey questions. Survey population frames were developed by using cross tabulations or filters to capture the answers based on the career stage: early, mid-level or senior. The **results per group** are shown below in section 6.2.

### 6.1. General results

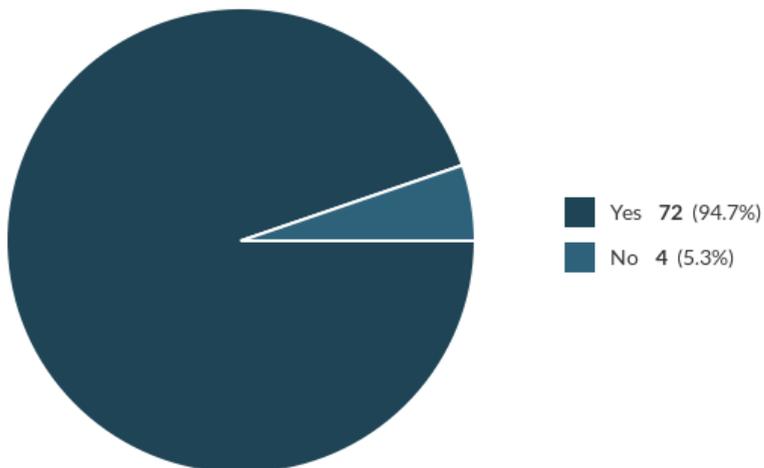
The results shown below correspond to the raw data from the JISC analysis conducted on 76 responses (18/08/2022).

## A. PERSONAL DETAILS

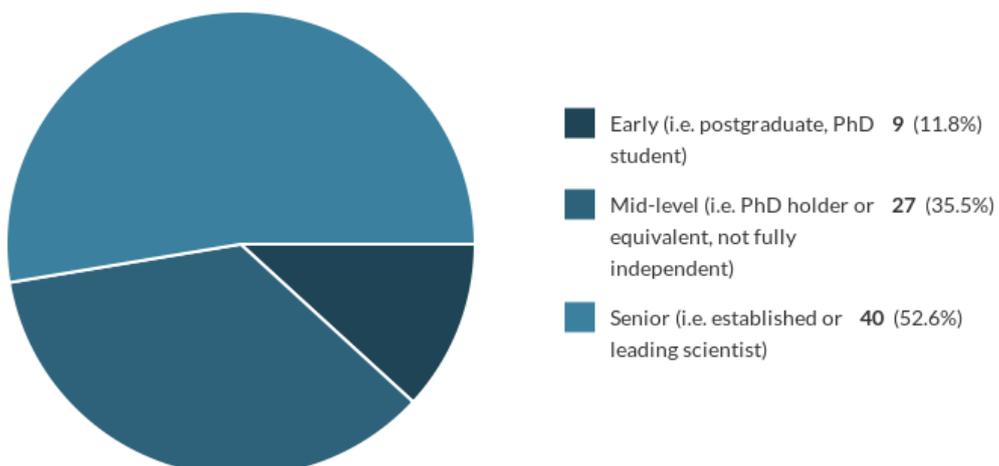
### 1. Working institution: academia or industry



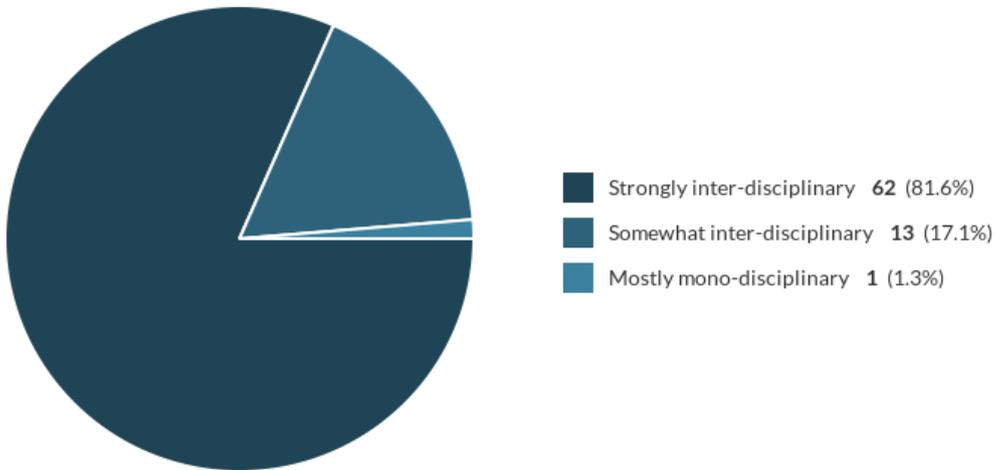
### 2. Workplace: UK (yes) or abroad (no)



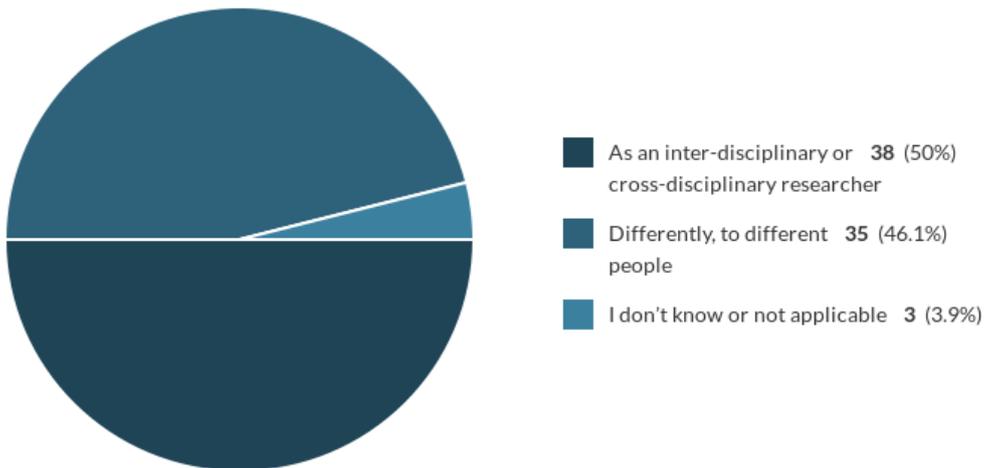
### 3. Career stage



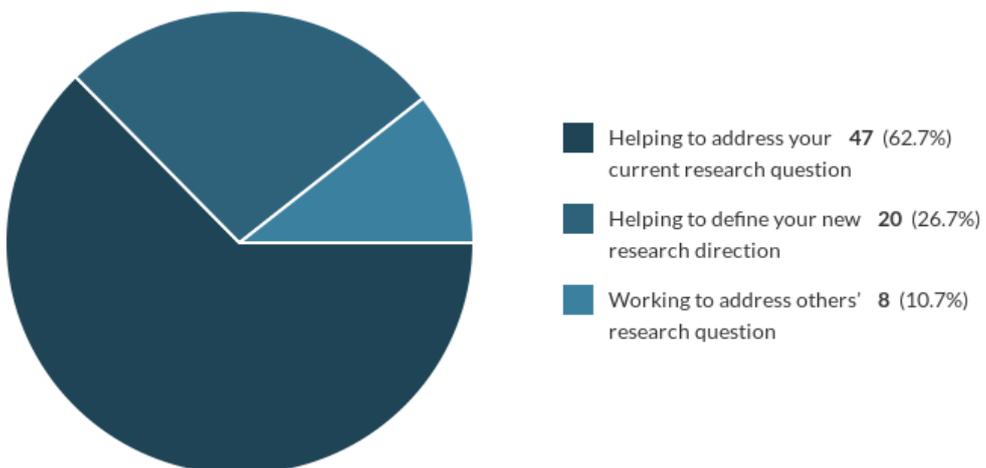
4. Degree of interdisciplinary involvement



5. Description of research identity

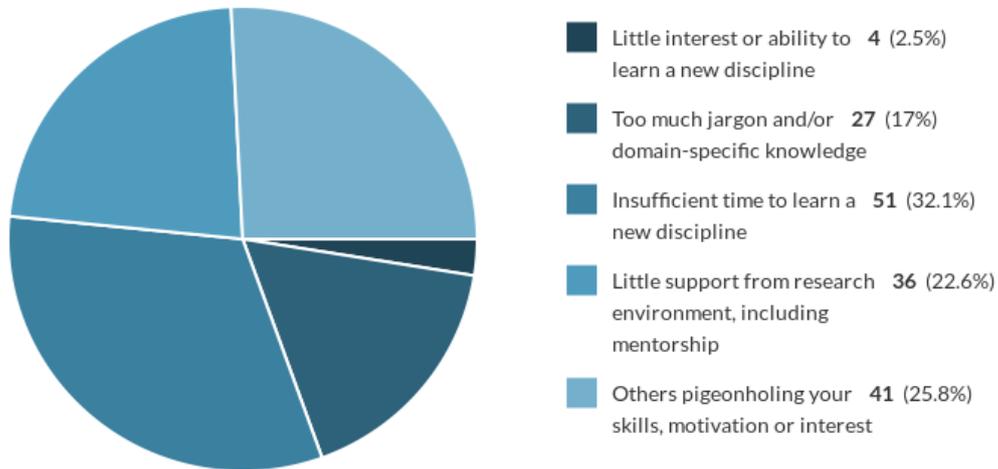


6. Most important potential benefit of interdisciplinary research for you



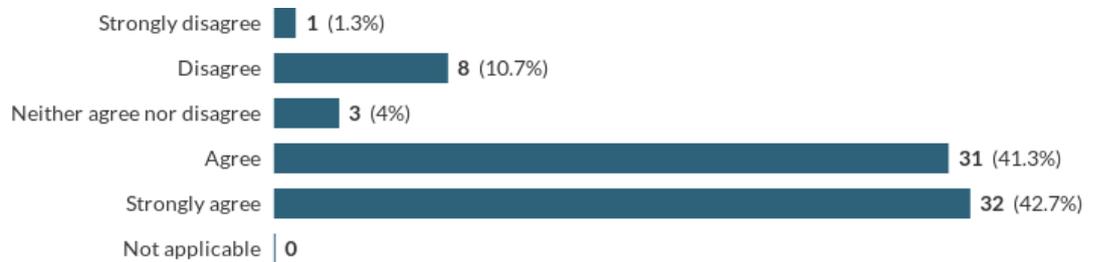
## B. INTER-DISCIPLINARY RESEARCH BARRIERS

### 1. Main barriers to undertaking interdisciplinary research

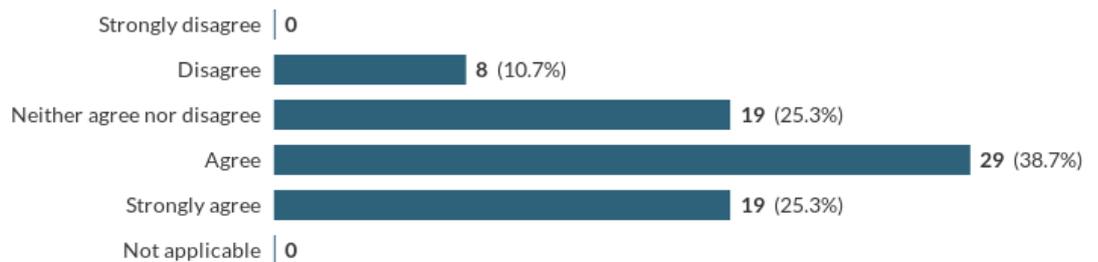


### 2. Rating scale question:

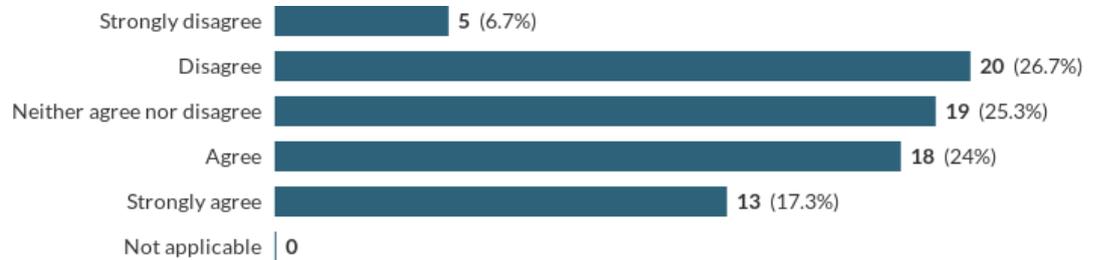
#### a. Communication is more challenging in interdisciplinary research collaborations



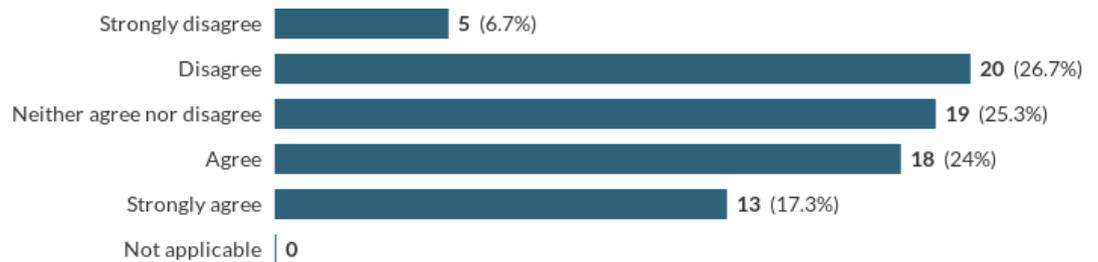
#### b. Interdisciplinary research requires researchers to meet more frequently than in single disciplinary collaborations



c. Additional training is required to undertake interdisciplinary research

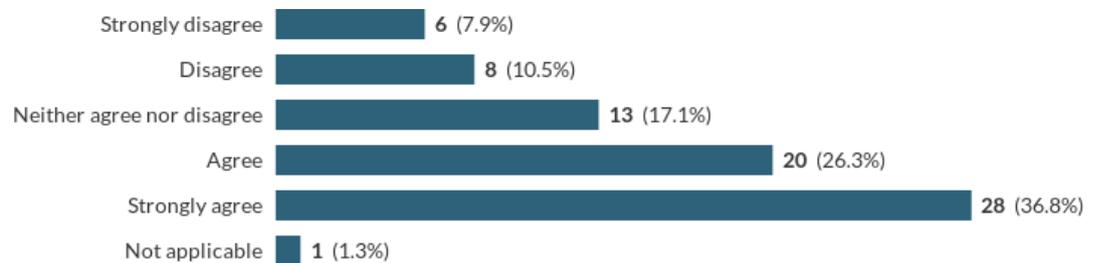


d. Collaborations are difficult to establish



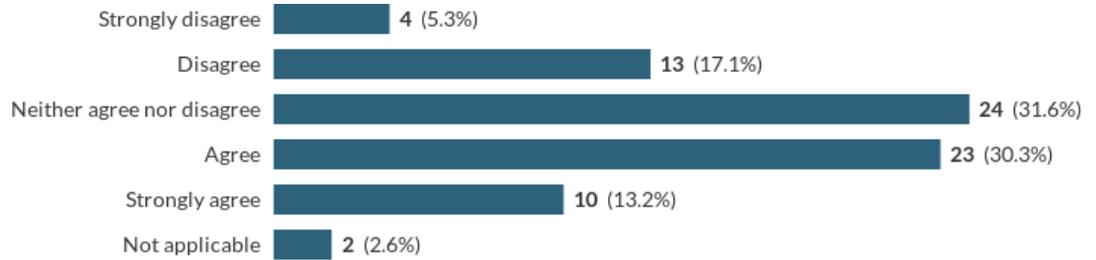
3. Rating scale question:

a. Career progression is more difficult in interdisciplinary research

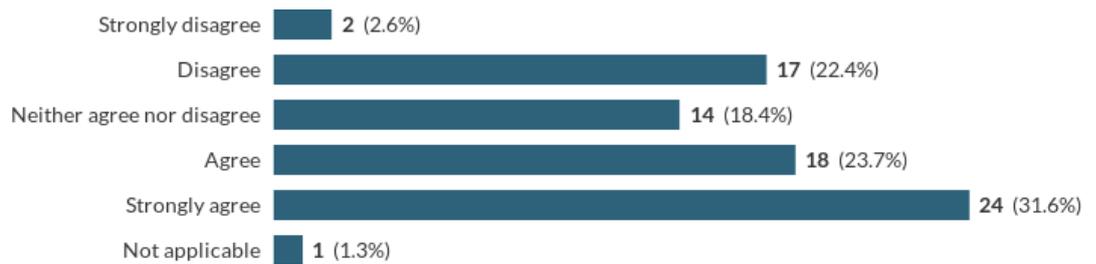




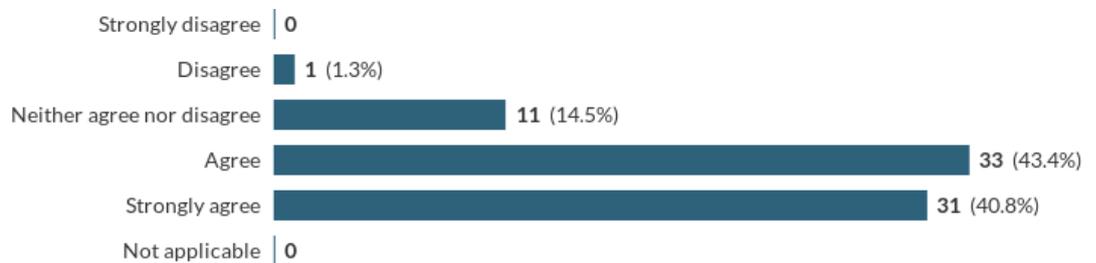
b. It is more difficult to get interdisciplinary research published in major research journals



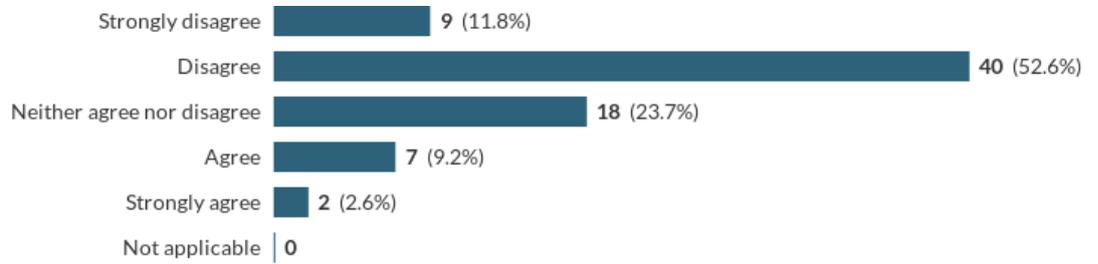
c. Single discipline research expertise is more highly valued in career evaluations than interdisciplinary expertise



d. Having a strategy in place is important to pursue your interdisciplinary research career

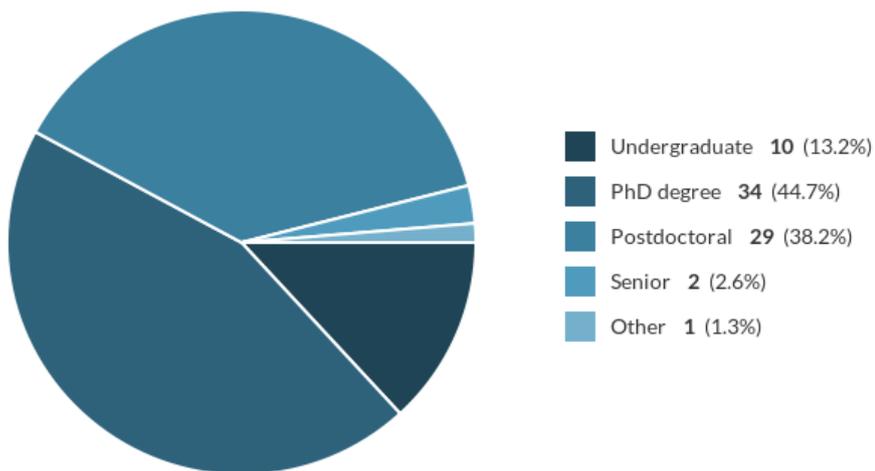


e. There is sufficient support/advice/training available for interdisciplinary research

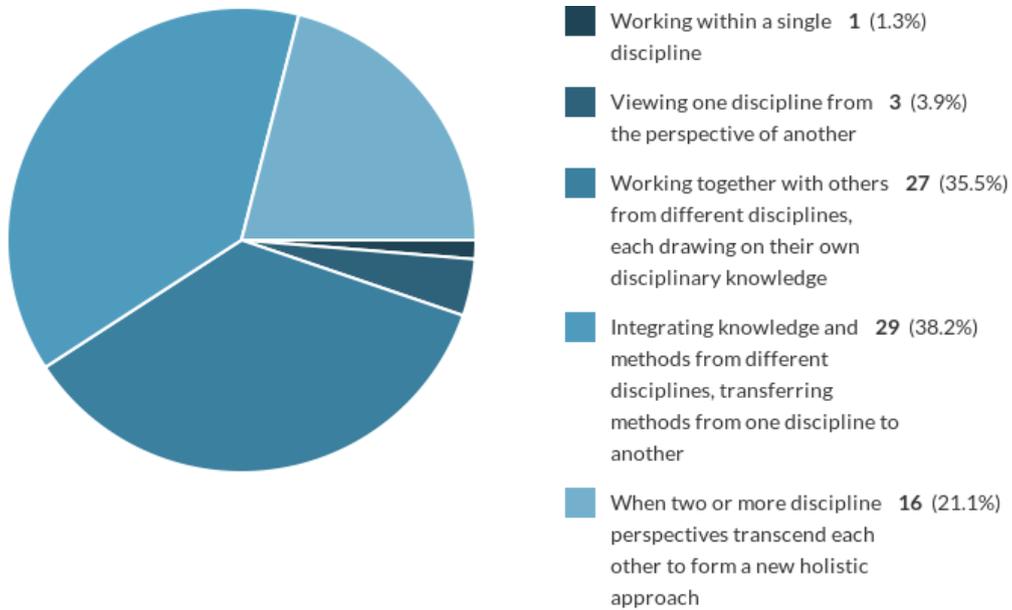


### C. CAREER DEVELOPMENT

1. When is the best time in a career to become an interdisciplinary researcher:

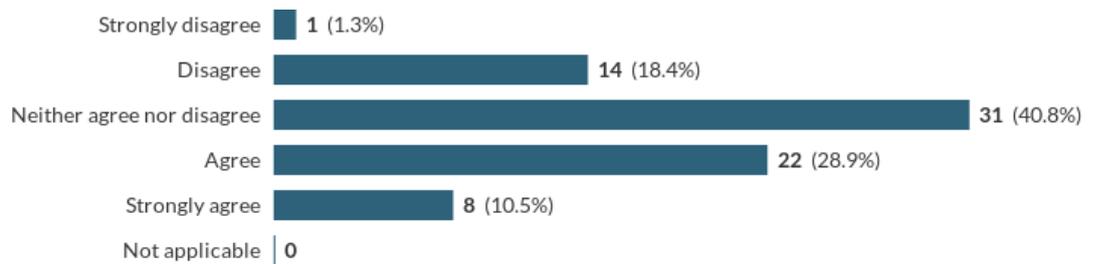


2. What, in general, provides you with greatest scientific value (single choice):

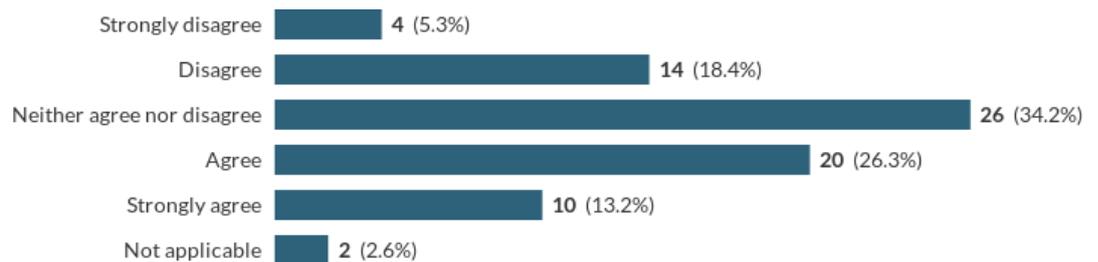


3. Rating scale question:

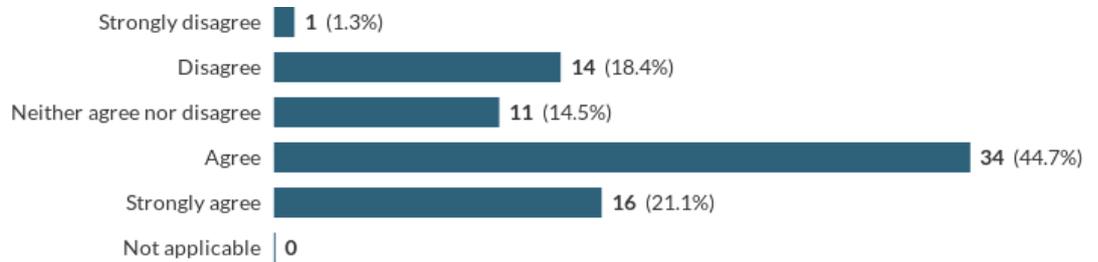
a. Interdisciplinary research provides better job opportunities



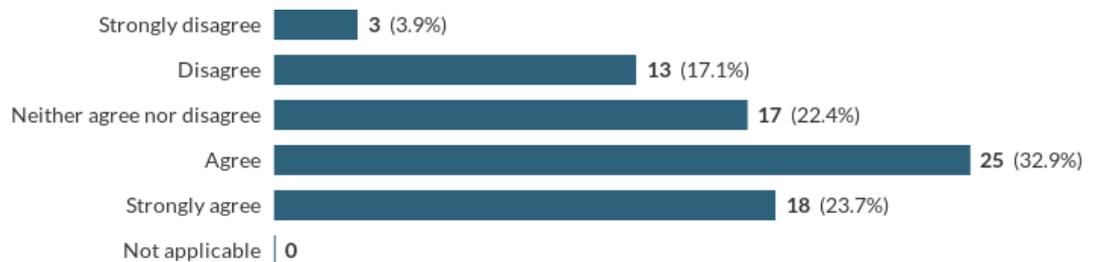
b. Interdisciplinary research is less likely to be funded than single disciplinary research



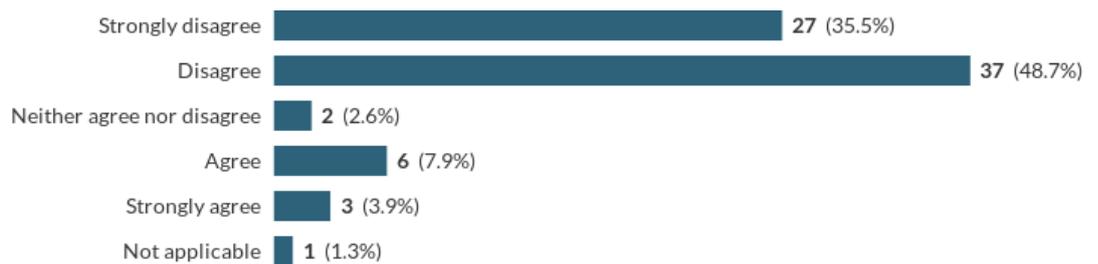
c. As a researcher, single disciplinarity is easier



d. Peers in core disciplines often consider interdisciplinary research to be less rigorous

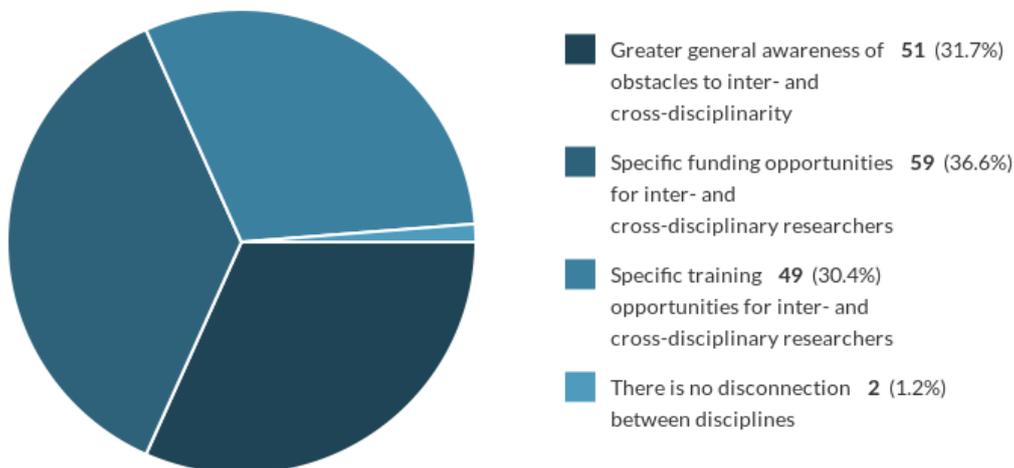


e. Interdisciplinary research has usually less scientific depth

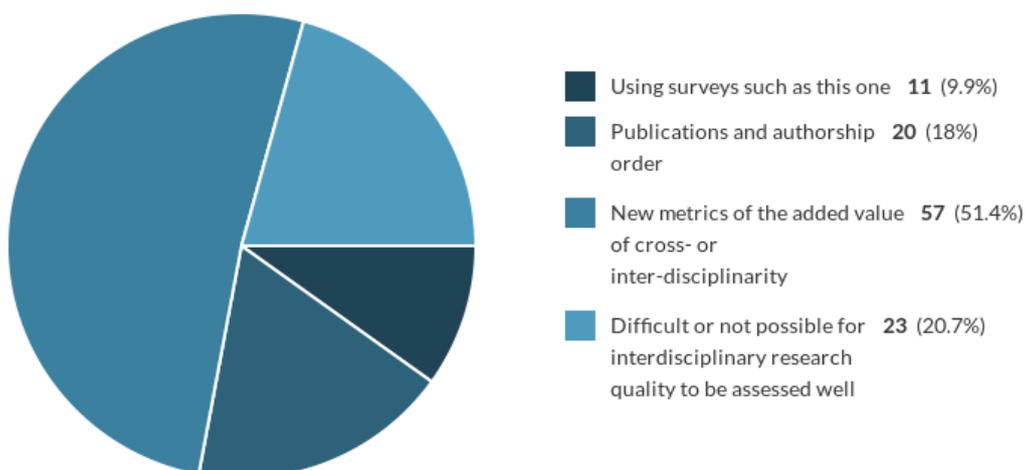


### D. YOUR SUGGESTIONS

1. How would you overcome any disconnection between disciplines (multiple choice)?



2. How might the quality of interdisciplinary research be best assessed (multiple choice)?



### E. ADDITIONAL REFLECTIONS

#### Free text answers:

A. In your career, have you experienced support or hostility to crossing disciplines or interdisciplinary research? If so, we would appreciate a brief summary of your experience here. (Unique response number – Response)

**911847-911829-96436097** - Very little support when crossing disciplines. Rather much greater support of researchers/research in single disciplines. There is a culture of neglect towards cross-disciplinary researchers rather than a conscious bias against them.

**911847-911829-96445965** - Support, as my current role is specifically designed to be interdisciplinary.

**911847-911829-96446107** - Definitely hostility during transition from wet-lab to dry-lab techniques. Still sometimes feel like I don't fit in the computer science world.

**911847-911829-96446222** - Some interdisciplinary projects have been discouraged by line managers/institute directors.

**911847-911829-96447937** - I became a cross-disciplinary researcher at the postdoctoral level transitioning from pure mathematics research to biology.

Having the support of a well thought out postdoctoral program to facilitate the transition was key to my success. During this transition I mostly experienced support and sometimes indifference, but never hostility. Not everyone appreciates the added value of cross-disciplinary knowledge in research, but the overwhelming need for this new type of knowledge in my field quickly sparked the interest and collaborations with most people I have interacted with. Adversaries to cross-disciplinary projects are, in my experience, becoming more rare and less relevant in my field of research.

**911847-911829-96450452** - I was criticized in a grant application review for not mentioning particular ("big name") applied researchers, even though many other names and industrial partners were mentioned.

**911847-911829-96451378** - I have been met with encouragement. I am trained as a chemist and worked in drug discovery as a medicinal chemist in industry. Over recent years I have led a multi-disciplinary team requiring me to become inter-disciplinary in nature. Skills I have learned through that journey were enabled by working for a PI who himself had a similar outlook and so was inherently supportive. I am now using those skills to set up my own academic lab.

**911847-911829-96451981** - It is difficult to apply for permanent positions as an interdisciplinary researcher, in places where most research institutions are mono-disciplinary.

**911847-911829-96454202** - Difficult to gain independent research funding if you do not generate your own research data.

**911847-911829-96453440** - Following a presentation to a broad scientific audience, a participant asked a technical question of the interdisciplinary researcher who was presenting. The moderator, a single-discipline researcher, misunderstood the response and interpreted it negatively, concluding half-jokingly "sounds like a disaster". In reality, the presenter had answered the question sufficiently and pointed out areas for further research. The hostility brought forward by the moderator was therefore absolutely uncalled for and detracted from the presentation. I was the audience member asking the question in this instance.

**911847-911829-96453613** - Yes, I have. I moved from a mathematical/statistical/computational background to work with people in science who are much more applied and 'real-world' (for lack of a better descriptor). I find that people I collaborate with fall in to one of two broad groups.

(1) People who take time to talk to me and understand what I do and how that is different from other computational colleagues. This leads to productive collaborations where both sides work together to produce high quality work.

(2) People who group all computational/mathematical people into one category and do not take time to understand my/others' expertise. This leads to confused collaborations with people being overly prescriptive in their requests for computational analysis, treating it more like a data analysis/computational pipeline service rather than a collaboration. This is especially difficult to overcome as a very new and junior researcher.

**911847-911829-96456350** - My experience in this regard has been one of support from most colleagues and mentors. It took a long time, and some difficult conversations at the beginning with potential advisors to assess the feasibility of a project, but once that was established, the research took off in a very positive direction. I have been doing this for three years now, and I can honestly say it has been the most rewarding experience of my career. I have been so nurtured in my development as a scientist. I came in with lots of enthusiasm, and although of course there have been difficulties, I have received encouragement and support to get through them. Also, I am very happy with my research outputs. Any hostility I received has been minimal, and to be honest, I couldn't care much about it because the people I mostly interact with have been so good, have the best interests, and are genuinely interested in doing interdisciplinary research.

**911847-911829-96457968** - Support. I was in graduate programs explicitly targeting interdisciplinary research.

**911847-911829-96482956** - I have experienced often enthusiastic sentiments (and no outright hostility that I recall), but in practice, challenges in carving out a career in interdisciplinary research (see part b below). I'm unsure if colleagues working in a more focused disciplinary way perceive me as less competent/expert, but I often feel that way when I put myself in a disciplinary setting and don't have the same depth of knowledge as others or lack vocabulary/concepts/etc. considered "common knowledge" in that discipline.

**911847-911829-96484268** - I would say I experienced support, for example from mentors or managers in the biological sciences, although their encouragement does not necessarily come with a full understanding of what the interdisciplinary research entails.

**911847-911829-96494873** - Taking the first step is easy, standing still is hard!: It is not difficult to gain the knowledge and make the cross to another discipline, but surviving in the new environment, if the right mindset is not there!

**911847-911829-96536640** - Trying to perform research at the interface of two very different core disciplines (ML vs Biology), a PI from one discipline can tend not to encourage development of the researcher in the other. This forms an obvious barrier to interdisciplinary research. Having specifically designed programs or courses has helped me personally to train in a new field and overcome obstacles to some extent. I strongly feel, that when working to address a scientific question using an interdisciplinary approach, this would work most effectively through regular meetings with researchers/teams from both core disciplines (rather than the core teams meeting individually, and the ID researcher being the only bridge/contact between them).

**911847-911829-96533165** - I work with multidisciplinary teams and learning from others occurs frequently; however, support for a more in-depth learning is normally coupled to the ability to demonstrate utility.

**911847-911829-96544444** - In academia hostility for the reasons specified in previous questions such as uncertainty about how results will be received by the wider scientific community (so impact on publication, grants, reputation, may be seen as "too risky"), lack of general knowledge by other peers which may lead them to disregard the results because they don't quite understand the methodology. Biotech is a lot more supportive in this regard. Industry in general is more goal-oriented and more likely to pull together knowledge, staff and resources from multiple disciplines to meet a need and attain a goal.

**911847-911829-96555615** - There is not enough support from departments and funding agencies for interdisciplinary career paths. From peers, it's difficult that they understand the value or the effort in tasks that are outside their expertise when working in multidisciplinary teams (for example clinicians not understanding the needs and work needed to develop good code, they think we just sit down for ten minutes and write two lines).

**911847-911829-96584634** - I have been fortunate enough to receive training and support in relation to crossing disciplines.

**911847-911829-96583225** - Support: mentor able to pair skills with appropriate collaborators to ensure high chance of interdisciplinary work succeeding. Hostility: busy senior collaborators have often appeared unwilling to engage in understanding point of views from researchers in other disciplines - perhaps because they might have to admit a knowledge gap. This has led to my contributions being ignored, even when the point of discussion is exactly what I'm a specialist on.

**911847-911829-96711881** - I have received support when wanting to run my own experiments from collaborators. But reviewers' comments for funding and even publications were sometimes aggressive and dismissive. Often, they used words as incremental if they were not aware of the value of the work in another field. Or my wet lab results were dismissed and I was labelled as a computational person.

**911847-911829-96715332** - Not so much hostility as lack of understanding. People can be supportive in principle but dismissive in details. There's also a bias towards working on fashionable things in the other discipline - areas people think they understand - rather than areas that might be close to the actual research frontier.

**911847-911829-96992600** - I feel that scientists from a single discipline appreciate and value the cross-discipline scientists but don't know the obstacles that they are encountering and therefore are not providing the necessary help (explaining their topics with less specific jargon etc.).

**911847-911829-96995212** - Generally this was viewed as an asset. However, I feel my dependence on collaborators from a range of fields has been seen by some as evidence of my "non-independence".

**911847-911829-96998454** - Forging new directions is perceived as a lack of focus (and a weak CV). Exploring a new landscape can't happen in a straight path. IDR is more susceptible to career disruption and stalling due to the opportunity cost of learning new skills and start up delays.

**911847-911829-97000217** - Independent fellowship funding is considerably harder to attain as the reviewers tend to be uni-disciplinary senior scientists in the individual domains. This means that they will tend to view the applicant as being NOT from their field - leading to a null set across all reviewers. This is at odds with faculty recruitment and university-level strategies that are pushing for multi/inter-disciplinary research.

This shows there is a general acceptance of multidisciplinary at the very highest levels, but that this is not necessarily reflected where it matters for career progression (the jump to independence is already hard enough with the current UK funding landscape).

**911847-911829-97040118** - Support from sequential line managers during postdocs who were very encouraging and gave good advice. Hostility only indirectly through "othering" from colleagues who didn't understand what I did.

**911847-911829-97072164** - I did a PhD and postdoc in wet lab and have recently started another postdoc position in computational biology. Still working on similar biological problems though. Generally, well supported by my previous supervisor, and have sympathetic supervisor in new group who knows I will take time to adjust.

**911847-911829-97077788** - In general individuals are excited about interdisciplinary research on the surface, however this can generate an unreasonable expectation of what can be accomplished in a collaboration. For instance, there is huge expectation for what machine learning can accomplish without an understanding of what machine learning is and what its weaknesses are. Usually the unreasonable expectations are placed on more computational or mathematical sciences from other sciences.

**911847-911829-97077269** - I haven't experienced hostility, i believe that PIs and researchers believe in the strength and the benefits of inter-disciplinary research. However, that being said better training and communication and in general a better system in place is required for projects and such collaborations to occur smoothly and end well with a finished result where everyone is happy. More often than not, there isn't a defined scope of what needs to be achieved and perhaps this can be better defined so people can contribute.

**911847-911829-97080721** - you work twice as hard, you get half the credit.

we are interdisciplinary researchers because time dictated a clear need for us. we can do all aspects of any experiment. we understand all expertise involved. we had to learn to produce our own data and to analyse it too in the same time and with the same salary of a "unidisciplinary" scientist because it is obviously more convenient to a PI to have everything in one person. yet these PIs are now evaluating our career and to them we are shallow and we are told to "focus on one". as an interdisciplinary scientist by training I feel deeply betrayed by the system. I am aware of my unique skillset. I'm just realizing that it may get me stuck in the same career level forever if the evaluation system doesn't change.

**911847-911829-97140832** - My experience has generally been positive and I have received encouragement to pursue cross disciplinary projects in many cases.

**911847-911829-97144627** - The most frustrating part was when specialists with a narrow view of what is important judged me as less competent than them, because I wouldn't focus on one thing. Single-field experts sometimes initially thought there was no chance that I could come up with an important research question as an interdisciplinary researcher, assuming it would always come from specialization. That said, this changed when they saw the utility of techniques and ways of thinking about science from the other disciplines - so it's an unpleasant hurdle, but not an insurmountable one. Overall, I feel the awareness of the value of interdisciplinarity is improving.

One annoying part is that computational expertise in interdisciplinary research tends to be undervalued on the basis of often taking less time than a typical wet-lab research. However, the fact that a computational research delivers a lot of results in two weeks doesn't mean it is easy, but can simply reflect high competence. As a guesstimate, a very skilled researcher in wet lab research can be around 2 times faster than a more junior one (and more consistent etc.), but in computational research, the difference can easily be tenfold or more. This is a problem in the context of authorship order, where the amount of time spent is not the only criterion, but I saw several times how computational authors would be under-credited based on "they spent just X days, whereas it took us weeks or months in the lab" - that is not how it works.

One extra challenge is that people tend to have a very poor idea of what is difficult in the other field, which can complicate project planning and/or communication. I.e., I was asked whether I could do a particular sort of analysis, which I said sure, and it would be a week of work. Then, I was asked "oh, and could you just add this, please", to which I said that it's a PhD worth of research. This works both ways - computational researchers often aren't that aware of which experiments are simple and which are difficult. But this is more the case for the interdisciplinarity in the way of teams of distinct specialists working together, rather than in people containing interdisciplinarity within themselves (who are actually very important for mediating communication between specialists).

**911847-911829-97143286** - I was very lucky to experience great support on multiple levels:

- working on many interdisciplinary projects since my master degree thesis/dissertation
- interdisciplinary doctoral training center (this is a great concept, in my opinion, both for the networking, and for the training)
- very supportive PhD supervisors (each from one discipline, but both interested in interdisciplinary research)
- more opportunities for collaborations
- institute supportive of interdisciplinary research

At the same time, I encountered various obstacles:

- I feel obtaining funding can be more difficult. Including seemingly small handicaps - the word and reference number limits are the same for everyone, but with an interdisciplinary research this means any single-discipline reviewer will always say the application is missing some key references/information.
- Some funding agencies/calls require shifting between disciplines (which is generally good), but if you start doing this already as an undergraduate, it can be difficult to demonstrate a yet another new shift when applying for independent funding.
- I witnessed many occasions when a single-discipline senior PI dismissed ideas from PhD candidates/Postdocs coming from a different discipline and it took much longer for them to convince the senior PIs that people can work across disciplines and bring new angles and good ideas and learn the other discipline well enough.
- The communication barriers are real and, in my experience, it takes years to learn how to communicate with other scientists across disciplines. In this way, I find the UK research environment in many ways better and more used to interdisciplinarity than in some other countries.

- Moreover, I witnessed junior computational biology PIs being initially treated a bit like technicians and having hard time to prove that their research is as valuable & independent as research of others (in fact, in field like genomics, there seems to be still rather a shortage of PIs/postdocs with this expertise).

**911847-911829-97166668** - The main form of hostility has been at the level of applying for independent/faculty positions and promotions, where interdisciplinary research can be valued less than research within a 'core' discipline, and there can be the false assumption that somehow I - as an interdisciplinary researcher - may have less core knowledge within my own discipline (with implications for my perceived potential as a teacher/lecturer). There is also the perennial issue of authorship order on major research publications that combine contributions from different disciplines.

**911847-911829-97175282** - Scientists from other disciplines have been very willing to engage. However, it is very challenging to secure funding for interdisciplinary work. There is strong pressure to dress it up e.g. as a clinical problem when my expertise is in medical imaging technology.

**911847-911829-97177433** - If you are in between disciplines people on both sides consider you an outsider with little knowledge.

**911847-911829-97167832** - While not having a specific example in mind, my general perception is support in words, but resistance to establish and support those initiatives in practice.

In some cases, it may reflect the additional challenges in arranging and setting up interdisciplinary projects, with respect to leadership, credits, and professional recognition.

Those discussions and arrangements are often led by more senior scientists, who are often in a better position with respect to networking opportunity and job stability, to safely invest the time and effort required to establish large interdisciplinary collaborations and attract funding.

In contrast, it is clearly more challenging for more junior researchers to convincingly attract funding and support at any comparable scale, at best aiming for smaller grants and scopes.

**911847-911829-97231261** - I have experienced both support and hostility. People who value interdisciplinary research are supportive. In contrast, many mono-disciplinary scientists think that interdisciplinary scientists are 'experts in nothing', and so their research is less rigorous and poorer in quality. Despite bold claims, most funding bodies (especially research councils) also do not like interdisciplinary scientists - we often fall in between the remits of specific councils and are often overlooked. For example, my research could easily be funded by MRC, BBSRC and EPSRC. If I apply to MRC, they send me off to BBSRC or EPSRC and when I apply to BBSRC, they send me off to the other two bodies claiming that they suit me better.

**911847-911829-97410742** - Supported by PI, but not sufficiently recognized in authorship list.

**911847-911829-97533834** - I introduced (and work with) a set of mathematical techniques from a very theoretical field of mathematics into an applied field of mathematics, namely mathematical biology. When submitting articles where we apply these mathematical techniques on biological models, there is often a theoretical reviewer that is very hostile and negative towards the work. Often, comments such as "this is trivial",

or "no novelty whatsoever" are made about the work even though it is often the case that the reviewer in question has not made an effort to try to understand the presented work.

**911847-911829-97551090** - Securing funding is the biggest hurdle. As an interdisciplinary researcher you always have to 'pretend' to be a member of whichever tribe's funding body you are applying to. This dramatically shapes the type of research questions you can ask.

**911847-911829-97551669** - My institute encourages crossing disciplines but the issue is 1/time to learn about other disciplines and 2/takes away in terms of time spent in your own research - difficult to carry out in-depth research in your current area.

**911847-911829-97552027** - My experience has generally been positive in the sense that my collaborators have been excited and supportive about interdisciplinary work. However, switching disciplines for my postdoc meant that I had to use substantial time training in new approaches, which resulted in a delay in producing publications compared with if I'd continued working on the same thing I did for my PhD.

**911847-911829-97560009** - Career progression difficulties. You may need to wait for the creation of a new "role" or opening for you, e.g. in a department.

**911847-911829-97587258** - As a mathematician I have found much support from those in the biological and physical sciences area. I have often felt like I am considered to have a very thorough skill set and there's a mentality that I am able to pick up anything.

**911847-911829-97597059** - As noted above, there is often hostility to researchers bringing new concepts into an established field of research. This remains the greatest barrier towards enticing physical scientists into biology.

**911847-911829-97628105** - I did my PhD as part of a CDT specifically aiming to be cross disciplinary, so plenty of support available. That has continued into postdoc level, and I've always felt supported by the department and university to do interdisciplinary work.

**911847-911829-97674317** - The biggest difficulty I have found is at the point of first taking up a teaching & research position. Traditional departments seem to want someone to teach a traditional single-focus undergraduate degree e.g. Chemistry, Biochemistry, Biomedical Sciences, Physics. However, my research often fits best into a different department to the areas I can teach most easily - there are many Chemistry / Physics departments where I could fit for research, however I would struggle to teach the breadth of undergraduate material expected of an academic. In those departments where I could easily teach, there is less interest in interdisciplinary research and a much worse research fit (hence departments favor someone with a better fit...).

I also see a disconnect between two types of interdisciplinary academics. One class does interdisciplinary research by remaining within one discipline themselves, collaborating with someone who does likewise, and employing a researcher to carry out the joint interdisciplinary project (i.e. the researcher is the interdisciplinary scientist). The second class are people who themselves belong to two disciplines (e.g. who have been that interdisciplinary researcher). Group 1 academics fit well into the UK academic system and are very clear that there is no disconnect between a core disciplinary identity interdisciplinary research. Group 2 academics have always been around, but are now coming through the system in greater numbers (due to increase in interdisciplinary research and DTPs in the past). Some of us see ourselves as genuinely belonging to multiple disciplines, and experience the teaching / research disconnect above. We also might consider Group 1 academics to be blinkered and narrow-minded. But Group 1 academics appear very comfortable and vocal in their departments, and encourage a 'single discipline really' viewpoint. At the end of the day this is about identity (and practical implications of this), which makes it all quite complicated...

Support: Being welcomed into an environment from a different discipline in an immersive fashion as an equal by peers / PIs. The best thing anyone more senior has ever said to me was (completely genuinely and without thinking) '...you can't think like that and say you're not a chemist...'. The RSC is also very good at being inclusive.

Hostility: The constant 'You're not a ... you're a ...' (the two identities change depending on the disciplinary identity of who is talking and tells me quite a lot about the person). Or 'are you a ... or a ...' (i.e. I have to choose - I don't choose, I'm both).

Hostility: having to constantly prove myself as a scientist to people with less experience and exposure (irrespective of seniority!) because I don't know everything they do. E.g. 'you are only a chemist if you know everything in the XX u/g degree because we're the top course in the country' (genuinely!!). Some are easy to

squash: giving a journal club presentation easily quiets the u/g summer student (but I still have to do it!), I have had to write a top quality review article before a particular PI (my boss) would believe I knew what I was talking about, most recently I have had to involve HR because any expertise I have that does not overlap with a particular colleague does not exist (to the extent that I am 'corrected' in public), and because the overlap is small the implication is that I don't have much expertise. Alternatively, the constant disregard of any expertise gained since my u/g degree - you can't be a XX as you don't have an u/g degree in it (although I do have decades of experience...).

**911847-911829-97689642** - General support, but required multiple managers/mentors and supervisors.

**911847-911829-97730329** - No, but REF assessment may not appreciate or sufficiently assess interdisciplinary research.

**911847-911829-97743751** - A very non-supportive environment.

People don't like to contribute or spend time but just get names on the proposals.

**911847-911829-97749033** - My core discipline relies on impactful research within a few specific areas. There is not a lot of room outside of those areas to propose cross discipline research.

**911847-911829-9777600** - Not really hostility. I think there sometimes are challenges when you enter an area where others are experts, while being an expert in something else. I think educated grown-ups should be able to get over that.

**911847-911829-97944997** - The people I have collaborated with for interdisciplinary research are pleased to have my perspective and toolset, and for me to share theirs. But this is a self-selected group!

**B. What training resources had you access to? Were they helpful?  
(Unique response number – Response)**

**911847-911829-96436097** - No - no training resources.

**911847-911829-96445965** - Edinburgh university XDF resources, extremely helpful.

**911847-911829-96446107** - Pretty much any MOOC or available online training material for SQL, R, Python and Genomics workshops. Incredibly helpful specially the R community.

**911847-911829-96446222** - I organized a training session from an outside consultant for a group of researchers interested in similar interdisciplinary skills.

**911847-911829-96447937** - The most important training resource for me has been to attend as many meetings as possible from the topic I am less familiar with.

**911847-911829-96450452** - None

**911847-911829-96451378** - much of my own learning was 'on the job' and learning from collaborators in other disciplines as well as my own team members who were from other disciplines and from whom i have learned a great deal.

**911847-911829-96451981** - No resource was available.

**911847-911829-96453440** - I undertook an interdisciplinary Masters degree and various internship in groups of mixed background, which strengthened my communication skills with researchers outside my field.

**911847-911829-96453613** - In terms of cross disciplinary research I had none at the beginning. Throughout the first ~ 1 year of my research career I have met more colleagues in similar situations who have given me invaluable advice, but no formal training.

**911847-911829-96456350** - Books, courses online, talks, and conferences. They did help (and keep helping) but there's still so much that I don't know about biology.

**911847-911829-96457968** - Cross-disciplinary MSc and PhD programs.

**911847-911829-96482956** - no specific training.

**911847-911829-96484268** - I did a somewhat interdisciplinary undergraduate degree and had a year of interdisciplinary training in my PhD. The former sparked my interest in biology in the first place, the latter was useful to choose between different research directions, which can be challenging for the novice researcher especially in interdisciplinary projects.

**911847-911829-96494873** - I had proper training in Maths and System Biology.

**911847-911829-96536640** - Online courses of core discipline in which I had no expertise (useful as a window into new fields). Targeted seminars introducing topics in new field (v useful, as able to ask many 'simple' questions). Review papers.

**911847-911829-96533165** - Literature, training courses.

**911847-911829-96544444** - None.

**911847-911829-96555615** - None.

**911847-911829-96584634** - I have had access to books, online courses and lecture-style talks as I transitioned into the field of biomedicine. However, I think that informal chats with individuals from the field has been what has engaged and benefited me the most.

**911847-911829-96583225** - Best training resource is access to researchers from other disciplines in an informal setting; for example at coffee/pizza after interdisciplinary seminars. Collaborations when paired with junior researcher (PhD/postdoc) extremely helpful for interdisciplinary training. Structured interdisciplinary training seminars helpful only if speaker attempts to address interdisciplinary audience, and not give standard research talk.

**911847-911829-96711881** - I had an MRC Centenary Award to go to the lab and learn how to do my own experiments. I was lucky to have great mentors.

**911847-911829-96715332** - The most important training resources was starting my postdoc training in a highly interdisciplinary place, a "Systems Biology" department full of smart and engaged interdisciplinary scientists. That sort of critical mass made a big difference.

**911847-911829-96992600** - Online courses that I found by myself. They were somewhat helpful.

**911847-911829-96998454** - Collaboration and mentorship were the only formal training resources I have used.

**911847-911829-97000217** - For domain-specific knowledge in maths, statistics, and quantitative fields, the MIT open courseware site has proven invaluable. For more biological topics this is harder to come by as they tend to be geared specifically at PhD students in the initial years of training, and focus on experimental/hands-on aspects. Therefore, reading journal articles and talking to domain-specific colleagues has become the only way to try to break into these fields.

**911847-911829-97040118** - None.

**911847-911829-97072164** - Internal training course in R and python.

**911847-911829-97077788** - I studied an uncommon interdisciplinary bachelor's degree. This meant I never specialized in a field, but had an awareness of where to search for information for specific inquiries and how to investigate topics without supervision. The most valuable aspect was learning the language to communicate with specialists across fields. More degrees like this would enable cross-disciplinary research to be facilitated.

**911847-911829-97077269** - I have had access to computational training resources which were very helpful. However, I would have liked more support on the biology, as i believe on that end i always felt like i dint know enough.

**911847-911829-97140832** - None - I have pursued training by myself.

**911847-911829-97144627** - Not much, to be fair... And I don't think that typical 2-hour "training resource" talks/seminars would be helpful. I think it is really helpful to have mentoring that helps one to be guided through how interdisciplinary research works and what are some of its obstacles. Maybe a workshop can be an entry point, but I think that one just needs to learn by doing in the end.

**911847-911829-97143286** - In the interdisciplinary doctoral training center, we had two trimesters of interdisciplinary modules and then two interdisciplinary rotation projects. While the modules could have been better designed/taught, the overall concept was very helpful.

**911847-911829-97166668** - Taught courses as part of a PhD undertaken at a Doctoral Training Centre.

**911847-911829-97175282** - Nothing formal.

**911847-911829-97167832** - Training resources are often challenging to identify, being listed on inconspicuous web pages, or providing general advice that is not easily put in practice. This may be where coaching/mentorship might help.

**911847-911829-97410742** - Training in interdisciplinary area - was helpful but program no longer funded.

**911847-911829-97416560** - Training in labs of collaborators/mentors made a lot of my work possible.

**911847-911829-97533834** - No particular resources. Although, I did my PhD in an interdisciplinary research group which was very helpful.

**911847-911829-97551090** - I was trained in an interdisciplinary EPSRC CDT program (between neuroscience, computational modelling, and machine learning). This was incredibly valuable.

**911847-911829-97551669** - None.

- 911847-911829-97552027** - I had very little formal training when switching disciplines and ended up having to self-teach myself most things. I went on a few courses, but mostly used textbooks, online lectures, etc.
- 911847-911829-97587258** - Additional support from supervisors in different fields.
- 911847-911829-97597059** - At the time that I entered biology there were none.
- 911847-911829-97674317** - None - immersive training in the different environments.
- 911847-911829-97689642** - Mainly self-taught or picked up on the job.
- 911847-911829-97749033** Nothing relevant.
- 911847-911829-97777600** - A lot of resources on understanding technology are publicly available. Talking to people who are experts in a field and trying to understand key principles is necessary for transition.
- 911847-911829-97944997** - None.

- C. Please briefly describe the topic or issue here that you wish to bring to the workshop. This helps us to understand what the key personal barriers to IDR might be.  
(Unique response number – Response)

- 911847-911829-96436097** - How might our research culture change to overtly support researchers crossing disciplines?
- 911847-911829-96446107** - As a mid-level scientist the potential for independent funding using IDR skillset is incredibly difficult. I have struggled a lot convincing review panel that Industry level/Commercial scale Data Science is very useful discipline to be added to genomic or informatic research topics.
- 911847-911829-96446222** - When doing interdisciplinary research, it is often difficult to get the depth of knowledge necessary and then can be hard to make the right sort of connections with other more expert researchers. Careers at the borders between two disciplines often do not fit well within the career structures within the University making career progression more difficult. Finding time for learning in-depth a new discipline is often difficult with the demands of the job.
- 911847-911829-96447937** - In my opinion, Lab meetings are the best way to learn about new topics but they tend to become very specialised within the already existing knowledge of each group. This makes it difficult for people, coming from new fields, to quickly get up to speed with the state-of-the-art research being undertaken research groups. I feel that a greater effort within research groups needs to be made to discuss on a regular basis the bigger picture of research questions, rather than the technicalities around methods. As IDR our aim is to fill the gap or approach technical difficulties with a different perspective, therefore making technical discussions a barrier in the development of novel and interesting research.
- 911847-911829-96450452** - I'm a mathematical statistician mainly working on generic methodology and theory. It's challenging to obtain research funding for interdisciplinary projects; mathematical statisticians don't care about the application, but more "applied" reviewers often have concerns about my lack of domain-specific knowledge/experience. It seems impossible to satisfy both types of reviewer.
- 911847-911829-96451378** - A key barrier is a perception that IDR can limit career opportunities, whilst my experience has been quite the opposite.
- 911847-911829-96451981** - How to have the scientific output of an interdisciplinary researcher well recognized by academic peers?
- 911847-911829-96454202** - Grants and fellowships are often reviewed by researchers who do not have an interdisciplinary background.
- 911847-911829-96453613** - There are many topics and issues to discuss, I am very new to being a researcher so I do not know them all nor fully understand them. However, one issue that has a big effect on me is that I have moved from a mathematical setting into a biological setting. There are many times where I have brought up a mathematical issue with an established biological scientist and I have been talked down and my point has been disregarded with no reason given. I do not know whether this is because there is another point I have not considered with regards to the biology or whether my points are just being ignored (I am sure I have been in both of these situations). But the power disparity between me and the people I am conversing with means that I feel I can't interject at points, even though in specific areas I may have more expertise.
- 911847-911829-96456350** - Doing successful interdisciplinary research requires time and malleability from both the "newcomer" interdisciplinary researcher and those already established in their field, collaborating with the

new person. Dedicating time to find a common language of understanding each other, scientific questions worth asking, willingness to learn from everyone involved, respect for each other's knowledge and discipline, and a lot of patience, are all needed to get results in these fields.

**911847-911829-96482956** - I am now an early-stage PI, but found it difficult to find a place in an academic system that is still largely divided by discipline-based university departments and funding schemes. I came from a mathematics background but reached a point when I was considered "not mathematical enough" to be hired in a math department or offered a math-specific fellowship. Meanwhile, I felt behind my peers in biology who carried out empirical work and drew on many more years of experience in the discipline. In the UK, I struggled to identify which discipline-specific UKRI research council I should align myself with to apply for an independent investigator fellowship, and felt that I would be shoe-horning my research into a poorly fitting box whichever council I went to. Given that X-Net is sponsored by MRC, I think that how UKRI could better support/fund interdisciplinary research(ers) could be a key discussion point for the workshop. I'd also be interested in discussing how cross-/inter-disciplinary researchers reconcile research and teaching in discipline-specific university departments.

**911847-911829-96484268** - How do you work in a department that is not your core discipline? What are the challenges for participating in seminars, teaching, recruitment?

**911847-911829-96494873** - Difficulties facing those who want to do IDR!

**911847-911829-96536640** - Training/nurturing of early/mid-career ID researchers in institutions that represent traditional core discipline silos, would greatly benefit from the guiding PIs from each field to be truly open to ideas/concepts from the other when addressing a scientific question (rather than viewing the other as the provider of a service/resource). I feel that a prerequisite towards this form of scientific openness, requires the PIs themselves to have at least partial desire to learn concepts in a different discipline, and this could be effectively fostered through regular joint meetings/brainstorming with researchers from both disciplines.

**911847-911829-96533165** - Working in a multidisciplinary environment is necessary in our industry; for me, a basic understanding of other disciplines is necessary but perhaps the biggest hurdle is time.

**911847-911829-96555615** - We really are reaching a point in research in which to move forward we need interdisciplinary teams, but we are not yet ready to support this. People who take the leap are usually placed in a different department to their background one, in which they have less career opportunities. Often reviewers of their applications do not even try to understand a different background, what it means in terms of publications etc. And there is no training, which is needed for everybody in an interdisciplinary team, not only for the person who changes, but also the host institution, to support this work and to understand and respect the work of others is as valuable.

**911847-911829-96584634** - I have been given advice in the past that it is best to become an expert in one or two things rather than have a bit of experience and knowledge in many things. I think this can be difficult in cross-disciplinary work: e.g. in cross-disciplinary work you may have a few papers published but they are all of a different type (perhaps one experimental paper, one bioinformatics paper and one mathematical modelling paper). I think this is less of a problem for senior, established researchers but I have the concern that early-career researchers working on cross-disciplinary projects may be hindered when applying for future funding and positions by the lack of consistency in their previous work.

**911847-911829-96583225** - Postdoc to permanent job transition. Everyone wants an interdisciplinary postdoc, but faculty positions require research plans. Interdisciplinary research plans most frequently require collaborators, but difficult to make long term inter-disciplinary collaborators when in a non-permanent position, as potential collaborators are wary about starting projects that may go nowhere. This incentivises focusing on (mainly) single-discipline research proposals.

**911847-911829-96711881** - How to improve the review process to acknowledge contribution from multidisciplinary research? Different reviewers? Ring-fenced funding.

**911847-911829-96715332** - I feel like IDR can be stranded between stools in funding, where funding for "interdisciplinary research" is geared towards novel collaborations or collaborations across departmental boundaries. For example, HFSP. This can then penalise people who have set up an interdisciplinary group or want to continue and strengthen an established line of IDR.

**911847-911829-96992600** - Having the feeling that you're lacking in skills and not having enough time to train appropriately.

**911847-911829-97000217** - The discrepancy between top-level lip-service to interdisciplinary research and the reality of how funding is assessed/reviewed.

**911847-911829-97040118** - Preconceptions about what a person moving into a new field can/cannot do or is/isn't interested in or will/will not understand (etc). This really holds up possible collaborations by people prematurely closing doors due to prior beliefs without properly communicating with the interdisciplinary researcher.

**911847-911829-97072164** - No sure what workshop you mean.

**911847-911829-97077269** - I believe the issue is often the lack of clear communication about the expectations and goals of an IDR project.

**911847-911829-97143286** - I am not aware of any workshop. I followed the link for this questionnaire from Twitter.

**911847-911829-97166668** - I don't understand the question - what workshop?

**911847-911829-97175282** - How to get a fair chance for funding of interdisciplinary research.

**911847-911829-97167832** - Practical examples of IDR collaborations established by early career researchers.

**911847-911829-97231261** - The lack of recognition by funding bodies that cross-disciplinary science needs to be funded through a new channel. The current funding schemes often support 'forced scientific marriages' rather than truly interdisciplinary science.

**911847-911829-97410742** - IDR researchers are seen as not having a sufficiently 'own' research, the ownership of the research question is seen as belonging to the individual who generates the samples.

**911847-911829-97416560** - Funding/skill exchange and training which is under supported and underfunded. Includes the provision of skilled technicians who can support interdisciplinary research, shown to work at e.g. the Crick.

**911847-911829-97533834** - Communication is key and this is mutual across the fields that are collaborating. For example, as a mathematician/theoretician I have worked with experimentalists and I've experienced unclear communication both by the theoreticians to the experimentalists and vice versa. As Stephen Pinker writes in his book "The sense of style" about clear scientific writing, one of the biggest fallacies or mistakes in general that we can make when communicating is called "the curse of knowledge". This is defined as the assumption that everybody you are talking to shares your expertise and knows exactly everything that you know. This becomes even more important to avoid in interdisciplinary research in my opinions, where a lot of expertise from the various fields are not shared across the disciplines.

**911847-911829-97551090** - Having the funding to pursue the research questions I believe are most important and interesting.

**911847-911829-97551669** - I can see the benefit of IDR but the issue is that IDR takes you away from doing in-depth research in your own area

**911847-911829-97552027** - I think how to place value on making novel insights/approaches that lead to new discoveries that otherwise wouldn't be made until much later. I like to work on problems where if I wasn't doing them it would take a long time for someone else to come along and solve the same problem, as opposed to a problem where someone else would solve it 6 months later. I don't think this is currently considered/given much weight in terms of how academic outputs are assessed.

**911847-911829-97587258** - The most important issue to me is the terminology. Most of the time individuals from any discipline assume an IDR will have picked up or note down any terms and look them up later. This slows down research and understanding when going onto a new project.

**911847-911829-97597059** - Navigating and exploiting the complexities of modern genomics data

**911847-911829-97674317** - I have followed an interdisciplinary research path because that is where the research questions and methods I am interested in have led me. To me it is about following the science, but also about identity (how I think, what I am) - clearly not all, and clearly only at work, but a surprising number of issues about identity in general (gender, sexual orientation, age) translate.

Other than this, the most important topic is the requirement within University departments for core teaching and research to align within a single discipline (driven by u/g teaching).

**911847-911829-97689642** - Recognised value of IDR as well as disciplinary experts.

**911847-911829-97730329** - Getting time to learn new disciplines. Recognition of the challenges of crossing disciplines but also the rewards and opportunities.

**911847-911829-97749033** - Clearly defining responsibilities from the beginning.

**911847-911829-97788962** - I'm not sure why interdisciplinary research has been 'identified' as a new entity. Nearly all work in life sciences has been interdisciplinary for quite a while now...

**911847-911829-97777600** - A lot of it can be a brand-new space and thus niche and difficult to bootstrap.

**911847-911829-97944997** - Understanding the concepts and language of both sides - the Kuhnian paradigm if you like. Until you can talk the same language, you cannot collaborate.

## 6.2. Results per group

To help with the analysis of survey response data, cross tabulation reports illustrate the relationship between two or more survey questions, giving a more detailed comparison of how different groups of respondents answered specific questions.

We looked at the relationship between all the variables in our survey responses considering the career stage of the individuals to closely investigate relationships within the data set that might otherwise go unnoticed. Barriers to and incentives for interdisciplinary research may be differently perceived at different points in the career of a researcher. We used cross tabulations to compare answers by career stage: early, mid-level or senior. We cross tabulated the career stage of the individuals against all the questions within the survey except free text questions because cross tabulation cannot be used on open ended answers.

Overall, we did not find major differences between the groups. For the cross tabulation we considered early career researchers (n= 9), mid-level (n=27) and senior career researchers (n=40). We found some variations between the two groups about the perception of the following topics:

- Communication being more challenging in IDR (question 9.1): Table 3 shows a representative example of cross-tabulation connecting the answers to this question. Senior researchers agreed or strongly agreed with this statement whereas mid-level and early career researchers showed mixed opinions.
- Single discipline research expertise is more highly valued in career evaluations than interdisciplinary expertise (question 10.3): senior researchers agree (34%) whereas the percentage of agreement for mid-level career researchers is lower (18%).
- There is sufficient support/advice/training available for interdisciplinary research (question 10.5): 36% of senior scientists disagree or strongly disagree vs 22% of mid-career scientists or 6% of the early career scientists.

	What is your current career stage?		
Communication is more challenging in interdisciplinary research collaborations	Early (i.e. postgraduate, PhD student)	Mid-level (i.e. PhD holder or equivalent, not fully independent)	Senior (i.e. established or leading scientist)
<i>Strongly disagree</i>	0.00%	100.00%	0.00%
<i>Disagree</i>	25.00%	25.00%	50.00%
<i>Neither agree nor disagree</i>	0.00%	100.00%	0.00%
<i>Agree</i>	12.90%	29.03%	58.06%
<i>Strongly agree</i>	6.25%	37.50%	56.25%
<i>Not applicable</i>	0.00%	0.00%	0.00%

Table 3. Cross tabulation displaying the results (% of row) from the specifically defined subgroups: early, mid- and late career stage to the topic “communication is more challenging in interdisciplinary research collaborations”.

## 7. References

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