abpi
Bringing medicines to *life*

Skills Gap Appendices

Contents

Appendix 1: Top priority deep dives

1 Chemometrics

Chemometrics is the science of extracting information from chemical systems by data-driven means using methods such as multivariate statistics, applied mathematics and computer science, in order to address problems in chemistry, biochemistry, medicine, biology and chemical engineering.

Despite a small sample size, 100% of responses indicated that chemometrics was a high priority discipline. Looking deeper, all responses had an issue with the quantity of candidates, and also with recruitment of PhD candidates and experienced staff. Whilst being highlighted as a particular concern for the future, practical skills for this discipline were less of an issue, with half of respondents identifying practical skills as not a problem.

2 Formulation science

The science and technology of formulation is about making products from raw materials. This includes designing the everyday products we all use: detergents, cosmetics, paints, pharmaceuticals, food and the oil in our cars. The formulation industry encompasses all the major names of household products we all depend on, but also specialist industrial products too.

This discipline was considered a top priority as two thirds of respondents (66%) rated it a high priority and the remaining one third (33%) rated it as medium priority. However, this discipline only had a low level of responses. In particular, 100% of respondents had found the quality of candidates to be an issue, recruitment of graduates/MSc students to be an issue, and practical skills to be a major concern. Two thirds of respondents (66%) also had an issue with the quantity of candidates and recruitment of both PhD candidates and experienced staff.

> **"A continued marketplace gap to recruit experienced formulation scientists with solid theoretical skills coupled with practical experience. Need rounded candidates with an understanding of in vivo performance (biopharmaceutics) of dosage forms plus excellent interpersonal/ communication skills."**
>
> Survey respondent talking about formulation science.

> **"We suspect our sector might not be benefiting as it could do from graduate talent emerging from some of the very good pharmaceutical science courses in the UK. We have had experience with offering roles to graduates of such courses and not being successful as the students have seen the degree only as a stepping stone to other study paths such as PhDs in other scientific disciplines. Perhaps this reflects the need for more industry engagement in such courses so students see the benefit and diversity of the careers available in the sector."**
>
> Survey respondent talking about formulation science.

3 Physiological modelling

Modelling and simulation at the pre-clinical stage of drug development involves integration of data on physicochemical properties, pharmacokinetics, pharmacodynamics, formulation and safety. Physiologically based pharmacokinetic (PBPK) modelling and simulation is a tool that can help predict the pharmacokinetics of drugs in humans and evaluate the effects of intrinsic and extrinsic factors, alone or in combinations, on drug exposure. The use of this tool is increasing at all stages of the drug development process.

All respondents for this discipline had issues with both the quality and quantity of candidates and also with the recruitment of PhD candidates. This led to it being considered a top priority, as half of responses rated it as a high priority discipline and half as a medium priority discipline. Despite this high rating, only half thought the subject had problems with practical skills and only half thought that it would be a problem in the future. This discipline did, however, have a relatively low number of responses.

4 Formulation science

Computational chemistry involves the use of computational approaches in drug design and in lead identification. The properties of molecules and target proteins are modelled to predict and gain insight into how these will interact. Computational chemists often work with structural chemists who in turn try to elucidate the structures and shapes of molecules, protein targets and protein-molecule complexes. These approaches are widely used in the design of new medicines. Chemoinformatics involves the application of computational techniques to existing datasets to address a range of chemical problems. Chemoinformatics toolkits allow virtual screening, chemical database mining and structure-activity studies.

This discipline has been a top priority discipline in previous surveys and is expected to continue to be a top priority, with 80% of respondents saying it will be a future concern. In particular, respondents had issues with both quantity (80%) and quality (80%) of candidates, with recruitment of experienced staff also being the top issue with 80% of respondents reporting this to be the case. Practical skills were also an issue, with 80% of respondents saying practical skills were either a concern or major concern. Overall, respondents were therefore worried about skills gaps in all aspects of the discipline, resulting in 60% reporting it as medium priority and 40% as high priority.

5 Pharmacokinetic/pharmacodynamics modelling

Pharmacokinetics (PK) focuses on how the body processes a drug, resulting in a drug concentration. Pharmacodynamics (PD) is concerned with how the drug acts on the body, resulting in a measurable drug effect. Through PK/PD modelling and simulation, which combines the two disciplines, pharmaceutical scientists acquire an earlier understanding of the link between drug and response, and can better characterise a drug's absorption, distribution, and elimination properties.

For this discipline, 83% of respondents had an issue with the quantity of candidates, reflecting the recurring theme, whilst 50% had an issue with the quality of candidates. Recruitment of experienced staff and PhD candidates were both considered top concerns for recruitment, with each receiving two thirds (66%) of votes. Two thirds (66%) also thought practical skills were either a concern or major concern, however concerns about the future of this discipline were more split, with only 50% thinking the subject was a future concern. Overall, this resulted in the discipline receiving two thirds (66%) of votes as medium priority and one third (33%) as high.

6 Epidemiology and pharmacoepidemiology

Epidemiology is the study of health and disease conditions in a defined population to identify patterns. Pharmacoepidemiology uses these techniques to study the uses and effects of medicines in large, well defined, populations.

Whilst two thirds (66%) of respondents for this discipline rated it as medium priority and one third (33%) rated it as high priority, overall performance for this subject was relatively mixed. Two thirds (66%) of respondents had a problem with the quantity of candidates, and all respondents (100%) had issues with recruitment of experienced staff. However, no respondents (0%) had an issue with the quality of candidates and two thirds (66%) did not have a problem with practical skills. Only one third (33%) had concerns about the future of the discipline.

7 Engineering in Manufacturing

Production engineers have the primary role of increasing efficiencies throughout the manufacturing process. This is achieved through implementing continuous improvement techniques and working closely with various other teams, such as Quality and even R&D. Their responsibilities include: asset care; developing and executing maintenance programmes; reducing waste; improving line speeds and minimising bottlenecks and; working closely with equipment manufacturers to obtain and integrate the latest technology.

Looking deeper to the cause of this concern, recruitment of experienced staff was again the top recruitment issue, with 80% of respondents reporting difficulties at this level. Concerns over practical skills however, were less of a major issue than other disciplines, although 60% of respondents still considered them to be of concern. Much like other top priority disciplines, concerns for quantity of candidates was much higher than the quality of candidates, with 80% raising concern for the former and only 20% for the latter.

"There is a lack of classically trained engineers/ technicians at that middle layer. We, like many companies, are now hiring & training apprentices and there are individuals at the experienced end of market but there is a real shortage in the middle areas. This is down to a lack of people who took on more vocational/apprenticeship/ C&G type training who would now be in their 30s/40s. Those who went on to do degrees will often be focused on higher level Engineering roles."

Survey respondent talking about engineering in manufacturing.

"There is a gap in the marketplace for experienced engineers looking to work in the pharma sector."

Survey respondent talking about engineering in manufacturing.

"Apprenticeships: The challenge is to provide consistent standard of science industry relevant apprenticeship across the UK."

Survey respondent talking about engineering in manufacturing.

Appendix 2: Geographical breakdown

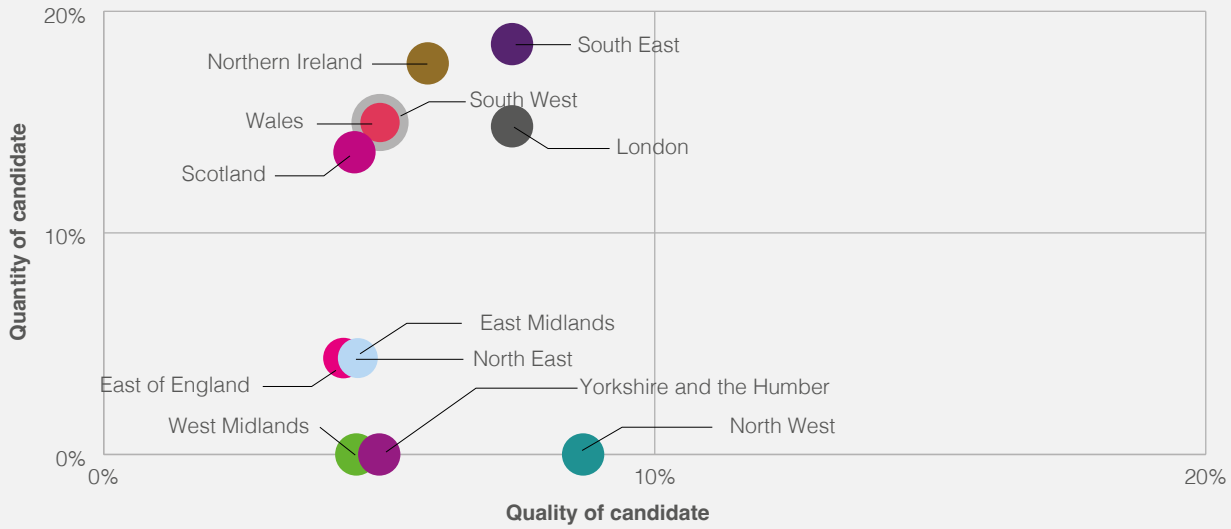
At a glance:

- Overall, the skills gap in the industry does not seem to vary much across geographical regions.
- The regions of most concern were London and the South East, which may be related to regional inequalities in the provision of high quality life sciences apprenticeships.
- Issues with quality of candidate versus quantity of candidate should be addressed by segmenting individual disciplines rather than regions.
- Recruitment of experienced staff was the level of recruitment with most concern, particularly in the South East – although again, this overall concern was low.

Overall, issues with the quality/quantity of candidates were perceived to be not as bad for particular regions as they were for specific subject areas (figure 1). For example, problems with quality never went over 9% (North West) and problems with quantity never went over 19% (South East). This suggests that the issues relating to quality/quantity of candidates should be addressed by focussing on individual disciplines rather than regions on the whole.

Despite low levels, the quantity of candidates was seen as more of an issue for the regions than quality, with Scotland, Wales, South West, London, Northern Ireland and South East all having over 14% of respondents saying they had an issue with the number of candidates they were recruiting. Northern Ireland, London and the South East had issues with both quality and quantity, suggesting that these are the regions which need the most attention from the pharmaceutical industry. Contrastingly, West Midlands, Yorkshire and the Humber, East Midlands and East of England seemed to have relatively low concerns with quantity and quality, suggesting these are the regions which the industry should worry less about.

Figure 1. Number of COVID-19 commercial clinical trials initiated in 2020, by country



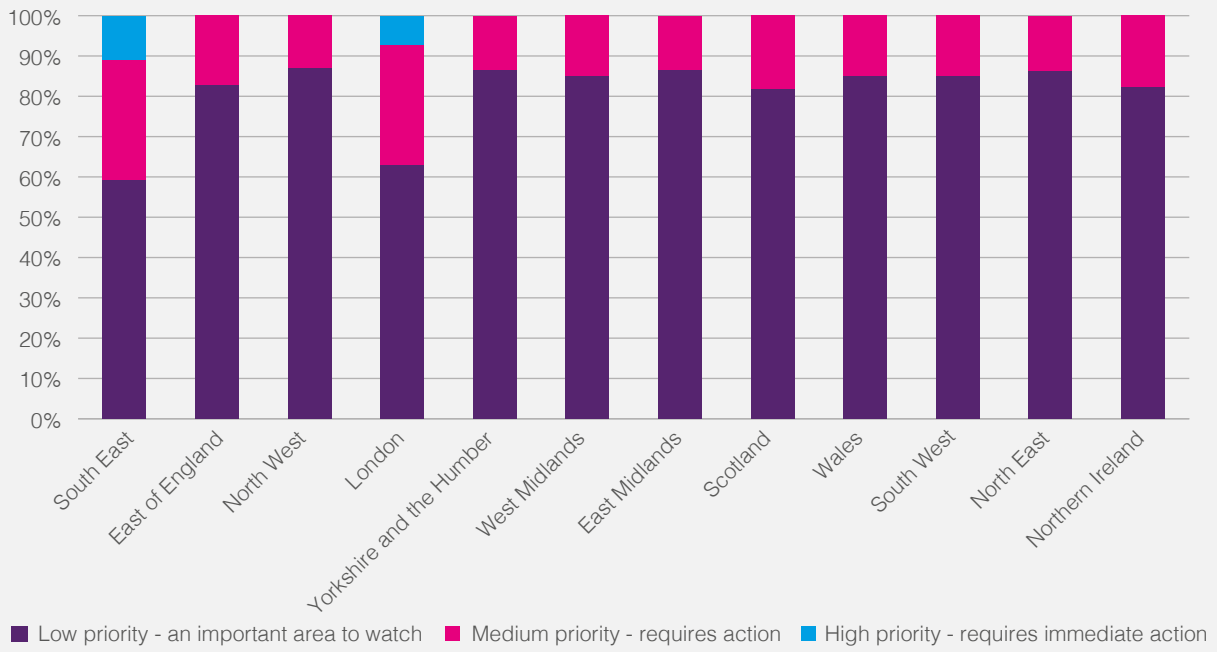
This sentiment is echoed when looking at which regions respondents rated as high, medium or low priority (figure 2). London and the South East were the only regions which had respondents raise concerns that they should be considered high priority, and the other regions such as Northern Ireland and Scotland had their medium priority responses creep towards 20%. Overall, however, the majority of respondents for all regions thought that they were low priority.

As outlined in the ABPI's recent paper Apprenticeships in the Life Sciences Sector, significant regional inequalities exist in the provision of high-quality life sciences apprenticeships, which may explain the increased concern in London and the South East.[1] Evidence from industry round-tables suggests that – in contrast to other common patterns of socio-economic opportunity – the more southern regions of the UK experience less choice in apprenticeship training provision.

This is not because of a lack of courses, but rather (with the exception of the Golden Triangle of Oxford, Cambridge and London) there is often simply not a commercially viable size of cohort to make it attractive for providers to run a variety of courses. This is particularly true for courses that involve high costs and expertise, such as life sciences apprenticeships that require specialist lab equipment. This might be due to a greater concentration of industrial clusters in the North of England which put a large science population very close together, which essentially guarantees providers that there will be enough candidates to take their courses. Widening access to opportunities to upskill, alongside supporting skills development across all UK regions, would help reduce regional skills gap concerns.

1. https://www.abpi.org.uk/publications/apprenticeships-in-the-life-sciences-sector-2021/

Figure 2: Percentage of respondents who rated each geographical region as high, medium or low priority.



> **"There are [some] areas in the UK where we struggle to source suitable candidates - London area and some of the more remote areas can prove a challenge"**
>
> Survey respondent talking about registered nurses.

Appendix 3: Core skills data

Table 1: Comparison of core skills concerns from 2018 with core skills concerns in 2021.

	Scientific knowledge		High level maths knowledge		Application of scientific, mathematical and digital knowledge		Problem solving		Communication		Team-working		Digital literacy
Year	**18**	**21**	**18**	**21**	**18**	**21**	**18**	**21**	**18**	**21**	**18**	**21**	**21**
Not a problem	17%	57%	33%	54%	17%	38%	19%	45%	22%	43%	30%	59%	36%
Less of a concern now	25%	21%	20%	21%	11%	24%	12%	28%	18%	36%	19%	24%	21%
A concern	54%	21%	33%	25%	56%	35%	46%	24%	41%	21%	38%	17%	32%
A major concern	6%	0%	1%	0%	8%	3%	11%	4%	10%	0%	0%	0%	11%
Total 'concern'	59%	21%	33%	25%	63%	38%	57%	28%	51%	21%	39%	17%	43%
% change	-38%		-8%		-25%		-29%		-30%		-22%		43%

Figure 3: Percentage change from 2018 in votes for total concern, major concern, and concern for each core skill.

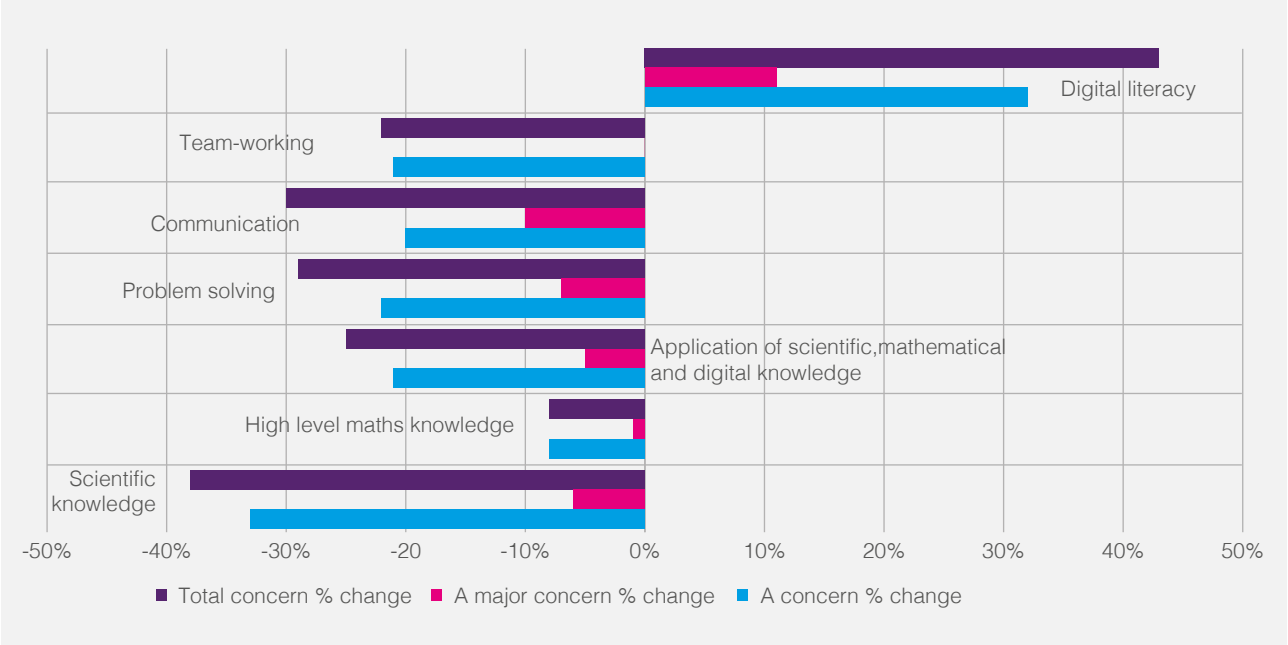


Table 2: Core skills concerns for those moving into leadership or management roles.

	Mentoring	Presentation	Supervising	Negotiating
Not a problem	46%	43%	46%	46%
Less of a concern now	14%	43%	18%	29%
A concern	32%	14%	32%	25%
A major concern	7%	0%	4%	0%
Total concern	**39%**	**14%**	**36%**	**25%**

Appendix 4: Future issues summary

Areas which are considered both a top priority now and a problem in the future are:

- Chemometrics
- Computational chemistry
- Formulation science
- Pharmacokinetic/pharmacodynamics modelling
- Physiological modelling

Top priorities now which are not considered to be a concern in the future are:

- Epidemiology and pharmacoepidemiology
- Engineering in manufacturing

The top seven future concerns which aren't currently part of the seven top priority disciplines are:

- Computational science – (to include: Computer Science, modelling & simulation)
- Clinical pharmacology/translational medicine (to include: Clinical Pharmacology Scientists (non-medical); Physician Pharmacologists; Pharmacometricians (modellers))
- Bioinformatics/computational systems biology (to include: Human Genomics)
- Data science (to include: Data Management and Machine Learning)
- Statistic

Although not receiving enough responses to be included in this report, anecdotal evidence suggests sustainable chemistry is a discipline in which skills are starting to grow in significance. As a result of the growing importance of sustainability, the SIP are now planning a report in 2022 that will focus on the skills needed to drive forward the science sectors green agenda and carbon neutral targets.

Table 3: Summary of areas anticipated as being of major concern in the future and a high priority now.

Subject Name	Problem for the future	High priority now
Chemometrics	100%	100%
Computational chemistry – (to include: Chemoinformatics)	80%	40%
Computational science – (to include: Computer Science, modelling & simulation)	75%	50%
Clinical pharmacology/translational medicine (to include: Clinical Pharmacology Scientists (non-medical); Physician Pharmacologists; Pharmacometricians (modellers))	70%	10%
Formulation science	67%	67%
Bioinformatics/computational systems biology (to include: Human Genomics)	60%	40%
Data science (to include: Data Management and Machine Learning)	57%	50%
Statistics	55%	18%
Drug metabolism and ADME	50%	0%
Immunology	50%	38%
Metabonomics	50%	0%
Toxicology	50%	50%
Veterinary medicine	50%	25%
Veterinary and toxicological pathology	50%	50%
Materials science	50%	0%
Medicinal and synthetic organic chemistry	50%	33%
Process chemistry	50%	0%
Precision Medicine	50%	0%
Registered Nurses (to include: Healthcare Practitioners and Nurses)	50%	25%
Device technology	50%	0%
Pharmacokinetic/ pharmacodynamics modelling	50%	33%
Physiological modelling	50%	50%
Programming	50%	50%

Appendix 5: Focus on practical skills

Similar to previous surveys, practical skills are a consistent concern for the industry and always seem to be in need of improvement. For example, in biological science areas, practical skills were considered a concern for most disciplines, with five subjects having over 50% of respondents thinking practical skills were a major concern (biopharmaceuticals/biologics, biotechnology, human genetics, molecular biology, and structural biology).

Compared to 2018, practical skills in the chemical sciences are much more of an issue. All chemical science disciplines (apart from chemical biology) had 100% of respondents who identified the discipline as a priority saying that practical skills were a concern, with materials science, physical chemistry and formulation science having 100% of respondents saying practical skills were a major concern. For some subjects such as analytical chemistry/biochemistry, it was noted that much of the training is conducted on the job due to the fact that no candidates had the right level of practical skills at the time of hiring.

> **"Finding talent which has not only a good breadth/level of knowledge but also broad practical experience is very difficult. We are mainly resigned to the fact that we probably have to recruit good chemists and train them up in analytical techniques and how to approach measurement problems in-house."**
>
> Survey respondent talking about analytical chemistry/biochemistry.

> **"Practical skills are a major concern for [structural chemistry], courses offering grad and PhD level skills to the depth required for our industry are few and far between."**
>
> Survey respondent talking about structural chemistry.

Similar concerns for practical skills were felt in almost all informatics, computational, mathematical and statistical disciplines, as well as almost all clinical and regulatory disciplines. For example, apart from epidemiology and pharmacoepidemiology, 50% or more of respondents thought their discipline had practical skills shortages in the informatics, computational, mathematical and statistical subject area. Specifically, 80% or more of the respondents for computational chemistry, data science, programming and health economics, outcomes, informatics and real world evidence disciplines thought practical skills in their subject were cause for concern or major concern.

> **"Practical skills for industry roles are not particularly well served by existing MSc courses."**
>
> Survey respondent talking about health economics, outcomes, informatics and real world evidence.

> **"Difficult to find candidates who have the right mix of theoretical and practical technical skills in addition to having good communication."**
>
> Survey respondent talking about statistics.

On the other hand, more peripheral scientific subject areas such as pharmacy, pharmaceutical engineering, developmental and translational science, and business areas seemed to have less concern for practical skills. There was an exception for formulation, however, which had 100% of respondents think that practical skills were either a concern or major concern.

> **"The talent pool we have had experience with in recent recruitment exercises is small and practical experience very limited."**
>
> Survey respondent talking about formulation

Appendix 6: Methodology

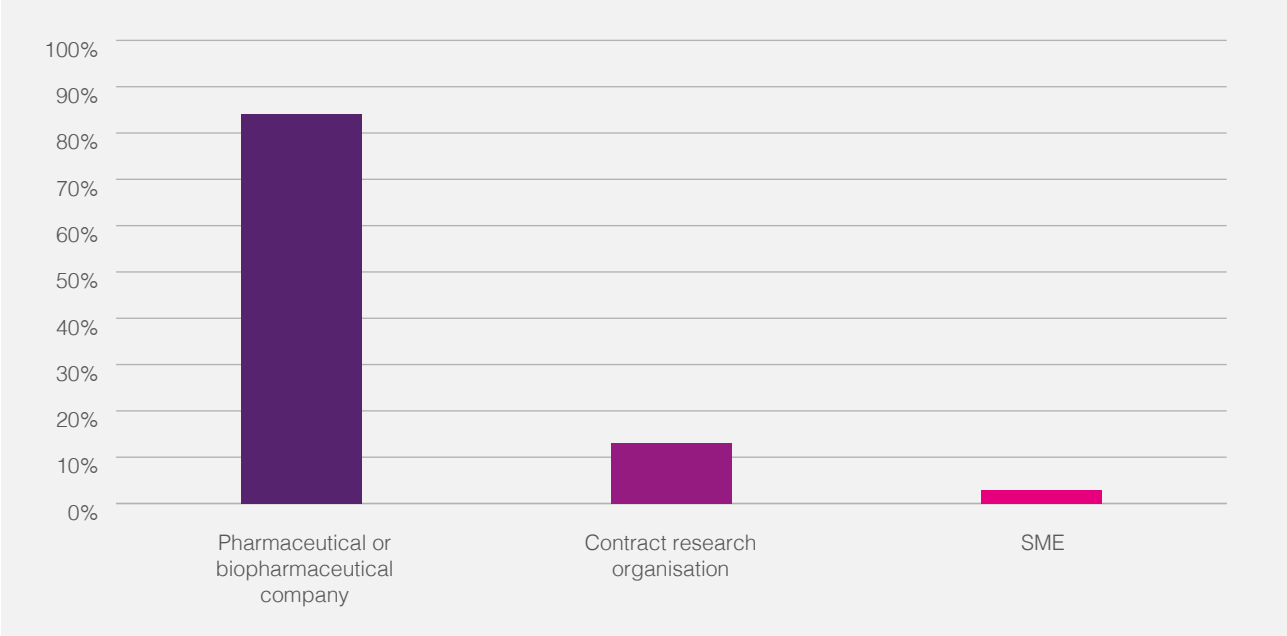
An online survey was used to seek views from the sector about the challenges of recruiting suitably qualified and suitably skilled staff, as well as questions about future threats to job growth, skills and recruitment. The survey was designed to provide data which could, as far as possible, be compared with those obtained in 2018 when the ABPI last reported data on the skills concerns of the sector.

The data obtained was analysed to determine the areas where immediate action is required to address skills gaps. Any discipline area for which 100% of respondents identified it as 'high priority', or failing that both 'high priority' and 'medium priority', was considered an overall top priority. This is different to previous surveys, in which any discipline area that over 50% of respondents identified as a 'high priority' was considered a top concern and thus was analysed further. The reason for this change is that disciplines where 50% of respondents voted for 'high priority' and 50% voted for 'not a problem' were being included as top priorities, at the expense of others which might have been 40% high priority and 60% medium priority. The ABPI believes that the new definition of 'top priority' is therefore much more representative than previous years. Similar to the last survey, we have also expected at least two weighted responses before considering areas a top priority.

Responses were sought from pharmaceutical and biopharmaceutical companies and contract research organisations (CROs). The majority of respondents were from pharmaceutical companies, with a very small minority from CROs. One respondent was an SME (figure 4). The survey data were collected between March 25th and June 7th 2021.

In total 31 different companies responded to the survey, with each organisation submitting one coordinated response. This is different from 2015, where individual companies submitted more than one response with their answers being weighted accordingly. Results are only shown for subject areas where there were two or more responses. A list of subject areas with less than two responses can be found in the appendices below.

Figure 4: Proportion of participating companies in each sector



The survey was grouped into the following overarching subject areas of: biological science; chemical science; clinical; pharmacy; informatics, computational, mathematical and statistics; regulatory; pharmaceutical engineering; developmental and translational science; and business. Within each of these overarching areas individual disciplines were listed. The definitions for these disciplines were generally the same as those used for our earlier survey if the discipline was included in 2018 – although our expert group updated some of the domains to reflect the changing industry landscape.

Participants were asked to comment on concerns with recruitment into the discipline areas that were relevant to them and/or their companies, as well as general questions about core competencies.

For each discipline area respondents were asked:

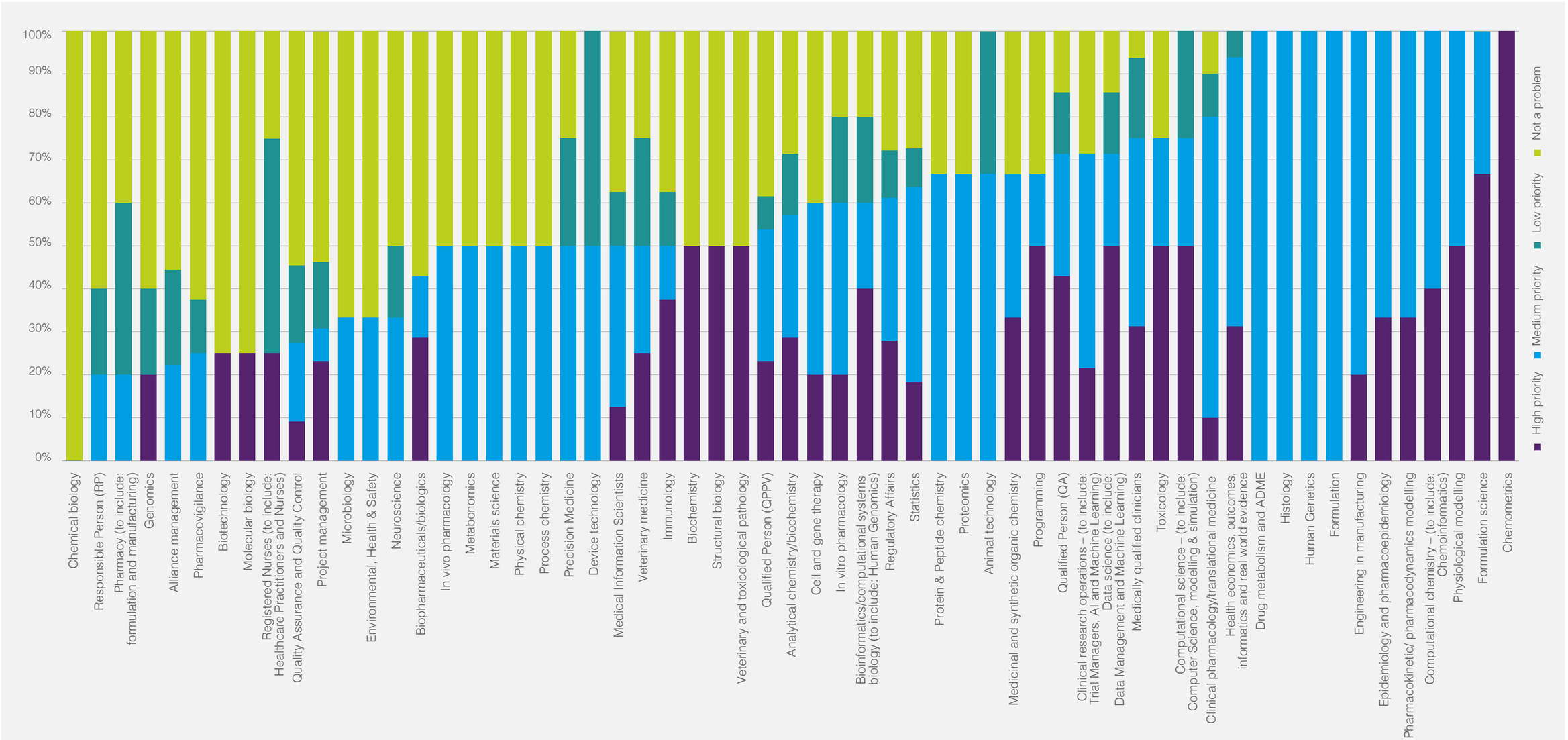
- Whether there is a problem with the number and/or quality of candidates;
- Whether recruitment for this area is expected to become more difficult in future;
- To rank the area's recruitment priority as low, medium or high;
- What qualification level of candidate recruitment is affected; and
- To rate the level of concern with practical skills (where applicable).

Additional general questions sought information on core competencies, which were rated in terms of how much of a concern they are. Information on the qualification level of individuals that companies are recruiting, and from where these individuals are being recruited, was also sought. A second section of the survey included subject agnostic questions, which focused on future threats to job growth and recruitment, including the impact of Brexit and COVID (for a general version of the questionnaire and a list of discipline areas included, see the appendices below).

Appendix 7: Section summaries

All subject priority rankings

Figure 5: Percentage of respondents who ranked each discipline as high, medium or low priority, or not a problem.



Section 1: Biological Science Areas

At a glance:

- No disciplines in this area are top priorities, however three appear in the top ten and four would've been considered top priorities in previous surveys.
- Whilst an improvement, the subject area should be closely monitored as over 70% of disciplines in this area had over half of respondents rate them as 'medium' or 'high' priority.
- Like 2018, there is a wide variety of shortages in terms of the level of staff - although experienced staff are consistently most demanded.
- Practical skills are of particular concern for all disciplines, apart from toxicology and veterinary and toxicological pathology.

Figure 6: Percentage of respondents rating each biological science discipline as high, medium or low priority or identifying it as 'not a problem'.

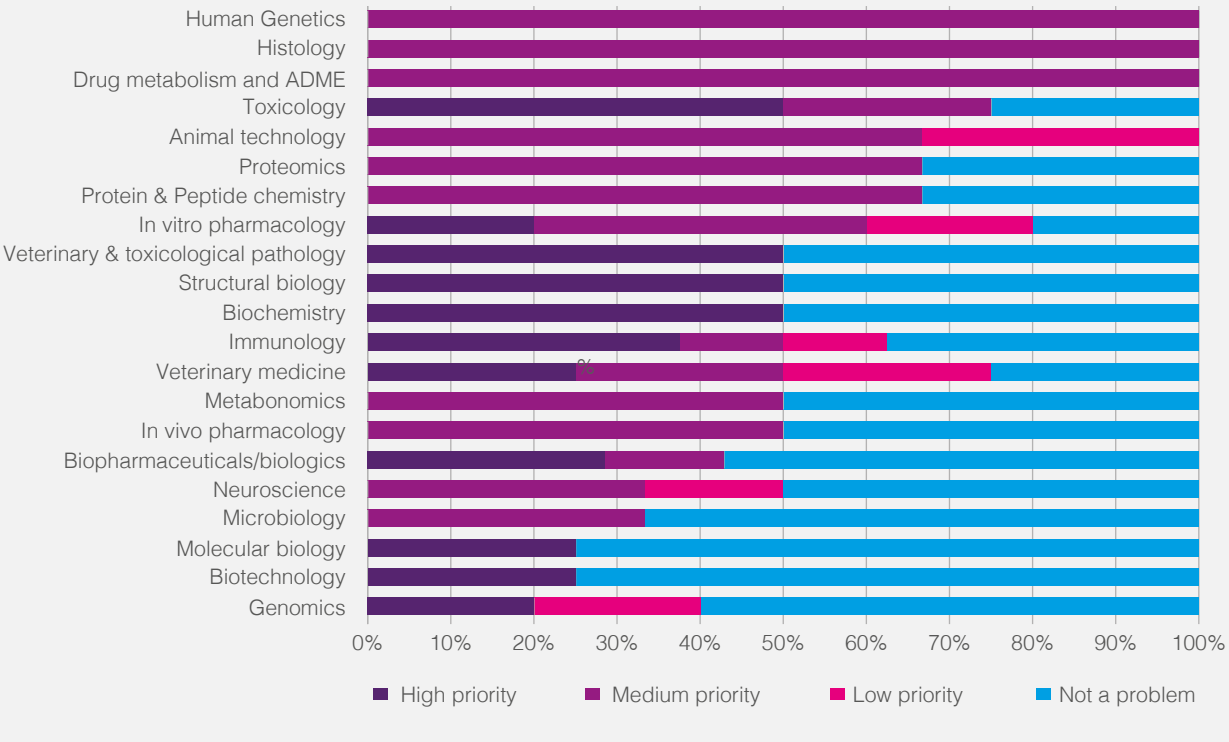


Table 4: Biological science areas where at least 50% of respondents consider it high or medium priority, and the associated experience of staff most needed.

Biological science areas where at least 50% of respondents consider it high or medium priority	Experience of staff most needed (most cited)
Animal technology	Experienced staff
Biochemistry	Graduate/MSc
Drug metabolism and ADME	Experienced staff
Histology	Non-graduate; experienced staff
Human Genetics	Experienced staff
Immunology	Experienced staff
In vitro pharmacology	Graduate/MSc; experienced staff
In vivo pharmacology	All levels apart from graduate/MSc
Metabonomics	Graduate/MSc; PhD; experienced staff
Protein & Peptide chemistry	Graduate/MSc; PhD; experienced staff
Proteomics	Experienced staff
Structural biology	Post-doc; experienced staff
Toxicology	All levels apart from non-graduate and apprenticeship
Veterinary medicine	Experienced staff
Veterinary and toxicological pathology	Graduate/MSc; post-doc; experienced staff

Figure 7: Of those who thought the subject was a priority, the percentage of respondents who identified each qualification level as an issue within the biological science disciplines.

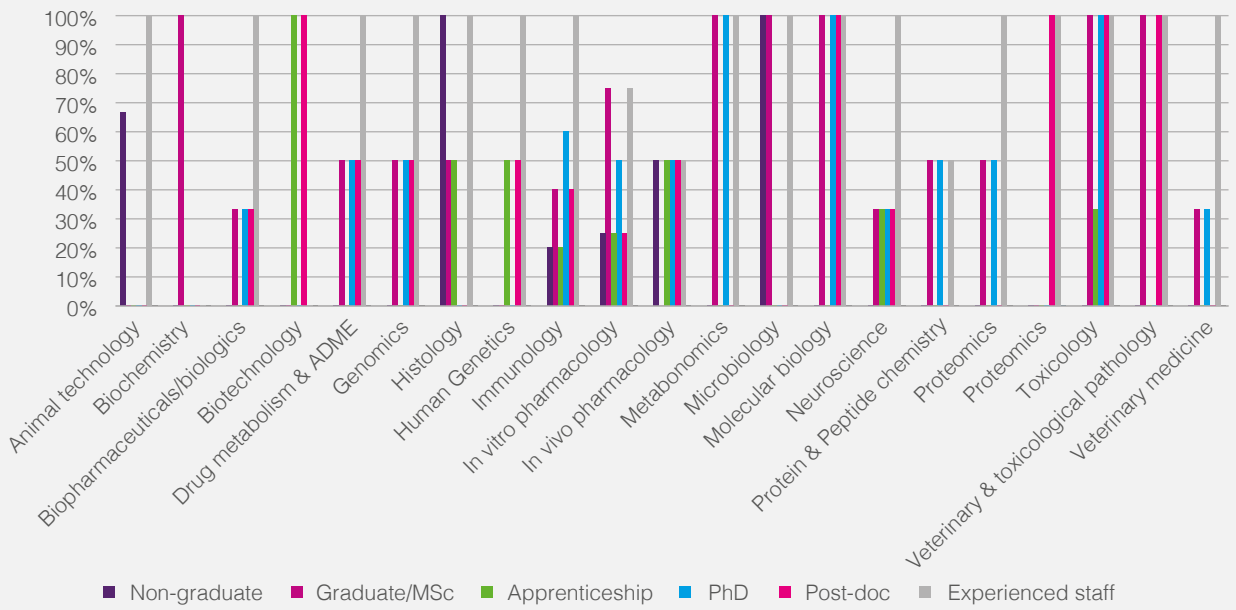


Figure 8: Percentage of respondents identifying a concern with the quantity vs quality of candidates for the biological science disciplines (number is sample size/size of bubble represents the number of respondents).

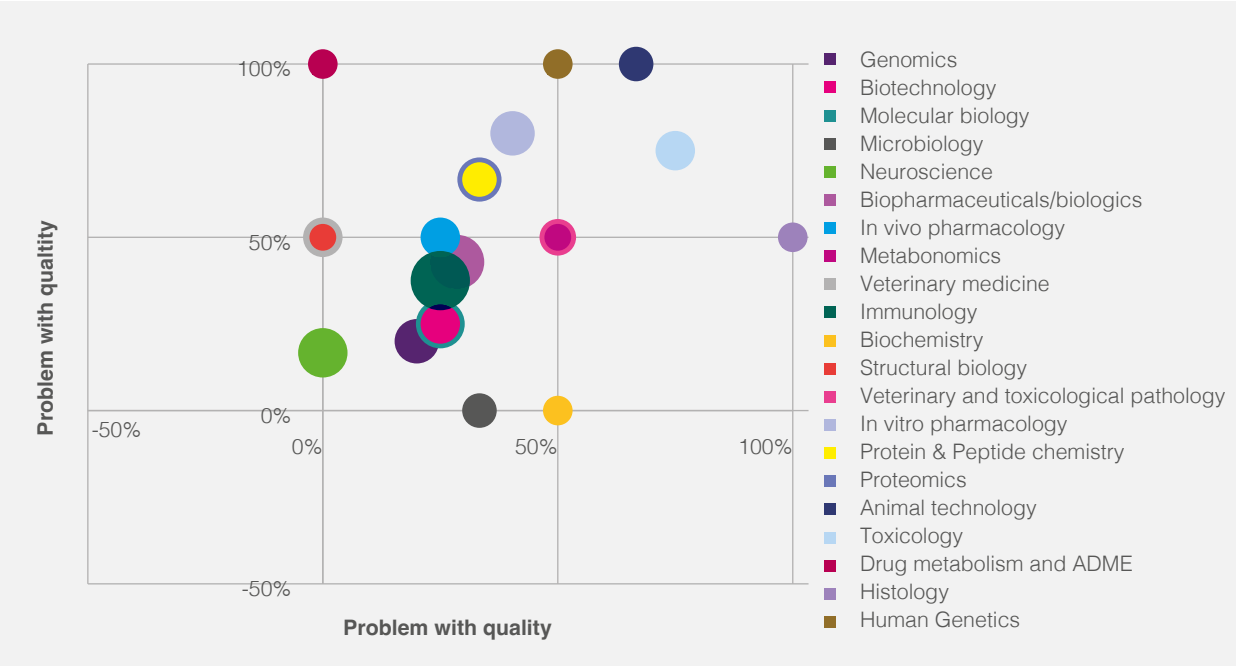


Figure 9: Of those who identified the subject as a priority, the percentage of respondents identifying practical skills as a major concern, a concern, or not a problem within the biological science areas.

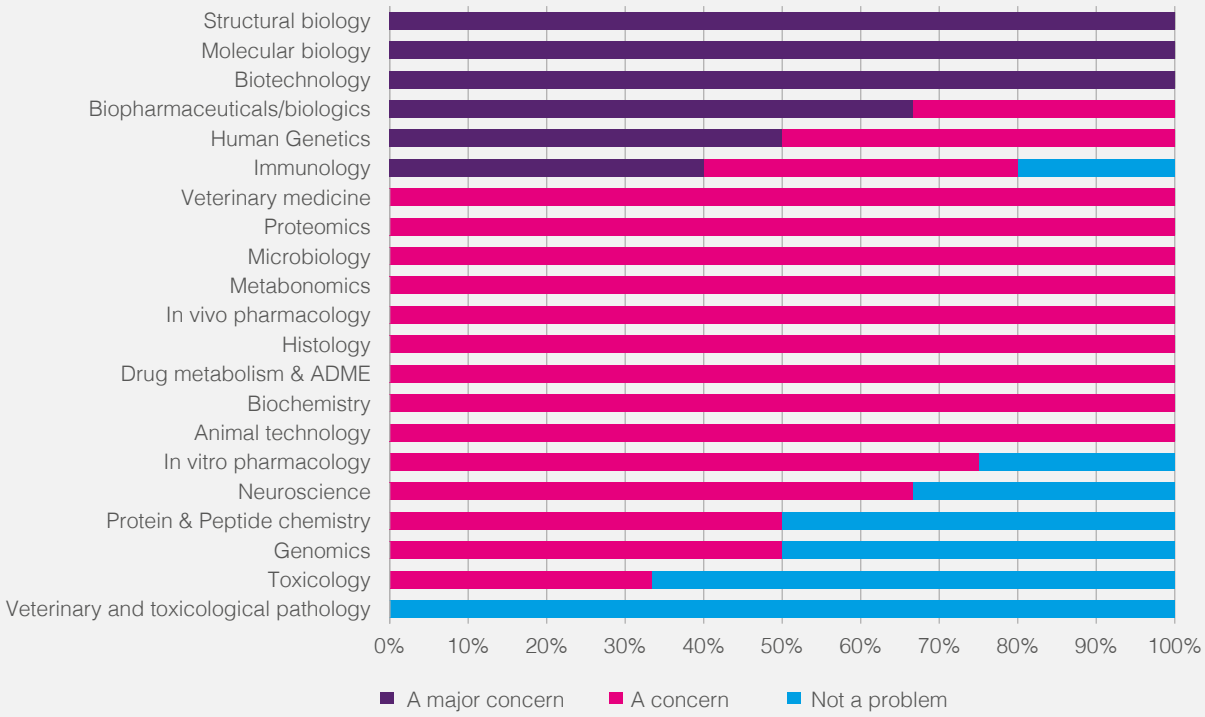


Table 5: Detailed results

Animal technology

Summary
Animal technicians are responsible for the day to day welfare of the animals used in in vivo research work. Tasks range from general animal care and husbandry to monitoring the health and development of the animals and ensuring environmental conditions are correct. Qualified animal technicians conduct technical procedures such as administering medicines and collecting clinical data as part of experimental protocols. Additionally, animal technicians are responsible for preparation of samples for pathology and administration of euthanasia.

Year		2008	2015	2018	2021
Quality		A	R	G	R
Number		A	R	R	R
Staff	Non-graduate	A	R	R	R
	Graduate/MSc	G	G	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	A	G	R
Overall priority		A	A	A	A

Biochemistry

Summary
Biochemists study chemical processes in living organisms, looking at the structure and function of biomolecules such as proteins and DNA. In the pharmaceutical industry, biochemists are employed in the area of drug discovery, identifying and validating new drug targets against which new chemicals will be tested in order to identify potential new medicines

Year		2008	2015	2018	2021
Quality		A	A	G	A
Number		G	A	G	G
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	A	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	R	G	G
	Post-doc	A	G	G	G
	Experienced staff	N/A	A	G	G
Overall priority		A	A	G	G / R

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Drug metabolism and ADME

Summary
This is the study of how the body affects a drug following its administration, through the rate and extent of absorption, distribution, metabolism and excretion (ADME). A good understanding of pharmacokinetics (PK) is crucial to the understanding of whether or not a drug will be safe for use in humans and gives information about dose size and frequency.

Year		2008	2015	2018	2021
Quality		R	A	A	G
Number		R	R	G	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	A	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	A	A	A
	Post-doc	R	A	G	A
	Experienced staff	N/A	R	A	R
Overall priority		R	A	A	A

Genomics

Summary
Genomics is a discipline where techniques to sequence, assemble and analyse genomes are used to establish their structure and function

Year		2008	2015	2018	2021
Quality		R	R	A	G
Number		A	A	R	G
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	R	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	A	A
	Post-doc	R	A	A	A
	Experienced staff	N/A	A	A	R
Overall priority		A	A	R	G

Histology

Summary
Histology is a discipline where daily, routine, and specialised histology techniques and procedures are performed for the benefit of a range of disciplines. Histologists can acquire specialist disease expertise.

Year		2008	2015	2018	2021
Quality		N/A	N/A	A	R
Number		N/A	N/A	A	A
Staff	Non-graduate	N/A	N/A	R	R
	Graduate/MSc	N/A	N/A	A	A
	Apprenticeship	N/A	N/A	N/A	A
	PhD	N/A	N/A	A	G
	Post-doc	N/A	N/A	G	G
	Experienced staff	N/A	N/A	A	R
Overall priority		N/A	N/A	A	A

Key

- R — High priority - requires immediate action
- A — Medium priority - requires action
- G — Low priority - an important area to watch
- N/A — Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Human genetics

Summary
Human genetics is the study of the inheritance of characteristics by children from parents. Much of this interest stems from a basic desire to know who humans are and why they are as they are. At a more practical level, an understanding of human heredity is of critical importance in the prediction, diagnosis, and treatment of diseases that have a genetic component.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	A
Number		N/A	N/A	N/A	R
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	G
	Apprenticeship	N/A	N/A	N/A	A
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	A
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	A

Immunology

Summary
Immunology is often incorporated into roles such biochemists and in vivo pharmacologists, with more senior positions being recruited as specialist immunologists.

Year		2008	2015	2018	2021
Quality		N/A	N/A	A	G
Number		N/A	N/A	R	A
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	N/A	N/A	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	A	A
	Post-doc	N/A	N/A	A	A
	Experienced staff	N/A	N/A	R	R
Overall priority		N/A	N/A	R	G / R

In vitro pharmacology

Summary
In vitro pharmacology is the study of how medicines interact with cells and tissues, with the aim of predicting what effects a medicine might have in humans. All experiments are carried out in a controlled environment outside a living organism. This work is essential to develop an understanding of how compounds that have the potential to become medicines act at both the cellular and molecular level.

Year		2008	2015	2018	2021
Quality		A	R	G	A
Number		A	A	G	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	R	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	A	G	A
	Post-doc	A	G	G	G
	Experienced staff	N/A	A	G	R
Overall priority		A	A	G	A

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

In vivo pharmacology

Summary
In vivo pharmacology is the study of how medicines interact with living organisms, with the aim of predicting what effects a medicine might have in humans. In vivo pharmacologists investigate how effective a compound is in living biological systems (pharmacodynamic effects) and establish whether a new compound could produce side effects (safety pharmacology).

Year		2008	2015	2018	2021
Quality		R	R	R	G
Number		R	A	G	A
Staff	Non-graduate	N/A	A	G	A
	Graduate/MSc	R	R	A	G
	Apprenticeship	N/A	N/A	N/A	A
	PhD	R	A	A	A
	Post-doc	R	A	A	A
	Experienced staff	N/A	A	R	A
Overall priority		R	A	A	G / A

In vivo physiology

Summary
Genomics is a discipline where techniques to sequence, assemble and analyse genomes are used to establish their structure and function

Year		2008	2015	2018	2021
Quality		R	R	G	N/A
Number		R	R	G	N/A
Staff	Non-graduate	N/A	G	G	N/A
	Graduate/MSc	R	R	G	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	R	A	G	N/A
	Post-doc	R	G	G	N/A
	Experienced staff	N/A	G	G	N/A
Overall priority		R	A / R	G	N/A

Metabonomics

Summary
Metabonomics looks at changes in the metabolites present in a cell or organism and can be used to determine thetoxicity of potential new drug targets.

Year		2008	2015	2018	2021
Quality		R	R	R	A
Number		A	R	R	A
Staff	Non-graduate	N/A	G	R	G
	Graduate/MSc	A	R	R	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	R	R
	Post-doc	R	R	R	G
	Experienced staff	N/A	A	R	R
Overall priority		A	A	R	G / A

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

In vivo pharmacology

Summary
In vivo pharmacology is the study of how medicines interact with living organisms, with the aim of predicting what effects a medicine might have in humans. In vivo pharmacologists investigate how effective a compound is in living biological systems (pharmacodynamic effects) and establish whether a new compound could produce side effects (safety pharmacology).

Year		2008	2015	2018	2021
Quality		R	R	R	G
Number		R	A	G	A
Staff	Non-graduate	N/A	A	G	A
	Graduate/MSc	R	R	A	G
	Apprenticeship	N/A	N/A	N/A	A
	PhD	R	A	A	A
	Post-doc	R	A	A	A
	Experienced staff	N/A	A	R	A
Overall priority		R	A	A	G / A

Microbiology

Summary
The study of microscopic organisms. It includes the sub-disciplines of virology, mycology, parasitology and bacteriology.

Year		2008	2015	2018	2021
Quality		N/A	A	G	A
Number		N/A	A	G	G
Staff	Non-graduate	N/A	G	G	R
	Graduate/MSc	N/A	G	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	G	G	R
Overall priority		N/A	A	G	G

Metabonomics

Summary
Molecular biology is the study of biology at a molecular level, particularly looking at the way in which various systems within a cell interact and how they are regulated. In the pharmaceutical industry, molecular biologists and bio-scientists are employed in the area of drug discovery, identifying and validating new drug targets against which new chemicals will be tested in order to identify potential new medicines to go into development.

Year		2008	2015	2018	2021
Quality		A	G	G	G
Number		G	G	G	G
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	G	G	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	G	A	G	R
	Post-doc	G	A	G	R
	Experienced staff	N/A	A	G	R
Overall priority		G	G	G	G

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Molecular/translational toxicology

Summary
Molecular biology is the study of biology at a molecular level, particularly looking at the way in which various systems within a cell interact and how they are regulated. In the pharmaceutical industry, molecular biologists and bio-scientists are employed in the area of drug discovery, identifying and validating new drug targets against which new chemicals will be tested in order to identify potential new medicines to go into Molecular and translational toxicologists study the adverse effects that drugs can have on living organisms, from the level of molecules and cells to whole organs. Their work increases the understanding of the safety of a drug before it is trialled in humans. This discipline does not include animal-based toxicology.

Year		2008	2015	2018	2021
Quality		R	A	G	N/A
Number		A	A	G	N/A
Staff	Non-graduate	N/A	G	A	N/A
	Graduate/MSc	N/A	A	A	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	R	R	G	N/A
	Post-doc	R	R	A	N/A
	Experienced staff	N/A	R	A	N/A
Overall priority		A	A	G	N/A

Neuroscience

Summary
Neuroscientists tend to work in teams, collaborating as part of that team, and possessing transferable skills which support therapeutic advances. Neuroscientists will often start their career as a bench scientist in R&D.

Year		2008	2015	2018	2021
Quality		N/A	N/A	G	G
Number		N/A	N/A	G	G
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	N/A	N/A	G	A
	Apprenticeship	N/A	N/A	N/A	A
	PhD	N/A	N/A	G	A
	Post-doc	N/A	N/A	G	A
	Experienced staff	N/A	N/A	A	R
Overall priority		N/A	N/A	G	G

Key

R	High priority - requires immediate action	A	Medium priority - requires action
G	Low priority - an important area to watch	N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Protein and peptide chemistry

Summary
Protein and peptide chemists are very important within the biological science areas, though often work in multidisciplinary groups. Protein and peptide chemists develop and execute analytical methods alongside characterisation of techniques and development and validation of methodologies.

Year		2008	2015	2018	2021
Quality		N/A	N/A	G	A
Number		N/A	N/A	G	R
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	N/A	N/A	G	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	G	A
	Post-doc	N/A	N/A	G	G
	Experienced staff	N/A	N/A	G	A
Overall priority		N/A	N/A	G	A

Proteomics

Summary
This is the large-scale study of the structure and function of proteins. Proteomics can be used to identify new biomarkers of disease as well as potential new drugs and drug targets.

Year		2008	2015	2018	2021
Quality		R	R	G	A
Number		A	R	G	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	R	R	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	R	A
	Post-doc	R	A	R	G
	Experienced staff	N/A	G	R	R
Overall priority		A	R	R	A

Structural biology

Summary
This involves the determination of the molecular structure of biological macromolecules, especially proteins and nucleic acids, as well as the structure of compounds complexed to these macromolecules. This information can be used in compound design by medicinal and computational chemists, as well as in developing an understanding of the relationship between structure and biological function.

Year		2008	2015	2018	2021
Quality		N/A	G	G	G
Number		N/A	G	G	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	G	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	R
	Experienced staff	N/A	G	G	R
Overall priority		N/A	G	G	R

Key

R High priority - requires immediate action
A Medium priority - requires action
G Low priority - an important area to watch
N/A Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Toxicology

Summary
Toxicologists study the adverse effects of chemicals on living organisms. Compounds that have the potential to become medicines are assessed for toxicity in both in vitro and in vivo experiments that are required by law for preclinical studies

Year		2008	2015	2018	2021
Quality		R	A	A	R
Number		R	A	A	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	R	A	A	R
	Apprenticeship	N/A	N/A	N/A	A
	PhD	R	A	G	R
	Post-doc	R	A	A	R
	Experienced staff	N/A	A	G	R
Overall priority		R	A	G	R

Veterinary medicine

Summary
In industry, vets advise on animal health and welfare, ensuring that all procedures requiring the use of animals are compliant with the principles of humane experimentation (the '3Rs' – refinement, reduction and replacement). Vets monitor animal health and will often advise scientists on techniques to minimise or prevent any pain, suffering or distress to the animals.

Year		2008	2015	2018	2021
Quality		A	G	G	G
Number		A	A	A	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	G	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	G	R	A
	Post-doc	A	G	A	G
	Experienced staff	A	R	R	R
Overall priority		A	G	A	G / A / R

Veterinary and toxicological pathology

Summary
Pathology is the study of the nature of disease and the structural and functional changes it causes. In industry pathologists work to establish disease models to assess potential therapies, and to characterise the structural changes in the disease state that occur in response to medicines. Veterinary pathologists examine histopathological evidence from routine toxicity studies to establish whether changes seen in tissues are due to normal variation and spontaneous natural disease processes or may have arisen due to the substance under test

Year		2008	2015	2018	2021
Quality		A	G	G	A
Number		R	R	R	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	G	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	G	G
	Post-doc	R	R	A	R
	Experienced staff	N/A	R	R	R
Overall priority		R	R	G / A	G / R

Key

R	High priority - requires immediate action	A	Medium priority - requires action
G	Low priority - an important area to watch	N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 2: Chemical Science Areas

At a glance:

- The chemical sciences had only one discipline considered high priority (formulation science) and was the only area in which a discipline received 100% of votes for 'not a problem' (chemical biology).
- Again, similar to 2018, response rates were generally lower for chemical science areas, and the disciplines with more responses were the ones which were seen as a higher priority. However both in 2018 and 2015, chemical science areas were also considered a lower priority area which may indicate that this is actually be the case despite low responses.
- Shortages were felt most prominently amongst experienced staff, with five out of the seven disciplines having 100% of respondents saying they had an issue recruiting experienced staff.
- Compared to 2018, practical skills in the chemical sciences are much more of an issue. All disciplines (apart from chemical biology) had 100% of respondents saying that practical skills were a concern.

Figure 10: Percentage of respondents rating each chemical science discipline as high, medium, or low priority or identifying it as 'not a problem'.

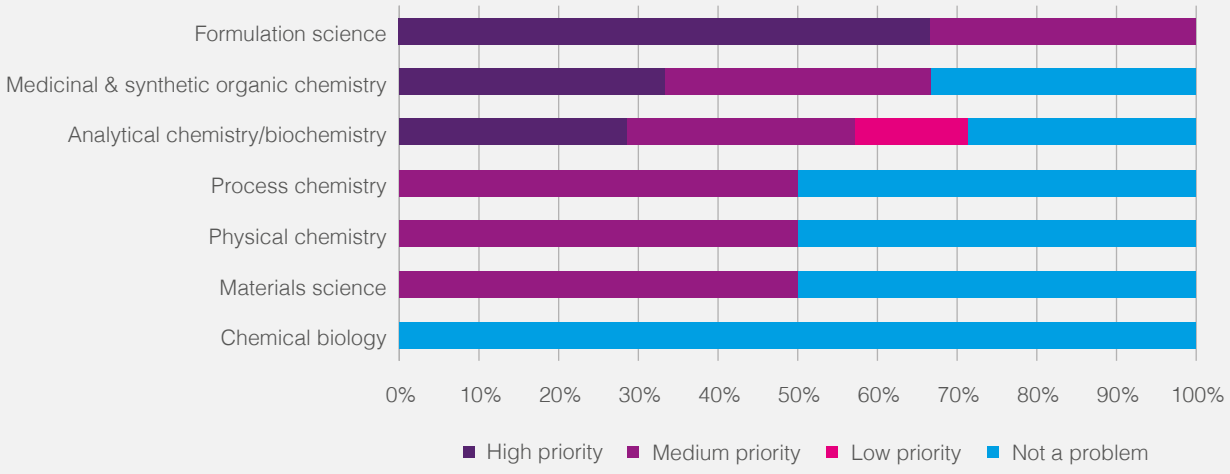


Figure 11: Of those who thought the subject was a priority, the percentage of respondents who identified each qualification level as an issue within the chemical science disciplines.

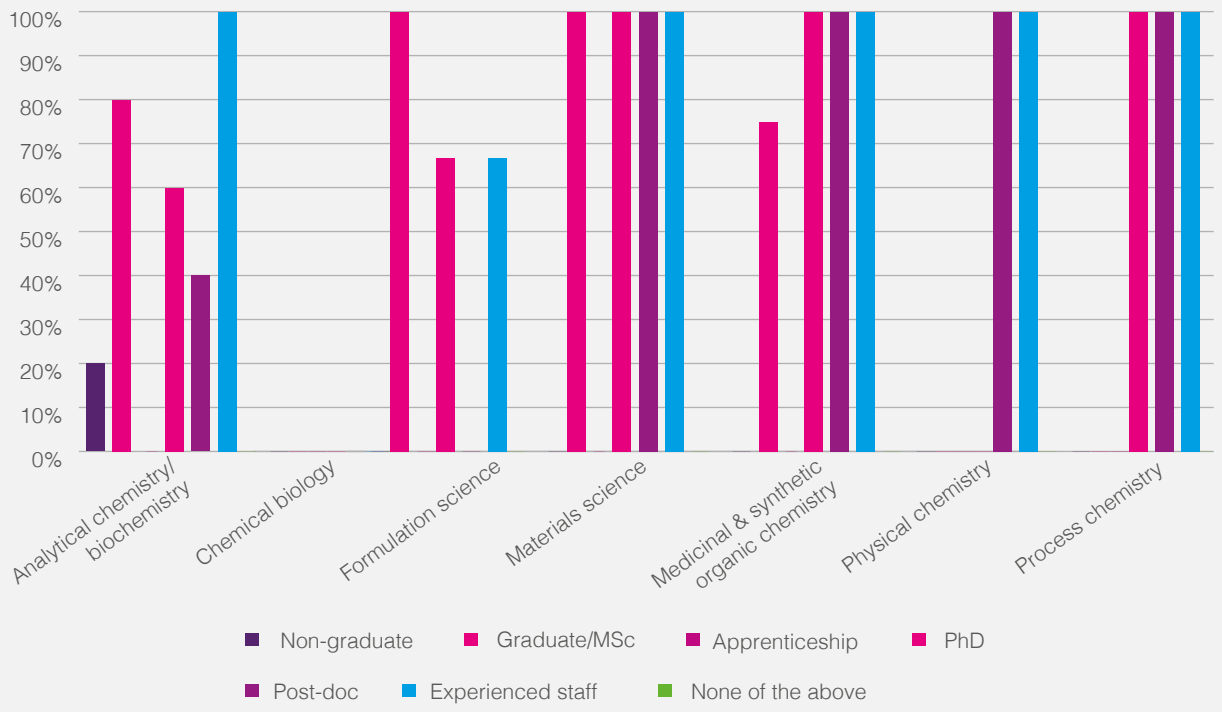


Table 6: Chemical science areas where at least 50% of respondents consider it high or medium priority, and the associated experience of staff most needed.

Chemical science areas where at least 50% of respondents consider it high or medium priority	Experience of staff most needed (most cited)
Analytical chemistry/biochemistry	Experienced staff
Formulation science (overall top priority)	Graduate/Msc
Materials science	Graduate/Msc; PhD; post-doc; experienced staff
Medicinal and synthetic organic chemistry	PhD, post-doc; experienced staff
Physical chemistry	Post-doc; experienced staff
Process chemistry	PhD; post-doc; experienced staff

Figure 12: Percentage of respondents identifying a concern with the quality vs quantity of candidates within chemical science disciplines (size of bubbles represents the number of respondents in each area).

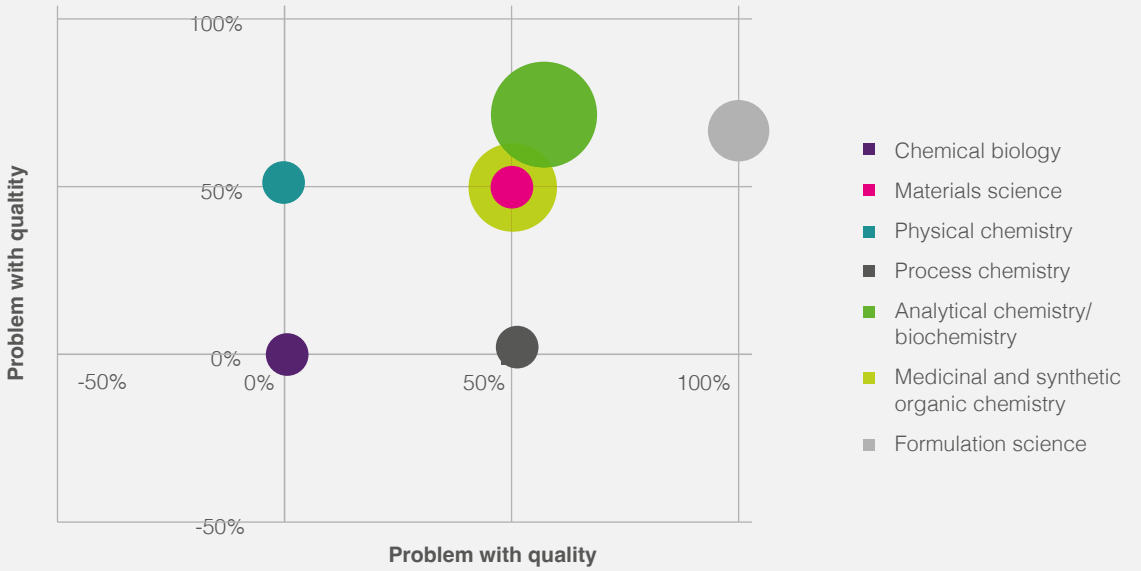


Figure 13: Of those who identified each discipline as a priority, the percentage of respondents who identified practical skills as a major concern, concern or not a problem within the chemical science areas.

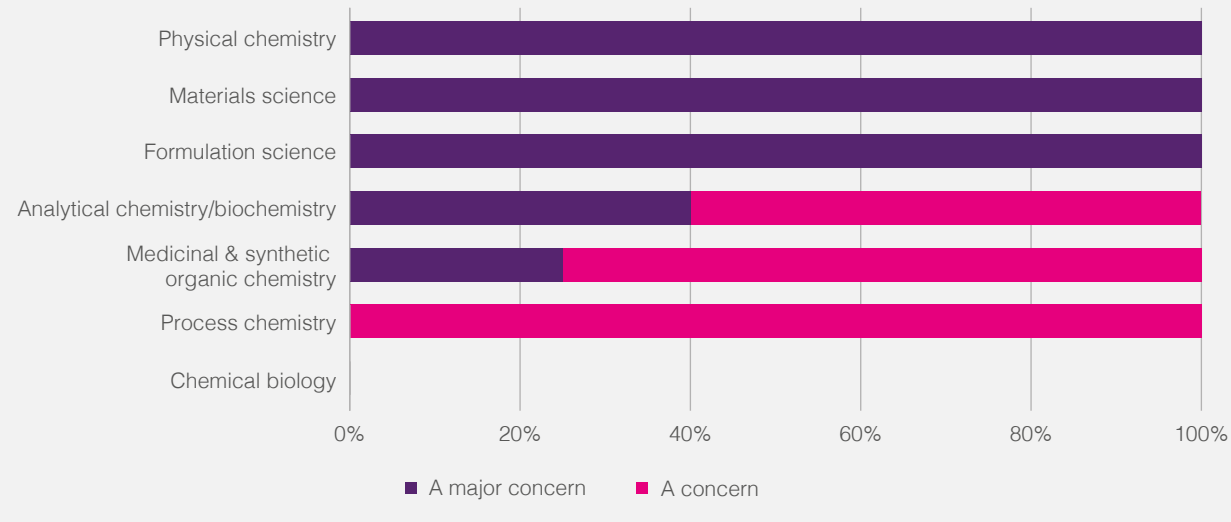


Table 7: Detailed results

Analytical chemistry/biochemistry

Summary
Analytical chemists/biochemists work at every stage of development of a medicine, from confirming the structure of a compound that has been made for the first time, to checking the purity of a batch of medicine that is about to be released for sale. Analytical chemists/biochemists may be involved in investigating biological targets, using biophysical techniques to screen and validate targets and studying how molecular properties affect biological activity. Analytical chemists/biochemists also develop techniques for biomarker identification and detection and probe design (mass spectrometry, PET, SPECT, MRI, labelling)

Year		2008	2015	2018	2021
Quality		R	A	A	A
Number		A	A	A	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	R	A	A	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	A	G	A
	Post-doc	A	G	G	A
	Experienced staff	N/A	A	R	R
Overall priority		R	A	G	G / A / R

Chemical biology

Summary
Chemical biology uses chemical techniques and tools, and compounds synthesised by chemists, to understand the biological processes that cause disease.

Year		2008	2015	2018	2021
Quality		N/A	G	G	G
Number		N/A	A	A	G
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	R	A	G
	Post-doc	N/A	R	A	G
	Experienced staff	N/A	A	G	G
Overall priority		N/A	A	G	G

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Formulation Science

Summary
Protein and peptide chemists are very important within the biological science areas, though often work in multidisciplinary groups. Protein and peptide chemists develop and execute analytical methods alongside characterisation of techniques and development and validation of methodologies.

Year		2008	2015	2018	2021
Quality		N/A	N/A	G	A
Number		N/A	N/A	G	R
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	N/A	N/A	G	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	G	A
	Post-doc	N/A	N/A	G	G
	Experienced staff	N/A	N/A	G	A
Overall priority		N/A	N/A	G	A

Proteomics

Summary
The science and technology of formulation is about making products from raw materials. This includes designing the every-day products we all use: detergents, cosmetics, paints, pharmaceuticals, food to the oil in our cars. The formulation industry encompasses all the major names of household products we all depend on, but also specialist industrial products

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	R
Number		N/A	N/A	N/A	R
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	R
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	R

Materials science

Summary
Materials science is an interdisciplinary field which deals with the discovery and design of new materials to meet a specific need. Pharmaceutical materials science applies physical principles from materials science to challenges in such areas as drug delivery, control of drug form, manufacture and processing of nanoscopic and microscopic particle systems, and the structure and properties of bulk powders and creation of dosage forms such as tablets or capsules.

Year		2008	2015	2018	2021
Quality		N/A	A	G	A
Number		N/A	G	G	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	R	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	R	G	R
	Post-doc	N/A	R	G	R
	Experienced staff	N/A	A	G	R
Overall priority		N/A	A	G	A

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Medicinal and synthetic organic chemistry

Summary

Synthetic chemists are involved in making chemical compounds, which are then tested for their potential as new medicines. Medicinal chemists are involved in the design of these compounds. Peptide chemists use synthetic organic chemistry techniques to make, purify and analyse compounds for use as medicines. In medicinal chemistry various techniques are used to design and predict the activity of compounds at a biological target such as a receptor or enzyme, as well as its likely pharmacokinetic profile and safety properties. Medicinal chemists are likely to have a background in synthetic organic chemistry but may have additional knowledge and skills around molecular understanding of biological systems and processes through application of synthetic, physical, analytical and computational methods. In many organisations chemists perform the role of both synthetic and medicinal chemist at the same time.Synthetic chemists are involved in making chemical compounds, which are then tested for their potential as new medicines. Medicinal chemists are involved in the design of these compounds. Peptide chemists use synthetic organic chemistry techniques to make, purify and analyse compounds for use as medicines. In medicinal chemistry various techniques are used to design and predict the activity of compounds at a biological target such as a receptor or enzyme, as well as its likely pharmacokinetic profile and safety properties. Medicinal chemists are likely to have a background in synthetic organic chemistry but may have additional knowledge and skills around molecular understanding of biological systems and processes through application of synthetic, physical, analytical and computational methods. In many organisations chemists perform the role of both synthetic and medicinal chemist at the same time.

Year		2008	2015	2018	2021
Quality		A	R	A	A
Number		A	A	A	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	A	A	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	R	R
	Post-doc	R	R	R	R
	Experienced staff	N/A	A	R	R
Overall priority		A	A / R	A / R	G / A / R

Physical chemistry

Summary

Physical chemists generate high quality physicochemical property data on compounds prepared as part of a drug discovery programme. This data is used by medicinal chemists in compound design. Structural chemists try to elucidate the structures and shapes of molecules. This approach can be used in the design of new medicines

Year		2008	2015	2018	2021
Quality		R	R	G	G
Number		A	R	G	A
Staff	Non-graduate	N/A	A	G	G
	Graduate/MSc	R	R	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	R	G	G
	Post-doc	A	A	G	R
	Experienced staff	N/A	R	G	R
Overall priority		R	G / A	G	A

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Process chemistry

Summary
Process chemists design suitable chemical syntheses for the large scale preparation of molecules that are being progressed to advanced clinical studies as potential drugs. For approved drugs, process chemists will have devised the synthetic route that will be used in commercial manufacture.

Year		2008	2015	2018	2021
Quality		A	A	G	A
Number		A	A	G	G
Staff	Non-graduate	N/A	A	G	G
	Graduate/MSc	A	R	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	G	R
	Post-doc	R	R	G	R
	Experienced staff	N/A	A	G	R
Overall priority		A	R	G	A

Protein and peptide chemistry

Summary
I Protein and peptide chemists are very important within the chemical science areas, though invariably work in multidisciplinary groups. Protein and peptide chemists develop and execute analytical methods alongside characterisation of techniques and development and validation of methodologies

Year		2008	2015	2018	2021
Quality		N/A	N/A	G	N/A
Number		N/A	N/A	G	N/A
Staff	Non-graduate	N/A	N/A	G	N/A
	Graduate/MSc	N/A	N/A	G	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	N/A	N/A	G	N/A
	Post-doc	N/A	N/A	G	N/A
	Experienced staff	N/A	N/A	G	N/A
Overall priority		N/A	N/A	G	N/A

Key

R	High priority - requires immediate action	A	Medium priority - requires action
G	Low priority - an important area to watch	N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 3: Clinical Areas

At a glance:

- For the first time since 2005, clinical pharmacology/translational medicine is not considered a top priority. However, 80% of respondents still thought it was at least a medium priority topic and 90% of respondents also thought that practical skills were a cause for concern.
- The fact that no clinical areas are considered a top priority marks a continuation in the progress made in this area.
- Again, recruitment of experienced staff was clearly the biggest cause for concern over all disciplines.
- Despite relatively low overall priority levels, practical skills were of some concern across all disciplines.
- Quantity of candidates was cause for concern for 50% or more of respondents for all clinical disciplines.

Figure 14: Percentage of respondents rating each clinical discipline as high, medium or low priority or identifying it as 'not a problem'.

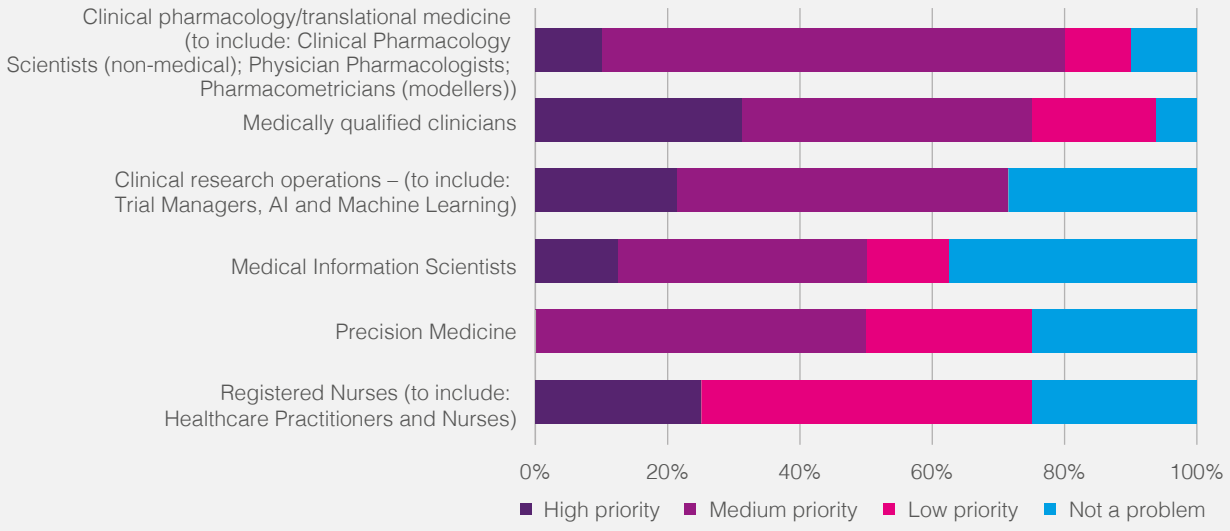


Figure 15: Of those who identified the subject as a priority, the percentage of respondents who identified each qualification level as an issue within the clinical disciplines.

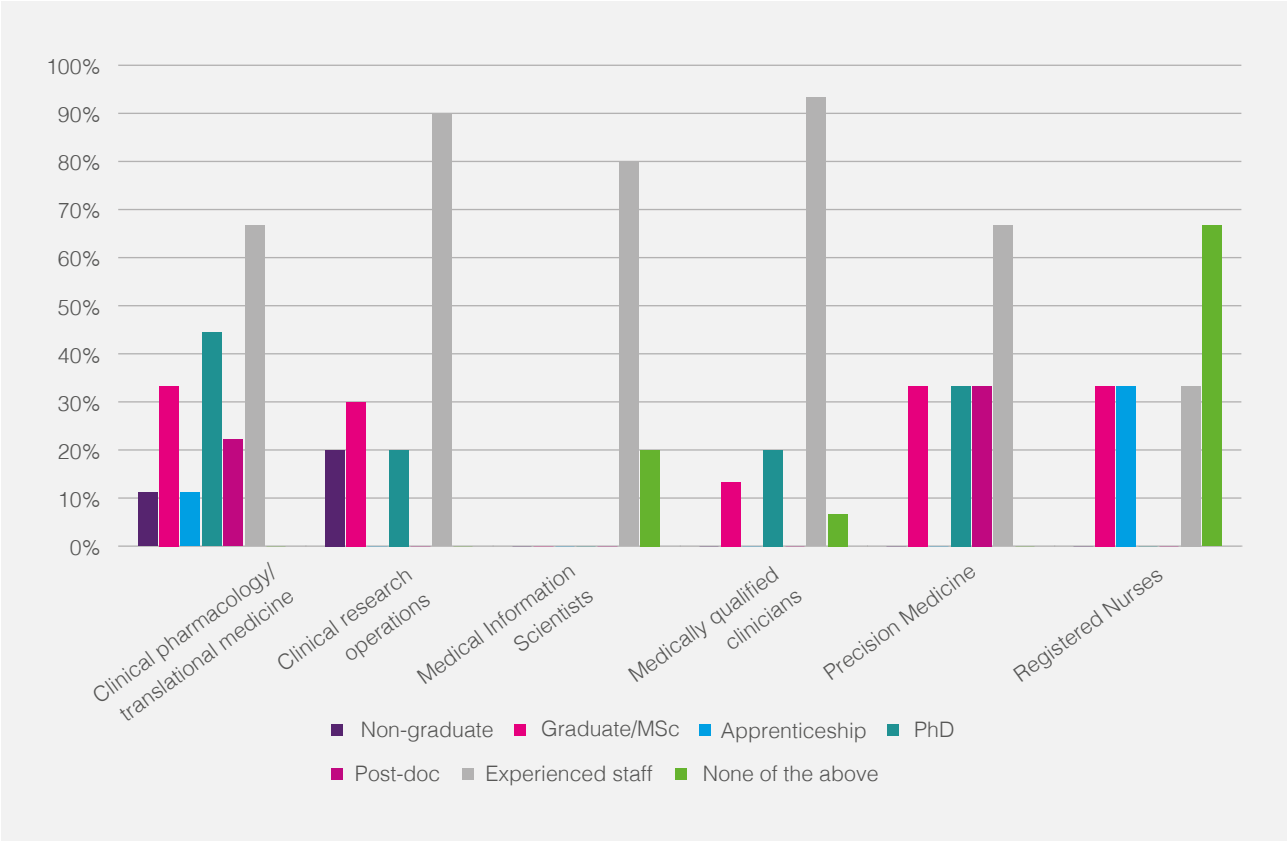


Table 8: Clinical areas where at least 50% of respondents consider it high or medium priority, and the associated experience of staff most needed.

Clinical areas where at least 50% of respondents consider it high or medium priority	Experience of staff most needed (most cited)
Precision Medicine	Experienced staff
Clinical pharmacology/translational medicine	Experienced staff
Medical information scientists	Experienced staff
Clinical research operations – (to include: Trial Managers, AI and Machine Learning)	Experienced staff
Medically qualified clinicians	Experienced staff
Process chemistry	PhD; post-doc; experienced staff

Figure 16: Percentage of respondents identifying a concern with the quality vs quantity of candidates (size of bubbles represents the number of respondents in each area).

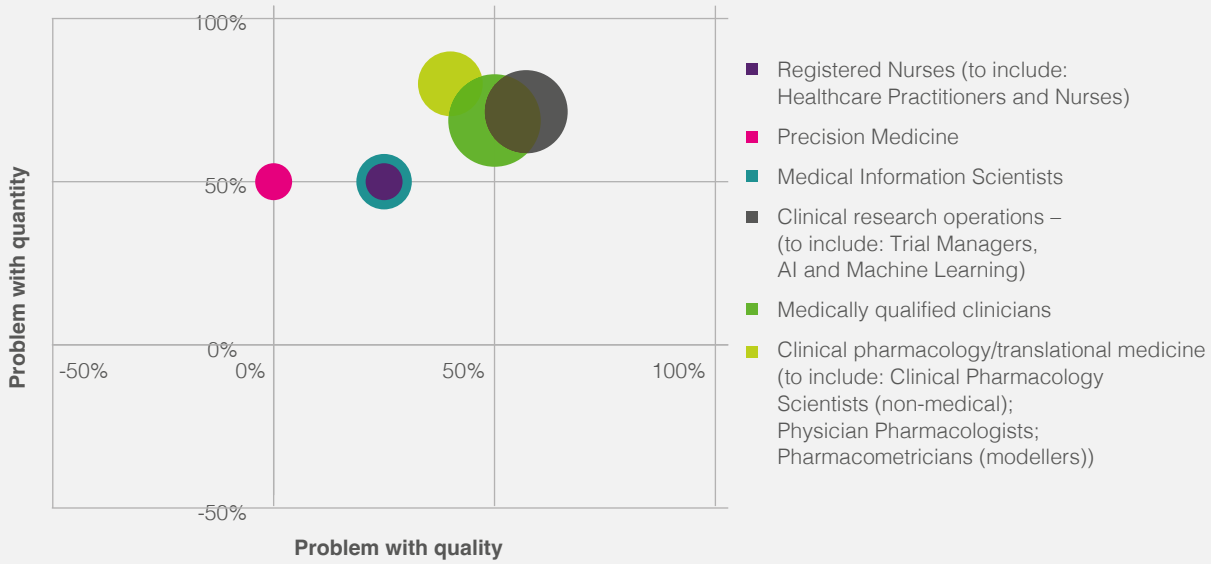


Figure 17: Of those who identified the subject as a priority, the percentage of respondents who identified practical skills as a major concern, concern or not a problem within the clinical areas.

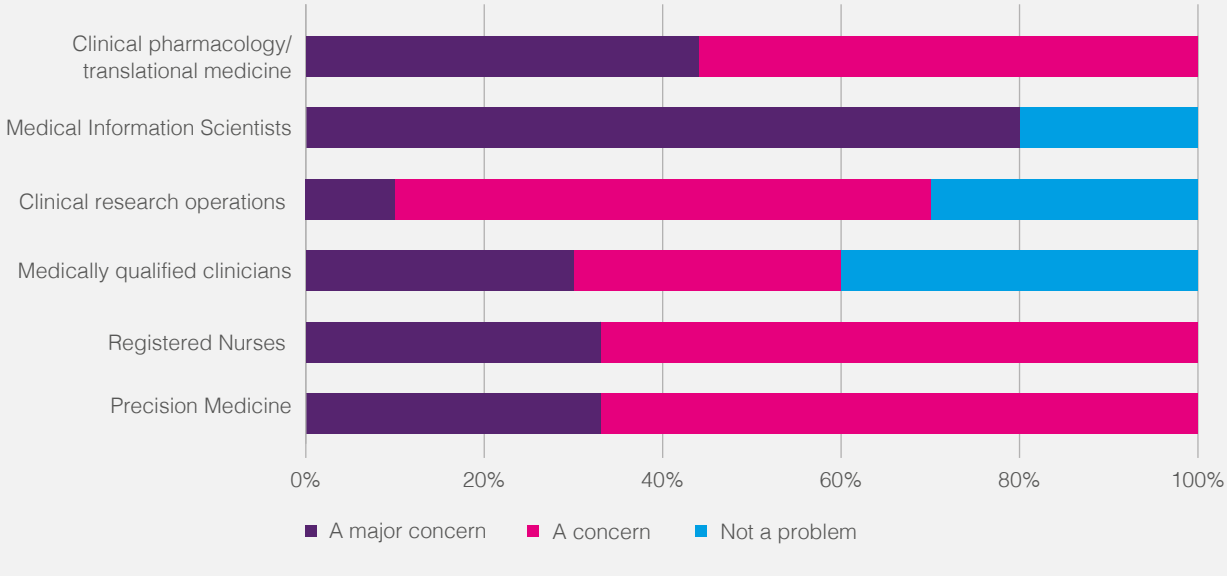


Table 9: Detailed results

Clinical pathology

Summary
Clinical pathology is the study of the nature of disease and the structural and functional changes it causes. In industry pathologists work to establish disease models to assess potential therapies, and to characterise the structural changes in the disease state that occur in response to medicines

Year		2008	2015	2018	2021
Quality		A	A	G	N/A
Number		R	R	G	N/A
Staff	Non-graduate	N/A	G	G	N/A
	Graduate/MSc	A	G	G	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	R	G	G	N/A
	Post-doc	R	G	G	N/A
	Experienced staff	N/A	R	G	N/A
Overall priority		R	R	G	N/A

Clinical pharmacology/translational medicine

Summary
Clinical pharmacology is the study of drugs and their clinical use. Clinical pharmacologists carry out work involving the analysis of the effects of medicines on people within clinical trial studies. Translational Medicine is a discipline that aims to bridge the divide between basic scientific research and patient care through translating scientific discoveries into real therapies and medicines (also known as "bench to bedside"). This section is to include: Clinical Pharmacology Scientists (non-medical); Physician Pharmacologists; Pharmacometricians (modellers).

Year		2008	2015	2018	2021
Quality		R	R	R	A
Number		R	R	A	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	A	A
	Post-doc	R	A	R	G
	Experienced staff	N/A	A	R	R
Overall priority		R	R	R	A

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Clinical research operations

Summary
This discipline involves working operationally in the field of clinical research trials, to ensure correct set-up monitoring and close-down of clinical trials. This includes developing protocols, identifying trial sites/locations, setting-up and monitoring trial progress, ensuring complete documentation throughout the trial and resolving any issues that arise with a view to high quality data being obtained in a timely fashion. Job titles include Project/Study Managers, Clinical Research Associates (CRAs) and Clinical Trial Assistants (CTAs).

Year		2008	2015	2018	2021
Quality		N/A	R	A	A
Number		N/A	A	A	R
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	N/A	G	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	A	R
Overall priority		N/A	A	G	A

Medical Information Scientists

Summary
Medical information scientists provide medical information in response to requests from healthcare professionals (HCPs), advising on the compliance and scientific accuracy of marketing campaigns and training the sales force on clinical data.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	G
Number		N/A	N/A	N/A	A
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	G / A

Medically qualified clinicians

Summary
There are many areas where doctors play an important part within the pharmaceutical industry, including clinical development, regulatory affairs, drug safety, and clinical pharmacology. They have a key role in supporting clinical research and clinical trials.

Year		2008	2015	2018	2021
Quality		R	A	A	A
Number		A	A	A	R
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	A	N/A	A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	A	A	G
	Post-doc	A	N/A	A	G
	Experienced staff	N/A	R	R	R
Overall priority		A	R	A	A

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Precision Medicine

Summary
Precision medicine is medical care designed to optimize efficiency or therapeutic benefit for particular groups of patients, especially by using genetic or molecular profiling.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	G
Number		N/A	N/A	N/A	A
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	A
	Post-doc	N/A	N/A	N/A	A
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	A

Registered Nurses

Summary
This section includes Healthcare practitioners and Nurses. There are numerous and diverse job roles within the Pharmaceutical industry for those with nursing experience who can apply knowledge of healthcare or healthcare systems – such roles for example, can be within Pharmacovigilance or Drug Safety disciplines

Year		2008	2015	2018	2021
Quality		N/A	N/A	G	G
Number		N/A	N/A	G	A
Staff	Non-graduate	N/A	N/A	G	G
	Graduate/MSc	N/A	N/A	G	A
	Apprenticeship	N/A	N/A	N/A	A
	PhD	N/A	N/A	G	G
	Post-doc	N/A	N/A	G	G
	Experienced staff	N/A	N/A	G	A
Overall priority		N/A	N/A	G	G

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 4: Pharmacy

At a glance:

- It is extremely encouraging to see that no respondents marked any of the pharmacy disciplines as high priority.
- Similar to 2018, response rates for the pharmacy area were typically low and this may explain why the results for this area appear so encouraging. Regardless, however, it would be wrong to ignore the clear positive trend for some of the disciplines, such as formulation, which has gone from high priority in 2015, to high/medium priority in 2018, to only medium priority now.
- In particular, device technology has seen a remarkable improvement since 2018. This year, 50% of respondents thought it was low priority whilst in 2018 over 80% considered it high priority.

Figure 18: Percentage of respondents rating each pharmacy discipline as high, medium or low priority or identifying it as 'not a problem'.

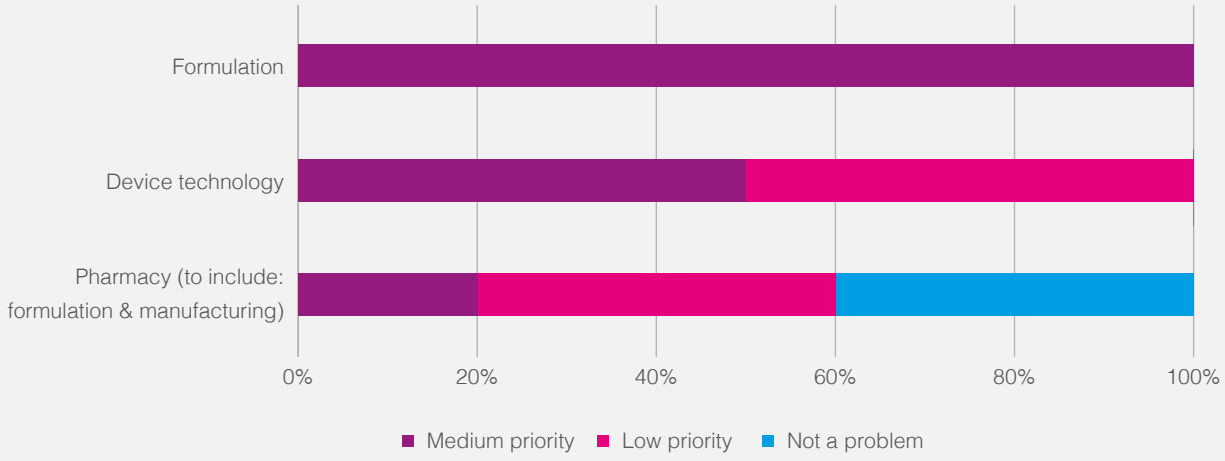


Figure 19: Of those who marked the subject as a priority, the percentage of respondents who identified each qualification level as an issue within the pharmacy science disciplines.

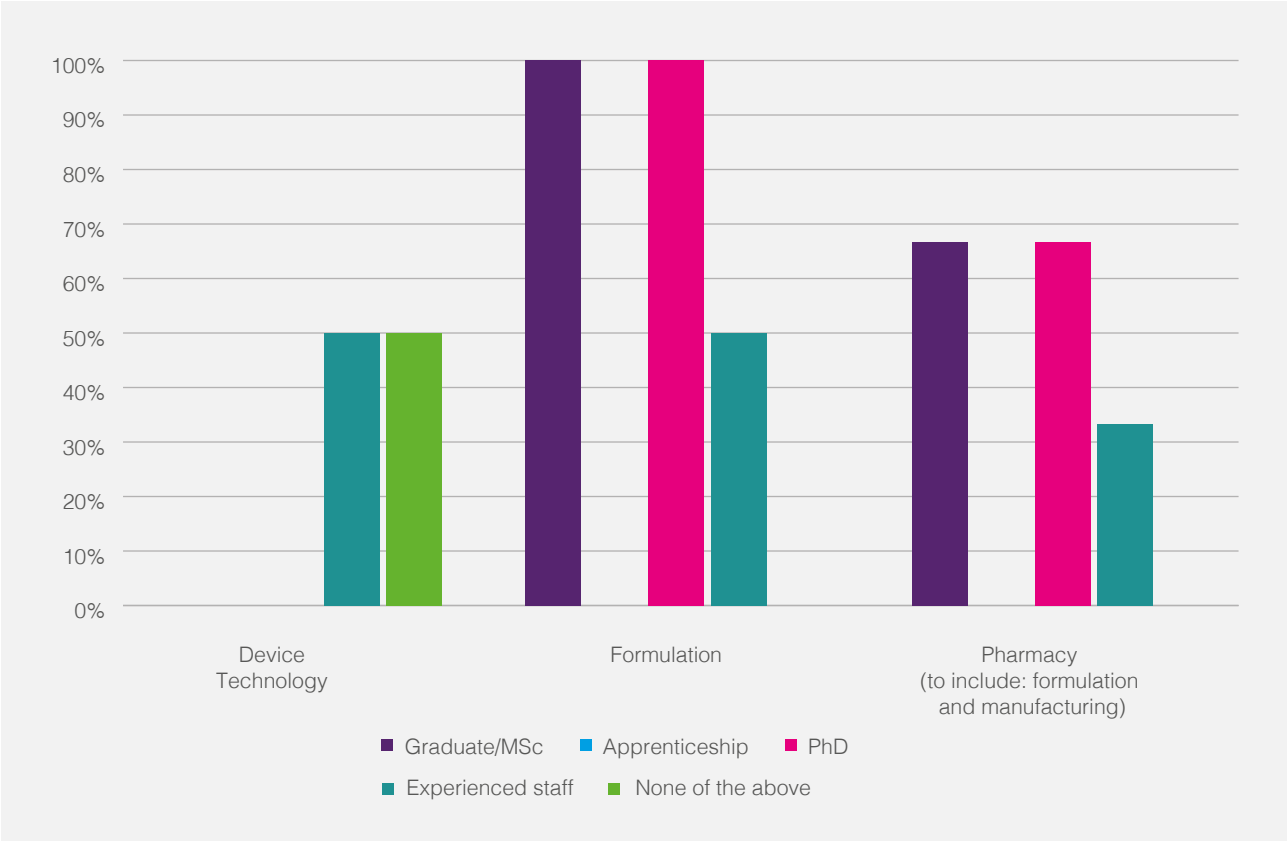


Table 10: Pharmacy areas where at least 50% of respondents consider it high or medium priority, and the associated experience of staff most needed.

Pharmacy areas where at least 50% of respondents consider it high or medium priority	Experience of staff most needed (most cited)
Formulation	Graduate/MSc; PhD
Device technology	Experienced staff

Figure 20: Percentage of respondents identifying a concern with the quality vs quantity of candidates (size of bubble represents number of respondents).

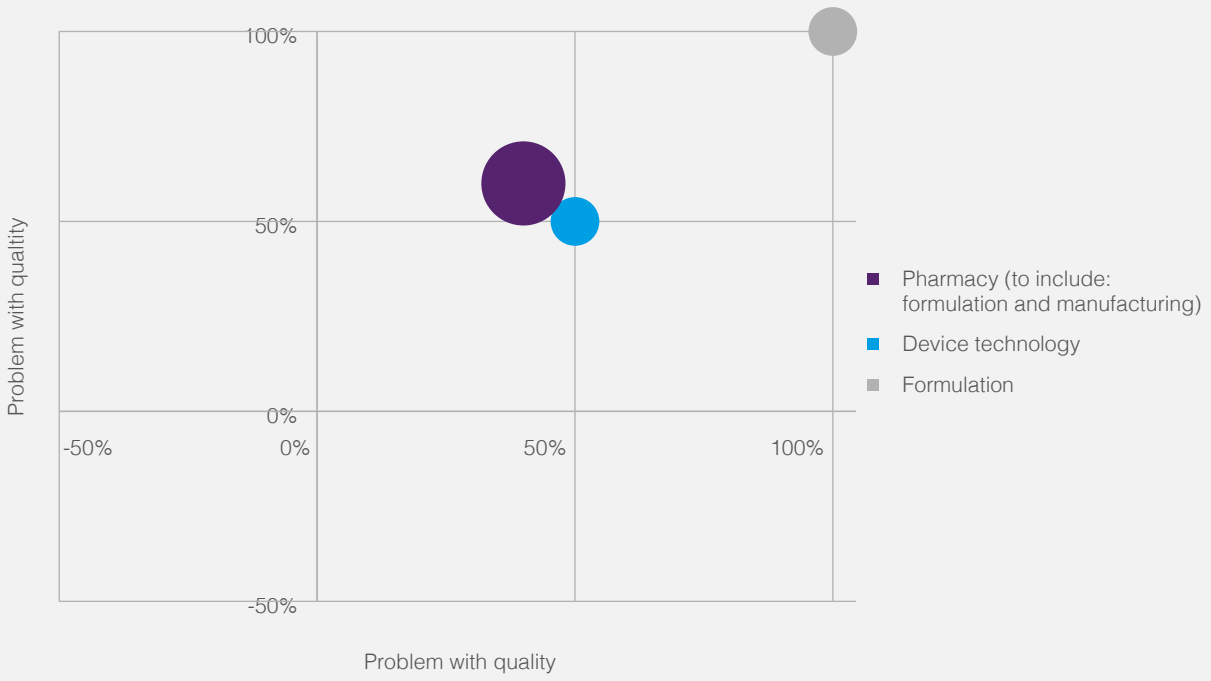


Figure 21: Of those who identified each discipline as a priority, the percentage of respondents who identified practical skills as a major concern, concern, or not a problem within the pharmacy areas.

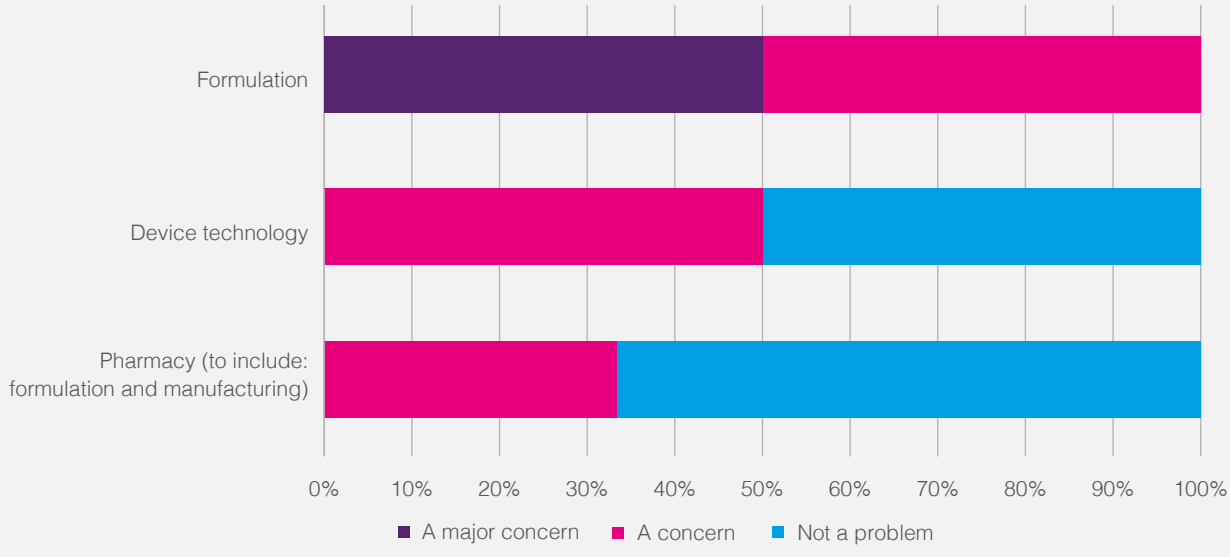


Table 11: Detailed results

Device Technology

Summary
Medical devices include drug delivery systems such as inhalers, injections and stents, and also clinical diagnostic tools

Year		2008	2015	2018	2021
Quality		N/A	G	R	A
Number		N/A	A	R	A
Staff	Non-graduate	N/A	G	R	G
	Graduate/MSc	N/A	A	R	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	A	R	G
	Post-doc	N/A	A	R	G
	Experienced staff	N/A	R	R	A
Overall priority		N/A	A	R	G / A

Formulation

Summary
This involves creation of a dose of a medicine (such as a tablet, capsule or injection) which will deliver the active substance to the correct part of the body, in the right concentration, and at an appropriate rate. For biopharmaceuticals formulation involves determining the appropriate excipients to add to the drug compound to deliver the desired dose via the desired delivery mechanism to the target organ or system in the body

Year		2008	2015	2018	2021
Quality		N/A	R	A	R
Number		N/A	R	A	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	A	G	R
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	G	A
Overall priority		N/A	A	G	A

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Pharmacy

Summary
Pharmacists work across the industry in areas such as the assessment of safety and efficacy of new medicines and the formulation of medicines and could be responsible for the release of medicines to the market

	Year	2008	2015	2018	2021
	Quality	A	A	A	A
	Number	A	A	A	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	A	G	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	G	G	R
	Post-doc	R	A	G	G
	Experienced staff	N/A	R	A	A
	Overall priority	A	A	G	G

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 5: Informatics, Computational, Mathematical and Statistics Areas

At a glance:

- This was the area of greatest concern, with five of the seven top priority disciplines being in this area and all disciplines having over 60% of respondents say they were either medium or high priority.
- Staff shortages were felt across all levels of qualification, although recruitment of experienced staff was of particular concern.
- The skills gap in this area grew from 2015 to 2018 and at a first glance, it might appear that the skills gap has subsequently shrunk slightly from 2018 to 2021 (due to there being less disciplines identified as top concerns). However, this might be due to the fact that some disciplines have been merged in this year's survey.
- Concerns were raised that recruitment in this area is being negatively impact by large tech companies. They have a better reputation/profile in this area and are also able to pay more. This may be a core reason behind why over 60% of respondents for all subjects reported a problem with the quantity of candidates being recruited.

Figure 22: Percentage of respondents rating each informatics, computational, mathematical and statistics discipline as high, medium or low priority or identifying it as 'not a problem'.

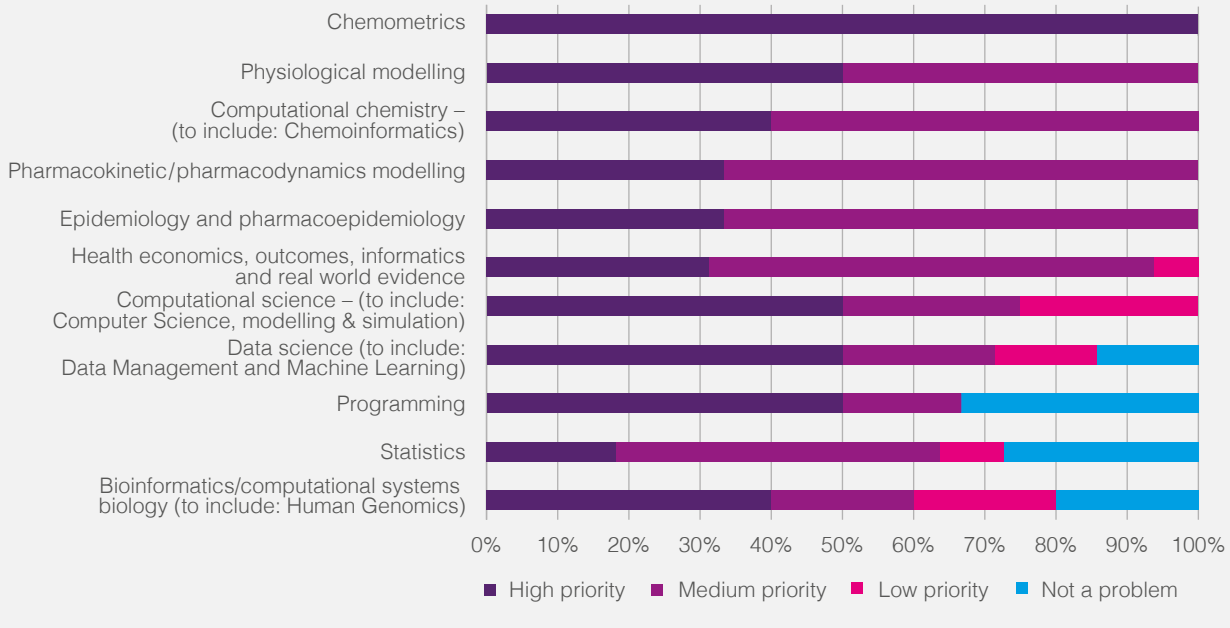


Figure 23: Of those who identified each subject as a priority, the percentage of respondents who identified each qualification level as an issue within the informatics, computational, mathematical and statistics disciplines.

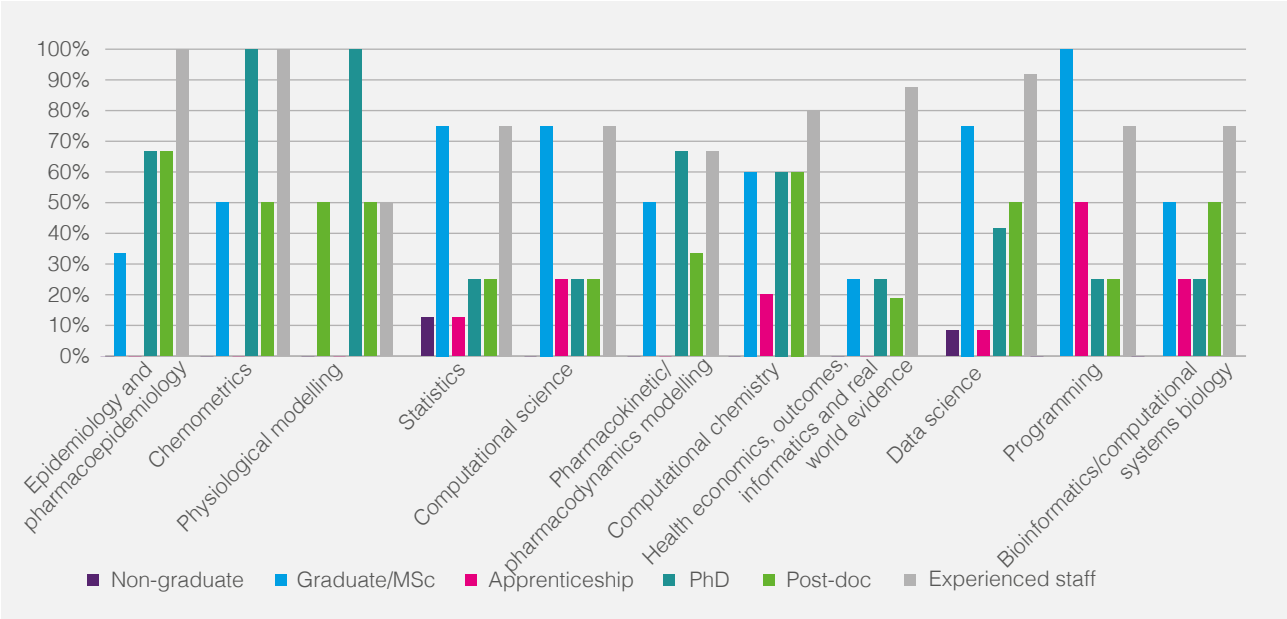


Table 12: Informatics, computational mathematical and statistics areas where at least 50% of respondents consider it high or medium priority, and the associated experience of staff most needed.

Informatics, computational mathematical and statistics areas where at least 50% of respondents consider it high or medium priority	Experience of staff most needed (most cited)
Chemometrics (overall top priority)	PhD; experienced staff
Programming	Graduate/MSc
Physiological modelling (overall top priority)	PhD
Data science (to include: Data Management and Machine Learning)	Experienced staff
Computational science – (to include: Computer Science, modelling & simulation)	Graduate/MSc; experienced staff
Computational chemistry – (to include: Chemoinformatics) (overall top priority)	Experienced staff
Bioinformatics/computational systems biology (to include: Human Genomics)	Experienced staff
Pharmacokinetic/pharmacodynamics modelling (overall top priority)	PhD; experienced staff
Epidemiology and pharmacoepidemiology (overall top priority)	Experienced staff
Health economics, outcomes, informatics and real world evidence	Experienced staff
Statistics	Graduate/MSc; experienced staff

Figure 24: Percentage of respondents identifying a concern with the quality vs quantity of candidates within the informatics, computational, mathematical and statistics disciplines (size of bubble represents number of respondents).

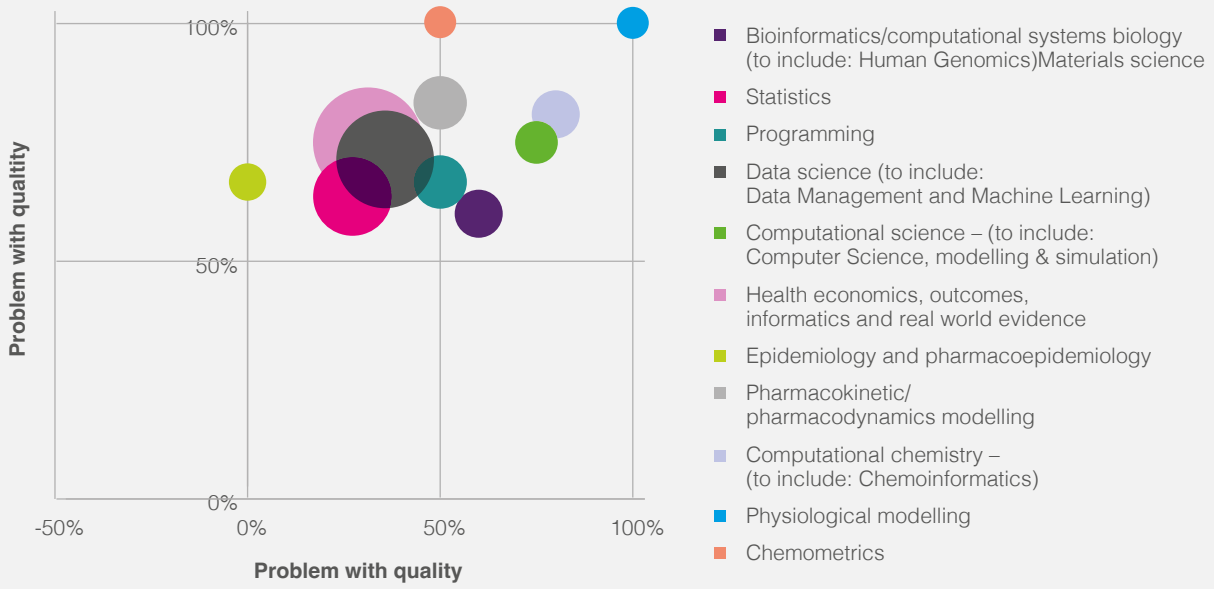


Figure 25: Of those who identified each subject as a priority, the percentage of respondents who identified practical skills as a major concern, concern, or not a problem within the informatics, computational, mathematical and statistics disciplines.

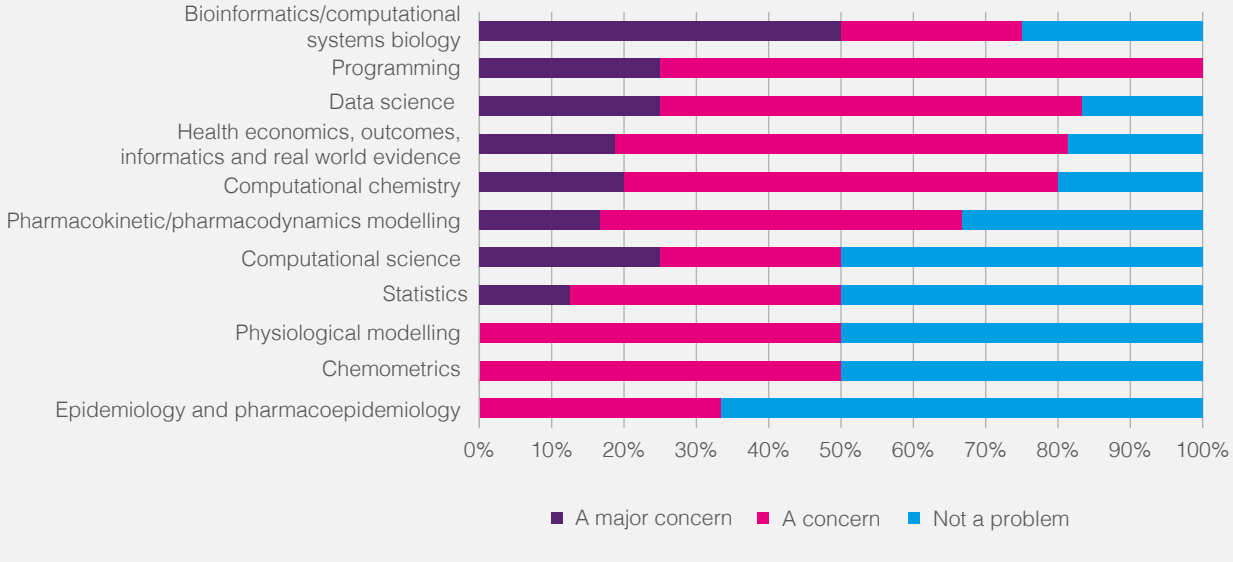


Table 13: Detailed results

Automation

Summary
Laboratory automation is a multi-disciplinary strategy to research, develop, optimize and capitalise on technologies in the laboratory that enable new and improved processes

Year		2008	2015	2018	2021
Quality		N/A	A	R	N/A
Number		N/A	R	R	N/A
Staff	Non-graduate	N/A	G	R	N/A
	Graduate/MSc	N/A	R	R	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	N/A	A	R	N/A
	Post-doc	N/A	G	R	N/A
	Experienced staff	N/A	R	R	N/A
Overall priority		N/A	A	R	N/A

Biomedical Imaging

Summary
Biomedical imaging is increasingly used in the pharmaceutical industry as a non-invasive technique during preclinical studies and clinical. It can be used, for example, to evaluate whether or not a medicine has had a biological effect, or if it reaches the target organ. Imaging techniques can also provide data on biomarkers of disease, providing an efficient way to accurately evaluate the effectiveness of some new medicines.

Year		2008	2015	2018	2021
Quality		A	R	R	N/A
Number		A	A	G	N/A
Staff	Non-graduate	N/A	G	G	N/A
	Graduate/MSc	N/A	G	G	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	A	R	R	N/A
	Post-doc	A	R	R	N/A
	Experienced staff	N/A	R	R	N/A
Overall priority		A	R	R	N/A

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Bioinformatics/computational systems biology

Summary
Systems biology integrates experimental and computational research to better understand complex biological processes. Bioinformatics and computational systems biology use statistical techniques, including Bayesian methods, to interpret large sets of biological data. Modelling and simulation of biological systems are used as an aid to predicting activity of potential medicines.

Year		2008	2015	2018	2021
Quality		R	R	G	A
Number		A	R	R	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	A	G
	Post-doc	R	A	R	A
	Experienced staff	N/A	R	R	R
Overall priority		A	R	R	R

Chemoinformatics

Summary
Chemometrics is the science of extracting information from chemical systems by data-driven means using methods such as multivariate statistics, applied mathematics and computer science, in order to address problems in chemistry, biochemistry, medicine, biology and chemical engineering.

Year		2008	2015	2018	2021
Quality		N/A	A	G	A
Number		N/A	R	R	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	R	R	R
	Post-doc	N/A	R	R	A
	Experienced staff	N/A	R	R	R
Overall priority		N/A	A	R	R

Computational chemistry

Summary
This discipline involves the use of computational approaches in drug design and in lead identification. The properties of molecules and target proteins are modelled to predict and gain insight into how these will interact. Computational chemists often work with structural chemists who in turn try to elucidate the structures and shapes of molecules, protein targets and protein-molecule complexes. These approaches are widely used in the design of new medicines.

Year		2008	2015	2018	2021
Quality		R	R	G	R
Number		R	R	R	R
Staff	Non-graduate	N/A	G	R	G
	Graduate/MSc	N/A	G	G	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	A	R	A
	Post-doc	R	R	R	A
	Experienced staff	N/A	R	R	R
Overall priority		R	R	R	A

Key

R	High priority - requires immediate action	A	Medium priority - requires action
G	Low priority - an important area to watch	N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Computational science

Summary
Computational Scientists use mathematical modelling techniques along with information from published literature to build hypotheses for drug targets. The use of computational science allows large data sets to be collected and analysed quickly.

Year		2008	2015	2018	2021
Quality		R	R	G	R
Number		A	A	R	R
Staff	Non-graduate	N/A	G	R	G
	Graduate/MSc	N/A	G	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	G	G
	Post-doc	R	R	R	G
	Experienced staff	N/A	A	R	R
Overall priority		A	A	R	R

Computer science

Summary
Computer Scientists within the pharmaceutical industry play a vital role within key growth areas of software development, app development, AI and coding.

Year		2008	2015	2018	2021
Quality		N/A	N/A	G	N/A
Number		N/A	N/A	G	N/A
Staff	Non-graduate	N/A	N/A	G	N/A
	Graduate/MSc	N/A	N/A	R	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	N/A	N/A	A	N/A
	Post-doc	N/A	N/A	A	N/A
	Experienced staff	N/A	N/A	R	N/A
Overall priority		N/A	N/A	G / A / R	N/A

Data management

Summary
Broadly this involves the development, execution and supervision of plans, policies, programmes and practices that control, protect, deliver and enhance the value of data and information assets. Clinical research data management is the application of informatics theories and methods to the definition, collection and processing of data for clinical studies and the design of associated work and data flow.

Year		2008	2015	2018	2021
Quality		N/A	R	G	N/A
Number		N/A	A	G	N/A
Staff	Non-graduate	N/A	G	G	N/A
	Graduate/MSc	N/A	R	A	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	N/A	G	G	N/A
	Post-doc	N/A	G	G	N/A
	Experienced staff	N/A	R	A	N/A
Overall priority		N/A	A	G	N/A

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Data science

Summary
The process of analysing data to find correlations or patterns in large sets of data, possibly from multiple sources.

Year		2008	2015	2018	2021
Quality		N/A	A	A	A
Number		N/A	R	A	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	R	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	R	A	A
	Post-doc	N/A	A	G	A
	Experienced staff	N/A	R	R	R
Overall priority		N/A	R	A	R

Epidemiology and pharmacoepidemiology

Summary
Epidemiology is the study of health and disease conditions in a defined population to identify patterns. Pharmacoepidemiology uses these techniques to study the uses and effects of medicines in large, well defined, populations.

Year		2008	2015	2018	2021
Quality		N/A	A	G	G
Number		N/A	R	R	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	G	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	A	G	R
	Post-doc	N/A	A	A	R
	Experienced staff	N/A	R	R	R
Overall priority		N/A	R	A	A

Health economics, outcomes, informatics and real world evidence

Summary
Health economics is a branch of economics concerned with issues relating to the allocation of health and healthcare. Health economists study factors that affect the supply and demand for healthcare and the market equilibrium, and look at healthcare system design and reform as well as aspects of financing, expenditure and purchasing.

Year		2008	2015	2018	2021
Quality		A	R	G	G
Number		R	R	R	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	R	A	A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	A	A	G	G
	Post-doc	N/A	A	G	G
	Experienced staff	N/A	R	R	R
Overall priority		A	R	G	A

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Health informatics

Summary
Health informatics deals with the resources, devices, and methods required to optimise the acquisition, storage,linkage, retrieval, and use of health-related data to improve health care outcomes and optimise the development and use of medicines.

Year		2008	2015	2018	2021
Quality		N/A	R	G	N/A
Number		N/A	A	A	N/A
Staff	Non-graduate	N/A	G	G	N/A
	Graduate/MSc	N/A	R	A	N/A
	Apprenticeship	N/A	N/A	N/A	N/A
	PhD	N/A	A	A	N/A
	Post-doc	N/A	A	A	N/A
	Experienced staff	N/A	R	R	N/A
Overall priority		N/A	R	A/R	N/A

Pharmacokinetic / pharmacodynamics modelling

Summary
Pharmacokinetics (PK) focuses on how the body processes a drug, resulting in a drug concentration. Pharmacodynamics (PD) is concerned with how the drug acts on the body, resulting in a measurable drug effect. Through PK/PD modelling and simulation, which combines the two disciplines, pharmaceutical scientists acquire an earlier understanding of the link between drug and response, and can better characterise a drug's absorption, distribution, and elimination properties.

Year		2008	2015	2018	2021
Quality		R	A	A	A
Number		R	R	R	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	R	R	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	R	A	R
	Post-doc	R	R	A	A
	Experienced staff	N/A	A	R	R
Overall priority		R	A	R	A

Physiological modelling

Summary
Modelling and simulation at the pre-clinical stage of drug development involves integration of data on physicochemical properties, pharmacokinetics, pharmacodynamics, formulation and safety. Physiologically based pharmacokinetic (PBPK) modelling and simulation is a tool that can help predict the pharmacokinetics of drugs in humans and evaluate the effects of intrinsic and extrinsic factors, alone or in combinations, on drug exposure.The use of this tool is increasing at all stages of the drug development process.

Year		2008	2015	2018	2021
Quality		N/A	G	G	R
Number		N/A	A	R	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	G	R	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	R	R	R
	Post-doc	N/A	R	R	A
	Experienced staff	N/A	G	R	A
Overall priority		N/A	A	R	A/R

Key

R	High priority - requires immediate action	A	Medium priority - requires action
G	Low priority - an important area to watch	N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Programming

Summary
Programming languages can be used for developing software that may help in medical field, such as being used to design a medical program or application.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	A
Number		N/A	N/A	N/A	R
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	R
	Apprenticeship	N/A	N/A	N/A	A
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	R

Statistics

Summary
Statisticians are a fundamental part of a drug development project team across the whole lifecycle of a pharmaceutical product – from laboratory work through to trials in humans (clinical trials) and finally to manufacturing and marketing. Pharmaceutical statisticians are closely involved with activities such as experimental design, sample sizecalculations, data collection, and the analysis, interpretation and presentation of results

Year		2008	2015	2018	2021
Quality		R	R	G	G
Number		R	R	A	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	R	R	A	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	R	A	G	G
	Post-doc	A	A	G	G
	Experienced staff	N/A	R	A	R
Overall priority		R	R	G	A

Key

R	High priority - requires immediate action	A	Medium priority - requires action
G	Low priority - an important area to watch	N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 6: Regulatory Areas

At a glance:

- Encouragingly, regulatory areas have seen an increase in the number of respondents and a relative decline in their level of priority. No regulatory areas were considered a top priority.
- Whilst qualified person (QA) has remained at a relatively similar high level of priority since 2018, qualified person (QPPV) has seen a dramatic decline in level of priority, as have other disciplines including pharmacovigilance. When taken with the results from 2015, it appears as if the skills gap in regulatory areas is narrowing.
- Similar to other subject areas, recruitment of experienced staff was the greatest concern, as well as quantity of candidates as opposed to quality of candidates.

Figure 26: Percentage of respondents rating each regulatory discipline as high, medium or low priority or identifying it as 'not a problem'.

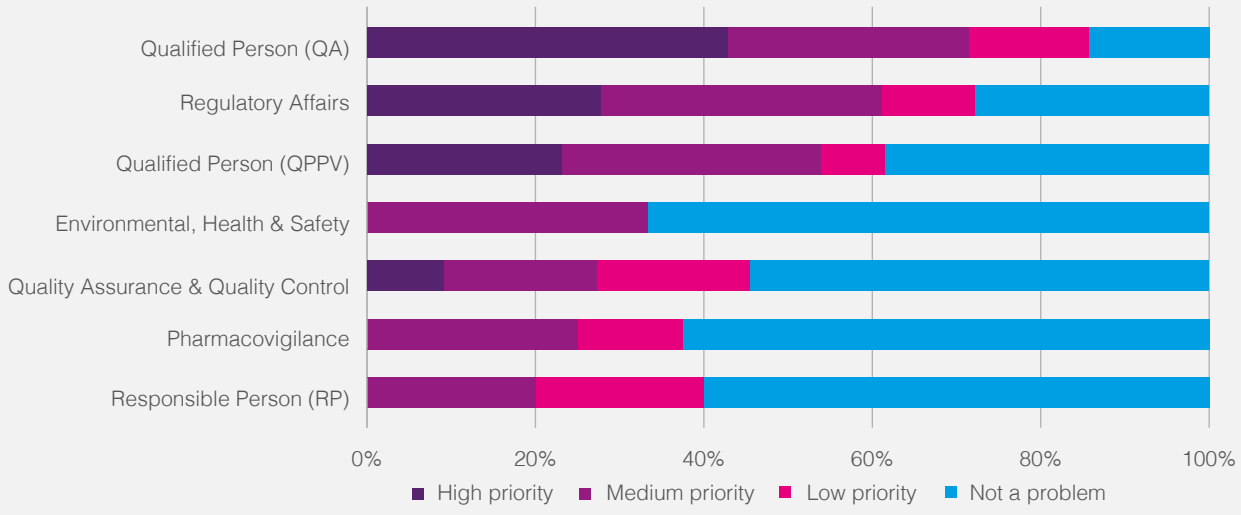


Figure 27: Of those who identified each subject as a priority, the percentage of respondents who identified each qualification level as an issue within the regulatory disciplines.

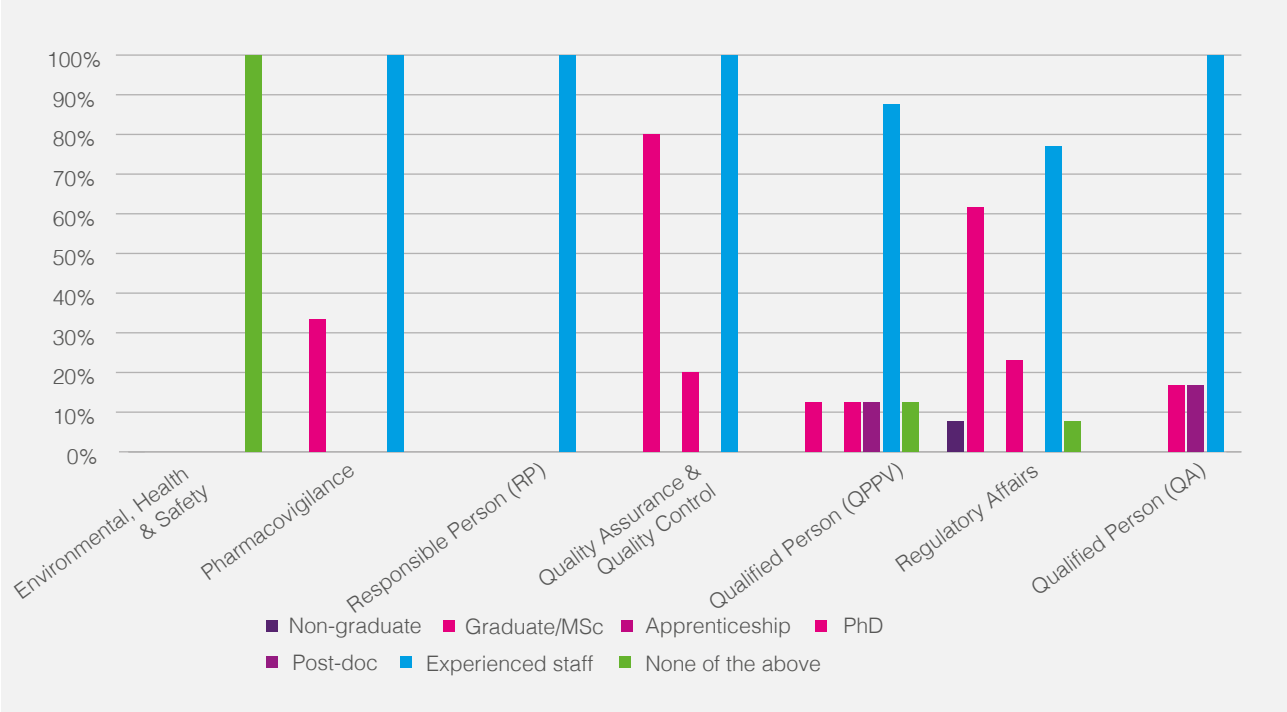


Table 14: Regulatory areas where at least 50% of respondents consider it high or medium priority, and the associated experience of staff most needed.

Regulatory areas where at least 50% of respondents consider it high or medium priority	Experience of staff most needed (most cited)
Qualified Person (QA)	Experienced staff
Regulatory Affairs	Experienced staff
Qualified Person (QPPV)	Experienced staff

Figure 28: Percentage of respondents identifying a concern with the quality vs quantity of candidates within the regulatory disciplines (size of bubbles represents the number of respondents).

Figure 29: Of those who identified each subject as a priority, the percentage of respondents who identified practical skills as a major concern, concern, or not a problem within the regulatory areas.

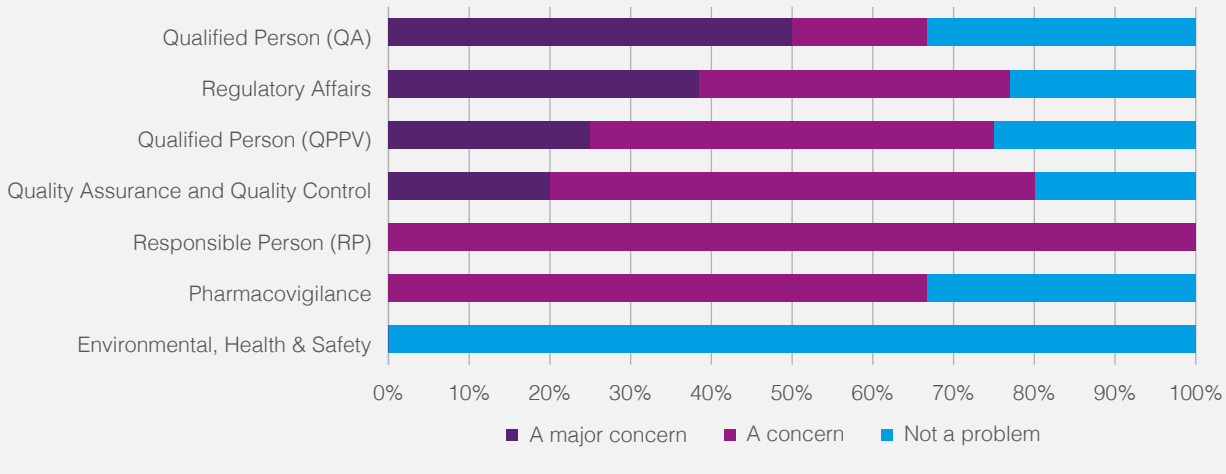


Table 15: Detailed results

Environment, health & safety

Summary
Environment, Health, Safety and Sustainability (EHS&S) refers to the practices to protect the health and safety of employees and the public as well as the environment. Strong EHS&S management requires the implementation of systems and processes to assess and control the risks of environmental impacts and health and safety hazards. Besides assuring compliance with applicable legislation, EHS&S management systems drive continuous improvement and learning.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	G
Number		N/A	N/A	N/A	A
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	G
Overall priority		N/A	N/A	N/A	G

Pharmacovigilance

Summary
Pharmacovigilance is the process of collecting, monitoring, researching, assessing and evaluating information from healthcare providers and patients on the adverse effects of medicines, to ensure that drugs on the market are safe for patients, and to identify new hazards associated with the medication.

Year		2008	2015	2018	2021
Quality		N/A	R	G	G
Number		N/A	A	A	G
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	A	R
Overall priority		N/A	A	G	G

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Quality assurance and quality control

Summary
Quality needs to be built into the product. The information and knowledge gained from pharmaceutical development studies provide scientific understanding to support the establishment of specifications and manufacturing controls which will enable to ensure a pharmaceutical product's quality throughout its life cycle. GLP, GCP and GMP guidelines ensure that appropriate standards are adhered to.

Year		2008	2015	2018	2021
Quality		N/A	R	A	A
Number		N/A	A	A	G
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	R
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	R	R
Overall priority		N/A	R	A	G

Qualified person (QA)

Summary
The primary legal responsibility of the Qualified Person is to certify batches of medicinal products prior to use in a clinical trial or prior to release for sale and placing on the market.

Year		2008	2015	2018	2021
Quality		N/A	A	A	G
Number		N/A	R	A	R
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	R	R
Overall priority		N/A	R	A	R

Qualified person (QPPV)

Summary
Under European Pharmacovigilance regulations, each marketing authorisation holder (MAH) is required to appoint a QPPV. The QPPV is responsible for creating and maintaining the MAH's Pharmacovigilance system. The system must fulfil the legal obligations regarding product safety and must be adequately resourced.

Year		2008	2015	2018	2021
Quality		N/A	G	G	G
Number		N/A	R	G	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	A	G	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	A	R
Overall priority		N/A	R	R	G

Key

R High priority - requires immediate action
A Medium priority - requires action
G Low priority - an important area to watch
N/A Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Regulatory Affairs

Summary
Regulatory affairs professionals ensure regulatory compliance and prepare submissions to regulatory authorities for new medicines and for any change to a marketed medicine.

Year		2008	2015	2018	2021
Quality		N/A	R	R	A
Number		N/A	A	A	A
Staff	Non-graduate	N/A	G	G	G
	Graduate/MSc	N/A	G	A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	G	G	G
	Post-doc	N/A	G	G	G
	Experienced staff	N/A	R	R	R
Overall priority		N/A	A	A	A

Responsible person (RP)

Summary
The RP is responsible for safeguarding product users against potential hazards arising from poor distribution practices. The duties of a RP include: to ensure that the provisions of the licence are observed, to ensure that the operations do not compromise the quality of medicines, to ensure that an adequate quality system is established and maintained, to oversee audit of the quality system and to carry out independent audits, to ensure that adequate records are maintained, to ensure that all personnel are trained, and to ensure full and prompt cooperation with product licence holders in the event of recalls

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	G
Number		N/A	N/A	N/A	A
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	G

Key

R	High priority - requires immediate action
G	Low priority - an important area to watch
A	Medium priority - requires action
N/A	Not applicable or not rated

Q = quality of candidates N = number of candidates Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority) .Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 7: Pharmaceutical Engineering

At a glance:

- Engineering in manufacturing - the only pharmaceutical engineering discipline asked about – is a top priority discipline as 100% of respondents rated it as either medium or high priority.
- The discipline also has issues with the recruitment of experienced staff, whilst practical skills were relatively less of a concern than disciplines in other areas.

Figure 30: Percentage of respondents rating each pharmaceutical engineering discipline as high, medium or low priority or identifying it as 'not a problem'.

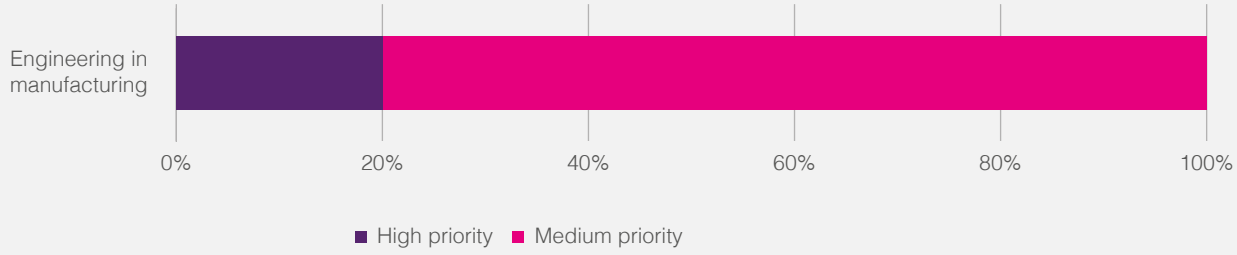


Figure 31: Of those who identified each subject as a priority, the percentage of respondents who identified each qualification level as an issue within pharmaceutical engineering.

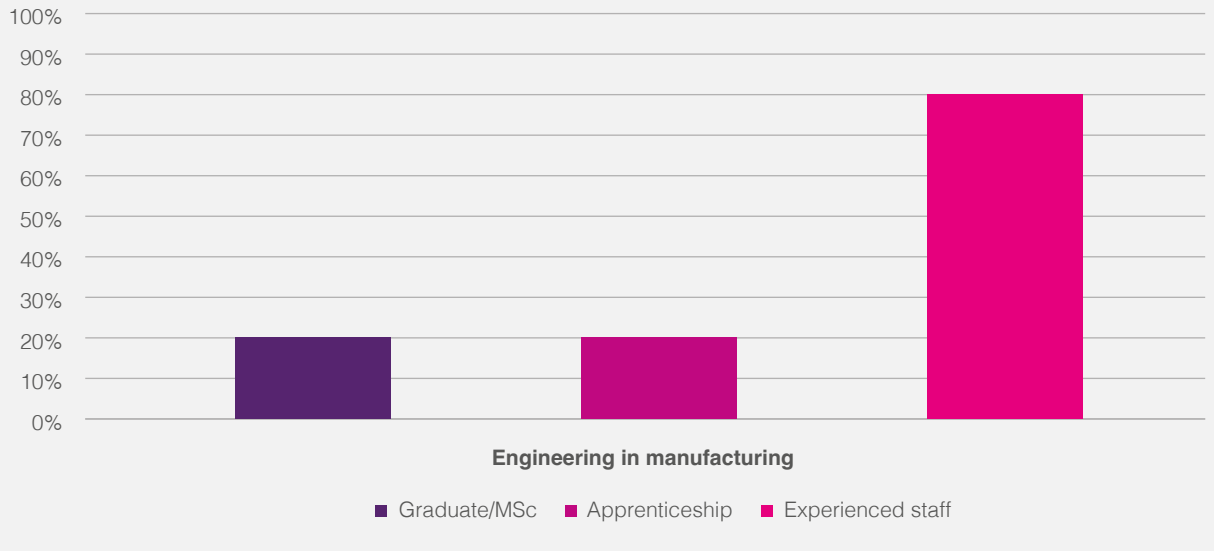


Figure 32: Percentage of respondents identifying a concern with the quality vs quantity of candidates for engineering in manufacturing (size of bubbles represents the number of respondents).

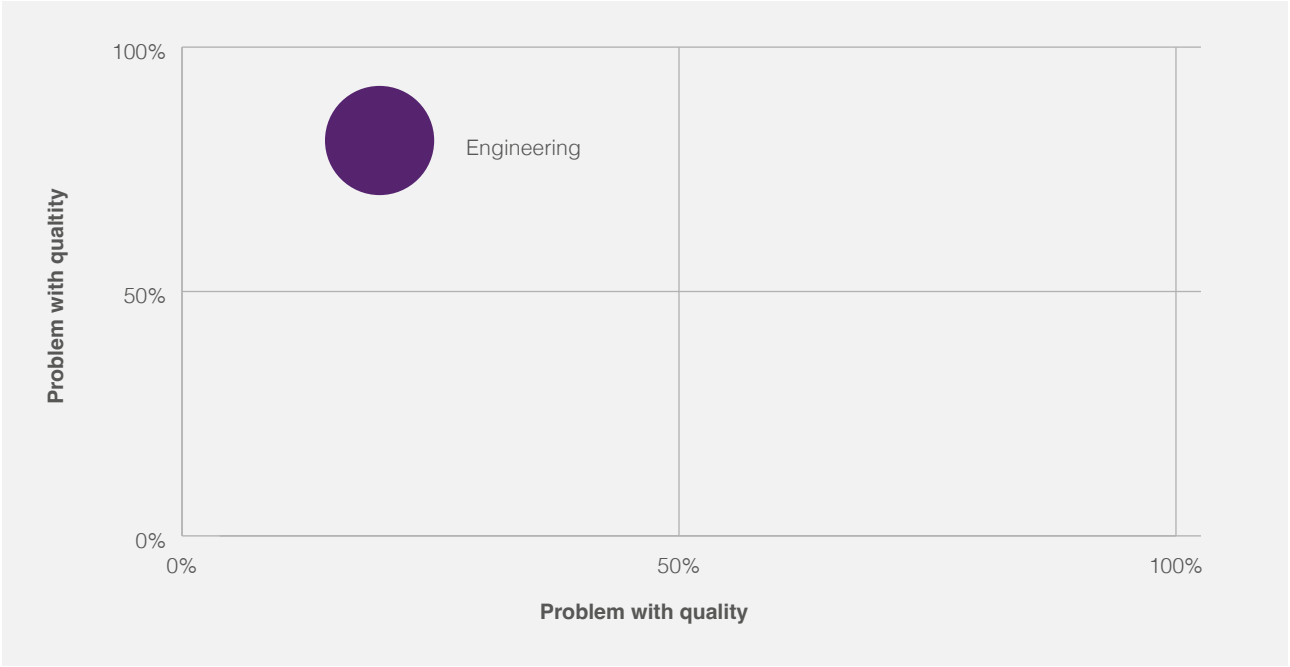


Figure 33: Of those who identified each subject as a priority, the percentage of respondents who identified practical skills as a major concern, concern, or not a problem within the pharmaceutical engineering.

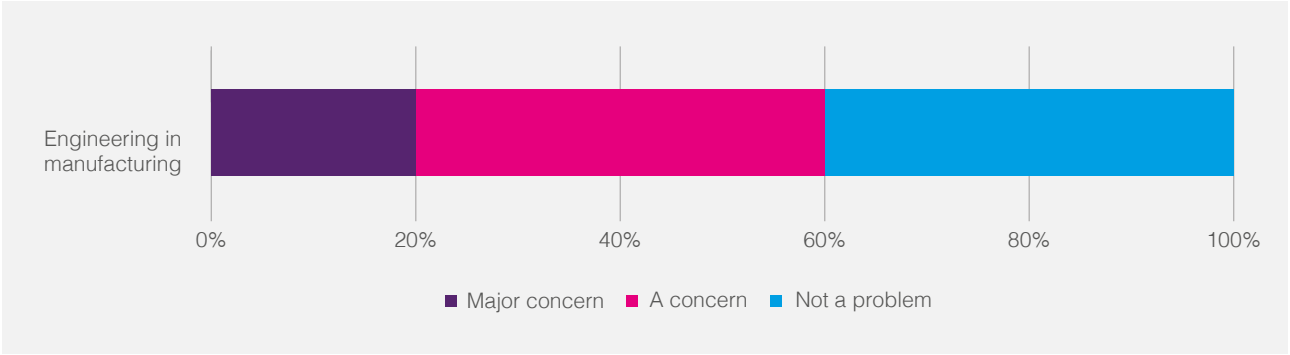


Table 16: Detailed results

Engineering in manufacturing

Summary
Production engineers have the primary role of increasing efficiencies throughout the manufacturing process. This is achieved through implementing continuous improvement techniques and working closely with various other teams, such as Quality and even R&D. Their responsibilities include: Asset care – developing and executing maintenance programmes; Reducing waste; Improving line speeds and minimising bottlenecks; Working closely with equipment manufacturers to obtain and; integrate the latest technology

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	G
Number		N/A	N/A	N/A	R
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	A

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 8: Developmental and Translational Science

At a glance:

- For this area, three disciplines were asked about (biochemical engineering, cell and gene therapy, and robotics) but only one came back with more than two responses (cell and gene therapy).
- Cell and gene therapy was considered not a problem by 40% of respondents, whilst the other 60% thought it was high/medium priority.
- Recruitment of staff was an issue across many different levels, and 100% of respondents thought that practical skills were a concern.

Figure 34: Percentage of respondents rating each developmental and translational science discipline as high, medium or low priority or identifying it as 'not a problem'.

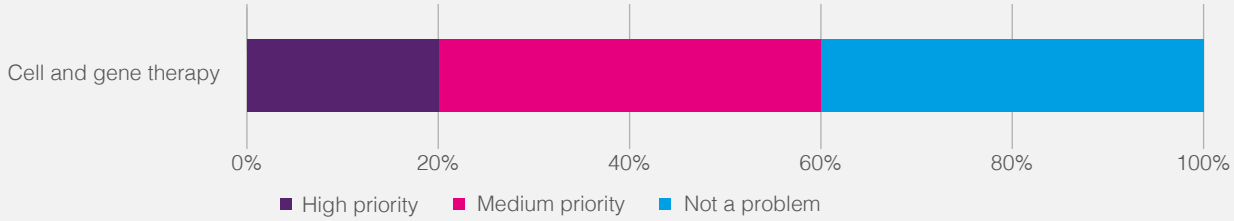


Figure 35: Of those who identified each subject as a priority, the percentage of respondents who identified each qualification level as an issue within developmental and translational science.

Figure 36: Percentage of respondents identifying a concern with the quality vs quantity of candidates for cell and gene therapy (size of bubbles represents the number of respondents).

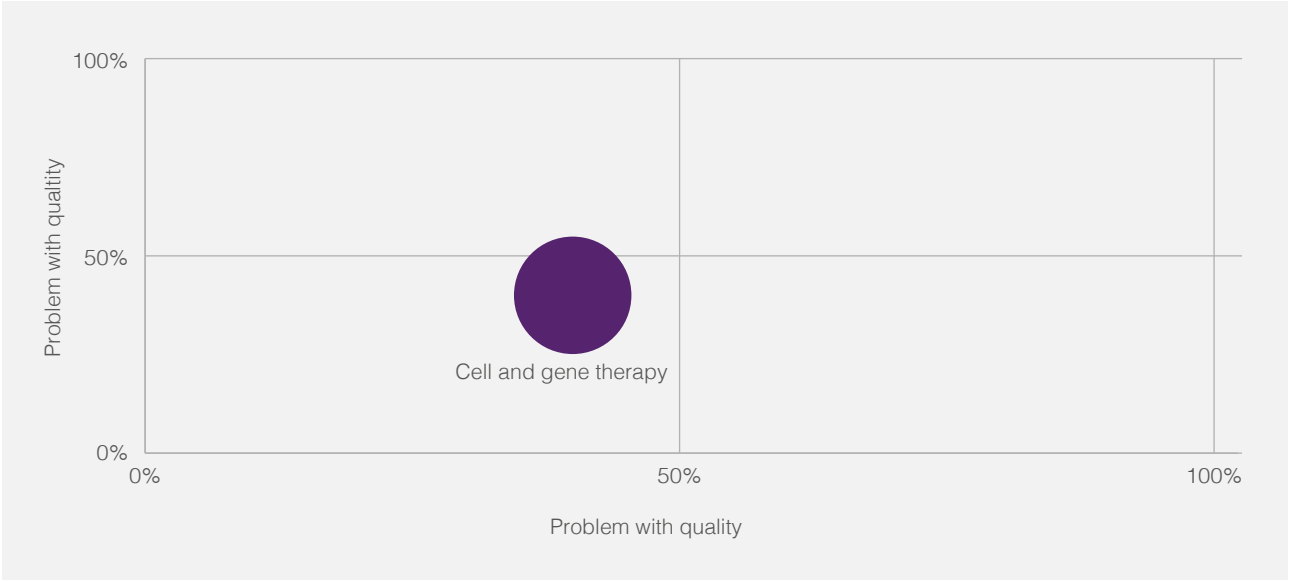


Figure 37: Of those who identified each subject as a priority, the percentage of respondents who identified practical skills as a major concern, concern, or not a problem within developmental and translational science.

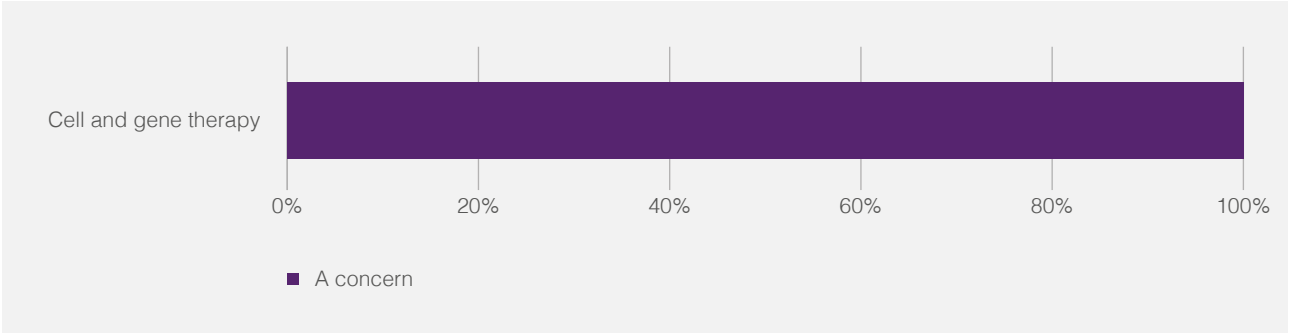


Table 17: Detailed results

Engineering in manufacturing

Summary
Gene therapy involves introducing genetic material into a person's stem cells to address the cause of a disease. There are several ways to do this including editing the mutated gene that has caused the disease, 'switching off' a mutated gene that doesn't work correctly or adding healthy functional copies of the gene.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	A
Number		N/A	N/A	N/A	A
Staff	Non-graduate	N/A	N/A	N/A	A
	Graduate/MSc	N/A	N/A	N/A	R
	Apprenticeship	N/A	N/A	N/A	R
	PhD	N/A	N/A	N/A	R
	Post-doc	N/A	N/A	N/A	R
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	G / A

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Section 9: Business Areas

At a glance:

- Similar to 2018, this appears to be a relatively low priority area with no disciplines being high priority.
- This was one of the only areas where quality of candidates was more of an issue than the quantity of candidates.

Figure 38: Percentage of respondents rating each business area as high, medium or low priority or identifying it as 'not a problem'.

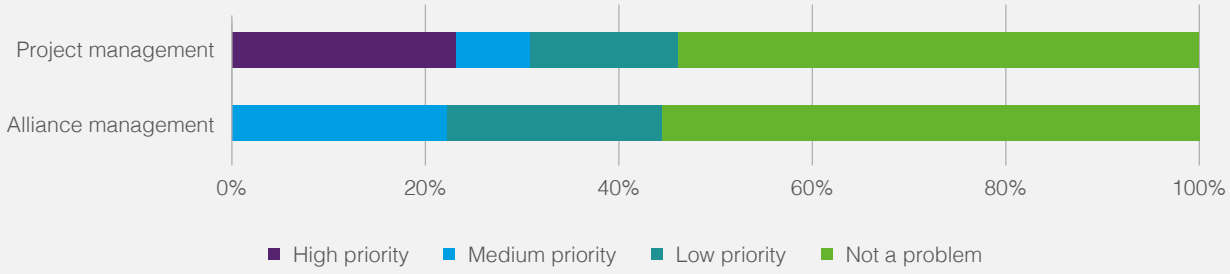


Figure 39: Of those who identified each subject as a priority, the percentage of respondents who identified each qualification level as an issue for business areas.

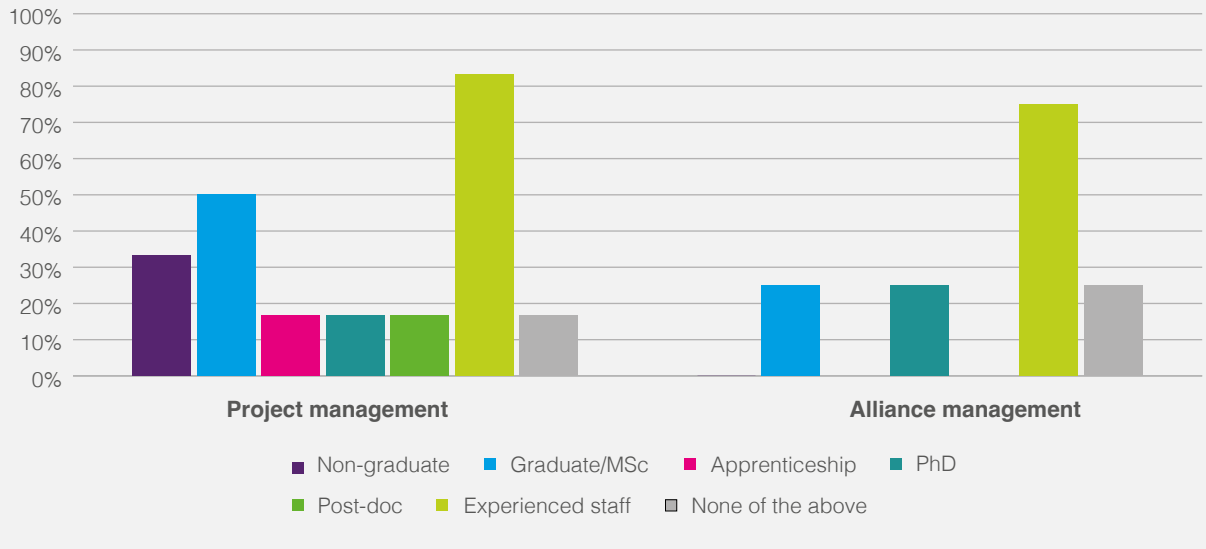


Figure 40: Of those who identified each subject as a priority, the percentage of respondents who identified practical skills as a major concern, concern, or not a problem for business areas.

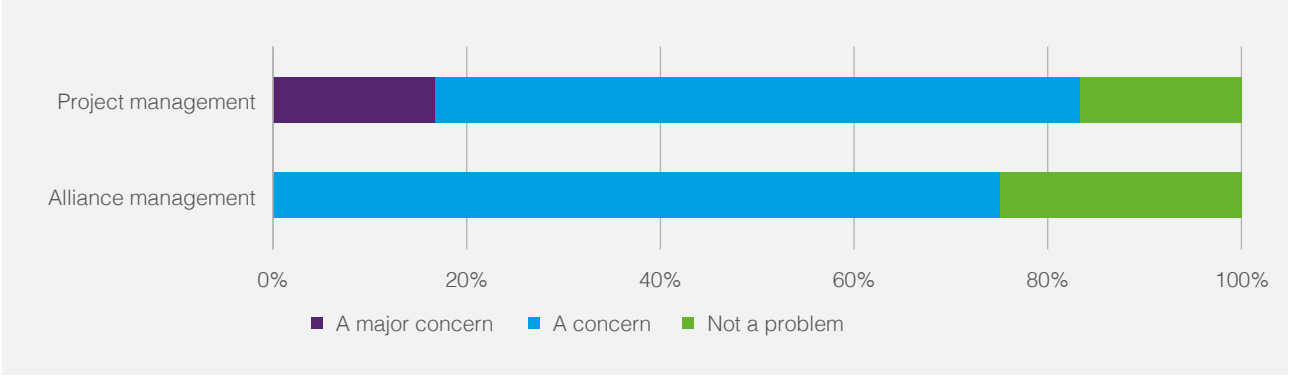


Figure 41: Percentage of respondents identifying a concern with the quality vs quantity of candidates for business areas (size of bubbles represents the number of respondents).

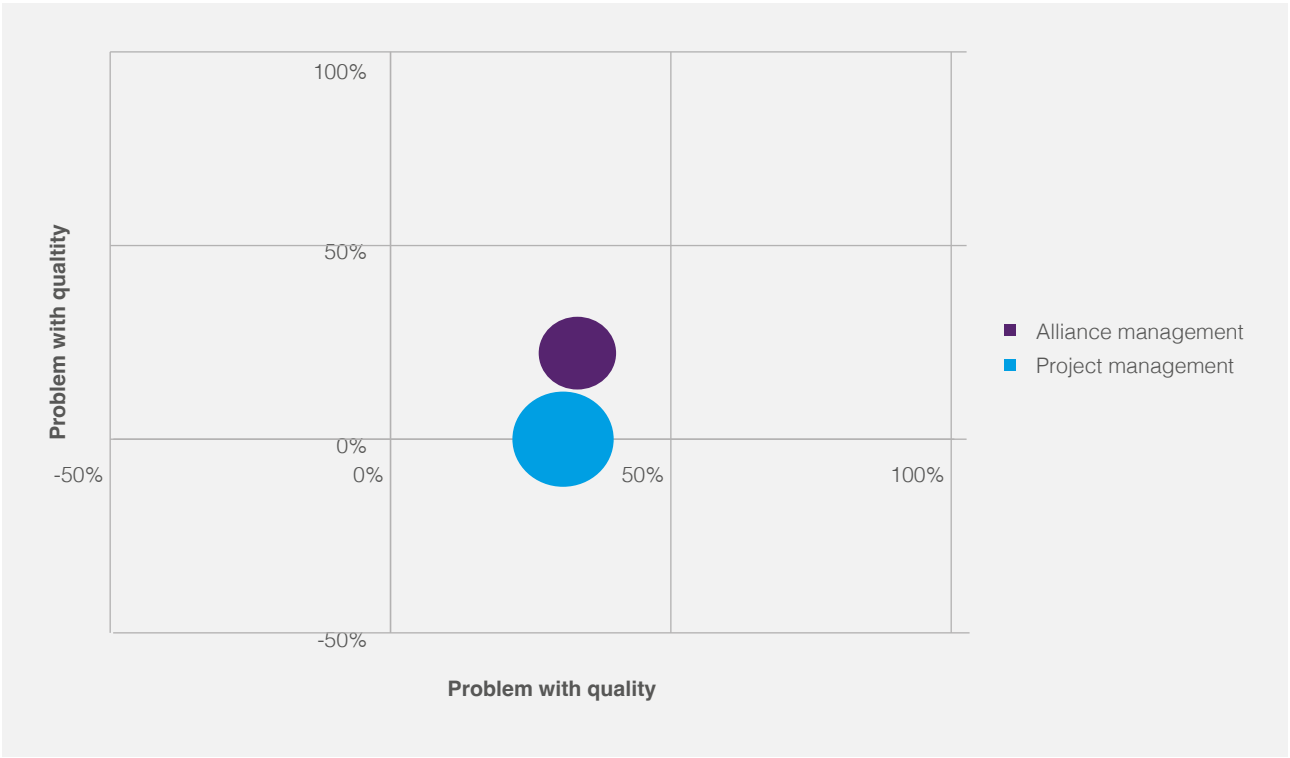


Table 18: Detailed results

Alliance management

Summary
Alliance Management is a relatively new role within the Life Science industry and arises with the need of the pharma industry to broadly collaborate instead of relying solely on its own R&D pipeline. The rise of Alliance Management is connected to the increasing number of partnerships from new product concept to licensing deals or potential mergers and acquisitions driven by the need to develop new products quickly, to reduce costs and gain access to new markets while limiting the risk exposure.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	A
Number		N/A	N/A	N/A	G
Staff	Non-graduate	N/A	N/A	N/A	G
	Graduate/MSc	N/A	N/A	N/A	G
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	G

Project management

Summary
Project management is a discipline that can be applied to all industries, regardless of the product or service they are designed to deliver. Beyond its basic application across various industries, project management has tremendous value when effectively implemented to significantly increase the success of the product or service being delivered. In the pharmaceutical industry, Project Management is the key to addressing the unique regulatory, compliance and quality related needs of the Particular industry. The process of drug development and the critical issue of time to market can capitalize on Project Management techniques to effectively apply Planning, Scheduling, Risk Management and Comprehensive Quality Assurance and Control to the process of bringing a drug to market in a cost-effective but with in the timeline.

Year		2008	2015	2018	2021
Quality		N/A	N/A	N/A	G
Number		N/A	N/A	N/A	G
Staff	Non-graduate	N/A	N/A	N/A	A
	Graduate/MSc	N/A	N/A	N/A	A
	Apprenticeship	N/A	N/A	N/A	G
	PhD	N/A	N/A	N/A	G
	Post-doc	N/A	N/A	N/A	G
	Experienced staff	N/A	N/A	N/A	R
Overall priority		N/A	N/A	N/A	G

Key

R	High priority - requires immediate action
A	Medium priority - requires action
G	Low priority - an important area to watch
N/A	Not applicable or not rated

Q = quality of candidates
N = number of candidates
Q, N, and recruitment level colour-coded according to the percentage of respondents identifying it as a concern (0 – 33% respondents considered low priority, 33 – 66% respondents considered medium priority and 66 – 100% respondents considered high priority)
Overall priority band colour-coded according to the priority level with the greatest percentage of respondents

Appendix 8: List of all subject areas

Those highlighted with a cyan ( ) marker recorded less than two responses and therefore were not analysed further.

Group 1

- Animal technology
- Biochemistry
- Biopharmaceuticals/biologics
- Biotechnology
- Drug metabolism and ADME
- Genomics
- Histology
- Human Genetics
- Immunology
- In vitro pharmacology
- In vivo pharmacology
- **In vivo physiology**
- Metabonomics
- Microbiology
- Molecular biology
- **Molecular/translational toxicology**
- **Necropsy**
- Neuroscience
- Protein & Peptide chemistry
- Proteomics
- Structural biology
- Toxicology
- Veterinary medicine
- Veterinary and toxicological pathology

Group 2

- Analytical chemistry/biochemistry
- Chemical biology
- Formulation science
- Materials science
- Medicinal and synthetic organic chemistry
- Physical chemistry
- Process chemistry
- **Protein & Peptide chemistry**
- **Structural chemistry**
- **Sustainable chemistry**

Group 3

- **Clinical pathology**
- Clinical pharmacology/translational medicine (to include: Clinical Pharmacology Scientists (non-medical); Physician Pharmacologists; Pharmacometricians (modellers))
- Clinical research operations – (to include: Trial Managers, AI and Machine Learning)
- Medical Information Scientists
- Medically qualified clinicians

Group 4

- Device technology
- Formulation
- Pharmacy (to include: formulation and manufacturing)

Those highlighted with a cyan ( ) marker recorded less than two responses and therefore were not analysed further.

Group 5

- **Biomedical imaging (including AI)**
- Bioinformatics/computational systems biology (to include: Human Genomics)
- Chemometrics
- Computational chemistry – (to include: Chemoinformatics)
- Computational science – (to include: Computer Science, modelling & simulation)
- Data science (to include: Data Management and Machine Learning)
- Epidemiology and pharmacoepidemiology -
- Health economics, outcomes, informatics and real world evidence
- Pharmacokinetic/ pharmacodynamics modelling -
- Physiological modelling
- Programming
- Statistics

Group 6

- Environmental, Health & Safety
- Pharmacovigilance
- Quality Assurance and Quality Control
- Qualified Person (QA)
- Qualified Person (QPPV)
- Regulatory Affairs
- Responsible Person (RP)

Group 7

- Engineering in manufacturing

Group 8

- **Biochemical engineering**
- Cell and gene therapy
- **Robotics**

Group 9

- Project management
- Alliance management

Appendix 9: Copy of survey

1. Name

2. Email address (in case of queries)

3. Job title

4. Name of company*

5. Industry sector: (select as many as apply)*

- Pharmaceutical or biopharmaceutical company
- Contract research organisation
- SME
- Other (please specify): *

6. Site postcode*

7. This response is on behalf of:*

- Company
- Site
- Department
- Individual
- Other (please specify): *

8. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- Animal technology
- Biochemistry
- Biopharmaceuticals/biologics
- Biotechnology
- Drug metabolism and ADME
- Genomics
- Histology
- Human Genetics
- Immunology
- In vitro pharmacology
- In vivo pharmacology
- In vivo physiology
- Metabonomics
- Microbiology
- Molecular biology
- Molecular/translational toxicology
- Necropsy
- Neuroscience
- Protein & Peptide chemistry
- Proteomics
- Structural biology
- Toxicology
- Veterinary medicine
- Veterinary and toxicological pathology
- None of these

9. In 2021, is there:*

- [ ] A problem with the quality of candidates
- [ ] A problem with the number of candidates
- [ ] A problem for the future
- [ ] Not a problem as I am aware

10. Is this:*

- [ ] Low priority – an important area to watch
- [ ] Medium priority – requires action
- [ ] High priority – requires immediate action

11. Does this affect Select as many as apply*

- [ ] Non-graduate recruitment
- [ ] Graduate/MSc recruitment
- [ ] Apprenticeship recruitment
- [ ] PhD recruitment
- [ ] Post-doc recruitment
- [ ] Recruitment of experienced staff
- [ ] None of the above

12. Are practical skills for this discipline:*

- [ ] A major concern
- [ ] A concern
- [ ] Not a problem

13. Please provide additional comments if you wish

129. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Analytical chemistry/biochemistry
- [ ] Chemical biology
- [ ] Formulation science
- [ ] Materials science
- [ ] Medicinal and synthetic organic chemistry
- [ ] Physical chemistry
- [ ] Process chemistry
- [ ] Protein & Peptide chemistry
- [ ] Structural chemistry
- [ ] Sustainable chemistry
- [ ] None of these

180. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Clinical pathology
- [ ] Clinical pharmacology/translational medicine (to include: Clinical Pharmacology Scientists (non-medical); Physician Pharmacologists; Pharmacometricians (modellers))
- [ ] Clinical research operations – (to include: Trial Managers, AI and Machine Learning)
- [ ] Medical Information Scientists
- [ ] Medically qualified clinicians
- [ ] Precision Medicine
- [ ] Registered Nurses (to include: Healthcare Practitioners and Nurses)
- [ ] None of these

216. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Device technology
- [ ] Formulation
- [ ] Pharmacy (to include: formulation and manufacturing)
- [ ] Medically qualified clinicians

232. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Biomedical imaging (including AI)
- [ ] Bioinformatics/computational systems biology (to include: Human Genomics)
- [ ] Chemometrics
- [ ] Computational chemistry – (to include: Chemoinformatics)
- [ ] Computational science – (to include: Computer Science, modelling & simulation)
- [ ] Data science (to include: Data Management and Machine Learning)
- [ ] Epidemiology and pharmacoepidemiology
- [ ] Health economics, outcomes, informatics and real world evidence
- [ ] Pharmacokinetic/ pharmacodynamics modelling
- [ ] Physiological modelling
- [ ] Programming
- [ ] Statistics
- [ ] None of these

293. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Environmental, Health & Safety
- [ ] Pharmacovigilance
- [ ] Quality Assurance and Quality Control
- [ ] Qualified Person (QA)
- [ ] Qualified Person (QPPV)
- [ ] Regulatory Affairs
- [ ] Responsible Person (RP)
- [ ] None of these

329. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Engineering in manufacturing
- [ ] None of these

335. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Biochemical engineering
- [ ] Cell and gene therapy
- [ ] Robotics
- [ ] None of these

335. Please select those disciplines you wish to comment on. If you do not wish to comment on any of those disciplines, please select the option at the bottom of the list.*

- [ ] Project management
- [ ] Alliance management
- [ ] Training
- [ ] None of these

367. **Do you wish to add information on any other discipline?***

- [ ] Yes
- [ ] No

368. **How many more disciplines do you wish to add information on? You will only be able to provide more information on maximum 2 disciplines, so if there are more than 2 you would like to comment on, please choose the 2 most important ones.***

- [ ] 1
- [ ] 2

381. **For new recruits; please indicate whether the following skills are currently problematic or not:***

	A major concern	A concern	Less of a concern now	Not a problem
Scientific knowledge	☐	☐	☐	☐
High level maths knowledge	☐	☐	☐	☐
Application of scientific, mathematical and digital knowledge	☐	☐	☐	☐
Problem solving skills	☐	☐	☐	☐
Communication skills	☐	☐	☐	☐
Team-working skills	☐	☐	☐	☐
Digital literacy	☐	☐	☐	☐

382. **For moving into Leadership or management roles, please indicate whether the following skills are currently problematic or not:***

	A major concern	A concern	Less of a concern now	Not a problem
Mentoring	☐	☐	☐	☐
Presentation	☐	☐	☐	☐
Supervising	☐	☐	☐	☐
Negotiating	☐	☐	☐	☐

367. Are there other general skills issues we should be aware of?
If there aren't any, please leave this question blank

☐	Skill issue 1: *	☐	Skill issue 6: *
☐	Skill issue 2: *	☐	Skill issue 7: *
☐	Skill issue 3: *	☐	Skill issue 8: *
☐	Skill issue 4: *	☐	Skill issue 9: *
☐	Skill issue 5: *	☐	Skill issue 10: *

How much of a concern are these skills issues?

A major concern	An increasing concern
☐	☐

384. For new recruits; please indicate whether the following skills are currently problematic or not:*

	Much more	More	About the same	Less	Much less	Do not recruit from this area
School leavers	☐	☐	☐	☐	☐	☐
Graduates	☐	☐	☐	☐	☐	☐
Apprentices	☐	☐	☐	☐	☐	☐
PhD/postdocs	☐	☐	☐	☐	☐	☐
Transferrers from other sectors	☐	☐	☐	☐	☐	☐

385. Thinking about your recruitment from the EU, are you recruiting more or less of the following compared to three years ago?*

	Much more	More	About the same	Less	Much less	Do not recruit from this area
School leavers	☐	☐	☐	☐	☐	☐
Graduates	☐	☐	☐	☐	☐	☐
Apprentices	☐	☐	☐	☐	☐	☐
PhD/postdocs	☐	☐	☐	☐	☐	☐
Transferrers from other sectors	☐	☐	☐	☐	☐	☐

386. Thinking about your recruitment from outside of the EU, are you recruiting more or less of the following compared to three years ago?*

	Much more	More	About the same	Less	Much less	Do not recruit from this area
School leavers	☐	☐	☐	☐	☐	☐
Graduates	☐	☐	☐	☐	☐	☐
Apprentices	☐	☐	☐	☐	☐	☐
PhD/postdocs	☐	☐	☐	☐	☐	☐
Transferrers from other sectors	☐	☐	☐	☐	☐	☐

387. In which regions do you recruit candidates? Select as many as apply*

- ☐ South East
- ☐ East of England
- ☐ North West
- ☐ London
- ☐ West Midlands
- ☐ Yorkshire and the Humber
- ☐ None of the above
- ☐ East Midlands
- ☐ Scotland
- ☐ Wales
- ☐ South West
- ☐ North East
- ☐ Northern Ireland

For each region, is there:*

A problem with the quality of candidates	A problem with the number of candidates	A problem for the future	Not a problem as far as I am aware
☐	☐	☐	☐

Is this*

Low priority - an important area to watch	Medium priority - requires action	High priority - requires immediate action
☐	☐	☐

Does this affect? (select as many as appropriate)*

Non-graduate recruitment	Graduate/ MSc recruitment	Apprentice recruitment	PhD recruitment	Post-doc recruitment	Recruitment of experienced staff	None of these
☐	☐	☐	☐	☐	☐	☐

388. **For each of the following, please indicate if you believe they pose a threat to job growth in your company in the next three years:***

	Not a threat to job growth	Minor threat to job growth	Major threat to job growth	Critical threat to job growth	Helps job growth
Brexit	☐	☐	☐	☐	☐
Availability of suitable candidates	☐	☐	☐	☐	☐
Covid	☐	☐	☐	☐	☐
Volume of health spending	☐	☐	☐	☐	☐
Availability of staff to manage recruitment/upskilling	☐	☐	☐	☐	☐
Preference to upskill existing staff	☐	☐	☐	☐	☐
Changes in global trade and investment environment	☐	☐	☐	☐	☐
Changing levels of government support for the industry	☐	☐	☐	☐	☐

389. **In your view, will Covid have an impact on the work-ready skills of the "class of 2020" school leavers and graduates?***

- ☐ Yes, a very negative impact
- ☐ Yes, a negative impact
- ☐ Will not have that much of an impact either way
- ☐ Yes, a positive impact
- ☐ Yes, a very positive impact
- ☐ Don't Know

390. What type of candidates are you most worried about being affected by the following issues, if any: (pick up to three per row)*

	Non-graduate recruitment	Apprenticeship recruitment	Graduate/MSc recruitment	PhD recruitment	Post-doc recruitment	Recruitment of experienced staff	None will be affected
Brexit	☐	☐	☐	☐	☐	☐	☐
Covid	☐	☐	☐	☐	☐	☐	☐
Lack of health spending	☐	☐	☐	☐	☐	☐	☐
Lack of available staff to manage recruitment/upskilling	☐	☐	☐	☐	☐	☐	☐
Changes in global trade and investment environment	☐	☐	☐	☐	☐	☐	☐
Automation of workforce	☐	☐	☐	☐	☐	☐	☐
Falling government support for the industry	☐	☐	☐	☐	☐	☐	☐

391. Which of the following groups, if any, do you think the Government is most focussed on supporting the education and job prospects of?*

- ☐ Non-graduates
- ☐ Apprentices
- ☐ Graduates/MSc
- ☐ PhD students
- ☐ Post-docs
- ☐ None of the above

392. Now a Brexit deal has been agreed, are you confident that you know what impact Brexit will have on your company's ability to recruit suitably skilled candidates?*

- ☐ Yes, I am very confident I know how Brexit will impact my business's access to suitably skilled workers
- ☐ No, I am not confident I know how Brexit will impact my business's access to suitably skilled workers

393. How will Covid affect the availability of suitably skilled candidates?*

- ☐ Increase availability a lot
- ☐ Increase availability a little
- ☐ Decrease availability a little
- ☐ Decrease availability a lot
- ☐ Don't know

394. Which parts of the industry/recruitment do you think has been the most impacted by Covid?
Please select up to three*

- ☐ Biological science areas
- ☐ Chemical science areas
- ☐ Clinical areas
- ☐ Pharmacy areas
- ☐ Informatics, computational, mathematical and statistics areas
- ☐ Regulatory areas
- ☐ Pharmaceutical engineering
- ☐ Development and translational science areas
- ☐ Business skills
- ☐ Other (please specify): *
- ☐ None of the above

395. Do you think that the drive for vaccines has improved the pharmaceutical industry's reputation as a potential employer?*

☐ Yes ☐ No ☐ Don't know

396. What type of candidates are you most worried about being affected by the following issues, if any:
(pick up to three per row)*

	I have used this strategy more during Covid than before Covid	I have used this strategy less during Covid than before Covid	I have not changed my use of this strategy	Don't know
Online interviews	☐	☐	☐	☐
Online tests	☐	☐	☐	☐
In person recruitment events	☐	☐	☐	☐
Online recruitment events	☐	☐	☐	☐
Recruitment agencies	☐	☐	☐	☐
Social media	☐	☐	☐	☐

397. How do you expect your recruitment strategies to change over the next three years?*

	I will use this strategy more over the next three years than I do at the moment	I will use this strategy less over the next three years than I do at the moment	I will not change my use of this strategy	Don't know
Online interviews	☐	☐	☐	☐
Online tests	☐	☐	☐	☐
In person recruitment events	☐	☐	☐	☐
Online recruitment events	☐	☐	☐	☐
Recruitment agencies	☐	☐	☐	☐
Social media	☐	☐	☐	☐

398. Has covid increased the need for any new skills in the following sectors?

Please select up to three*

- ☐ Biological science areas
- ☐ Chemical science areas
- ☐ Clinical areas
- ☐ Pharmacy areas
- ☐ Informatics, computational, mathematical and statistics areas
- ☐ Regulatory areas
- ☐ Pharmaceutical engineering
- ☐ Development and translational science areas
- ☐ Business skills
- ☐ Other (please specify): *
- ☐ None of the above

The Association of the British Pharmaceutical Industry

A company limited by guarantee registered in England & Wales number 09826787

Registered office 7th Floor, Southside, 105 Victoria Street, London SW1E 6QT

RMI-0128-0919

Design by tothepoint