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Skills for Biopharma

Researching and Forecasting the Current and Future Skills Needs of the Biopharma Sector in Ireland to 2027

Prepared by the EGFSN Secretariat

National Skills Council

Expert Group on Future Skills Needs

Contents

Acknowledgments 1

Introduction to the Expert Group on Future Skills Needs 2

Foreword 3

Executive Summary 4

1 Introduction 11

1.1 Objectives of the Study 12

1.2 Research Methodology 13

1.3 Outline of the Biopharma Sector in Ireland 14

1.4 Review of the International Biopharma Sector 18

2 Skills in the Biopharma Sector 20

2.1 Employment by Biopharma Subsector 21

2.2 Business Functions in Biopharma Subsectors 21

2.2.1 Manufacturing 21

2.2.2 Services 23

2.3 Scoping Biopharma Skills – Roles and Competencies 23

2.3.1 General Biopharma Roles 23

2.3.2 Biopharma Service Roles 25

2.4 Future Skills 27

2.5 Conclusion 28

3 Trends and Drivers of Biopharma Skills Demand 29

3.1 Growth Prospects and Trends for the Global Biopharma Sector 30

3.1.1 Global Growth Prospects 30

3.1.2 Global Trends 30

3.2 Growth Prospects and Trends for the Biopharma Sector in Ireland 31

3.2.1 Trends in the Biopharma Sector in Ireland 31

3.2.2 Employment Trends 33

3.2.3 International Recruitment and In-Demand Occupations 35

3.3 Broad Expert Insights 37
3.4 Specific Skills Shortages in Biopharma 38
3.4.1 Specific Skills Needs Identified in the Expert Interviews 38
3.5 Skills for Digital Transformation 39
3.6 Recruitment and Retention 40
3.7 Conclusion 42
4 The Supply of Skills 43
4.1 Funding and Oversight 44
4.2 Specialist Biopharma Training Providers 48
4.3 Further and Higher Education Providers 49
4.3.1 Higher Education (HE) Sector 49
4.3.2 Further Education and Training (FET) Sector 50
4.4 Graduate Numbers from HE and FET 51
4.4.1 HE and FET Graduates by Relevant Broad Field of Study 51
4.4.2 HE Graduates by Field of Study 53
4.4.3 HE and FET Graduates – All Fields of Study 54
4.5 Challenges and Opportunities 55
4.5.1 Challenges 55
4.5.2 Opportunities for Skills Enhancement 59
4.6 Conclusion 61
5 Forecasting Biopharma Skills Needs and Supply 62
5.1 Forecasting the Growth of In-Demand Occupations 63
5.2 Modelling Biopharma Employment Growth 2023-2027 65
5.3 Forecasting Graduate Inflow to Biopharma 2023-2027 70
5.4 Modelling Gaps between Skills Demand and Supply 2023-2027 71
5.5 Forecasting the Demand for Training, Reskilling and Upskilling of Existing Staff 2023-2027 72
5.6 Conclusion 74

6 Conclusion **75**

6.1 The Biopharma Sector and its Skills Needs 76

6.2 Modelling Gaps between Skills Supply and Demand to 2027 80

6.3 Challenges Identified 82

6.4 Opportunities for Skills Enhancement 83

6.5 Actions to be Taken 83

7 Recommendations **85**

1 Strengthening STEM Education in Schools 86

2 Increasing Capacity for Education & Training at Tertiary Level 86

3 Increasing Collaboration between Industry and Academia 87

4 Promoting Careers in Biopharma 87

5 Promoting New Pathways into the Sector 87

6 Developing Leadership and Transversal Skills 88

7 Growing Digital Skills 88

8 Accelerate the Development of Skills for ATMPs 88

9 Fostering an Environment of Diversity and Collaboration 88

10 Developing a Skills Framework and Further Skills Mapping 88

Appendix A: Terms of Reference **89**

Appendix B: Biopharma Companies Consulted **93**

Appendix C: Regional Workshops Agenda **94**

Appendix D: Steering Group Members **95**

Appendix E: Global Overview of the Biopharma Sector **96**

Appendix F: FET Learner Completions in Biopharma-related Courses 2016-2021 **99**

Appendix G: Glossary of Terms **100**

Figures and Tables

Figure 1.1:	Total Net Selling Value of production in selected sectors 2013-2021	16
Figure 3.1:	Employment growth in Biopharma subsectors 2016-2022	34
Figure 3.2:	Net additional employment by Biopharma subsector 2016-2022	34
Figure 3.3:	Employment permits issued to Chemical and Biopharma employers 20216-2023	35
Figure 4.1:	HE Graduates in relevant fields of study (broad ISCED classicisation, NFQ Level 6-10)	52
Figure 4.2:	FET major awards in relevant fields of study (broad ISCED classification)	52
Figure 4.3:	Combined FET and FET awards in relevant fields of study (broad ISCED classification, all NFQ levels)	53
Figure 4.4:	Awards by NFQ Level 2020 (all fields of study)	54
Figure 5.1:	Historical and forecast employment in selected standard occupational categories 2021-2027 (all sectors)	64
Figure 5.2:	Historical and forecast Biopharma employment growth 2017-2027 (all scenarios)	66
Figure 5.3:	Forecast Biopharma employment growth by subsector 2022-2027 (medium scenario)	68
Figure 5.4:	Total recruitment need (additional plus replacement jobs) by Biopharma subsector and growth scenario 2023-2027	70
Figure 5.5:	Forecast number of employees engaged in training, upskilling & reskilling (all scenarios) 2023-2027	72
Table 2.1:	Distribution of Biopharma employment by subsector	21
Table 3.1:	Employment trends in the Biopharma sector 2016-2022	33
Table 3.2:	Employment permits issued to Biopharma companies by SOC 2016-August 2023	36
Table 3.3:	Recruitment challenges by subsector/functional area	40
Table 3.4:	Ease of recruitment and retention in Manufacturing subsectors	41
Table 3.5:	Ease of recruitment and retention in Services subsectors	42
Table 4.1:	Enrolment trends in selected Apprenticeships relevant to Biopharma 2019-2022	47
Table 4.2:	Innopharma Enrolments 2022-2023	49
Table 4.3:	GetReskilled Awards 2018-2022	49
Table 4.4:	FET major awards in STEM disciplines 2019-2022	50
Table 4.5:	Change in graduate numbers from HE and FET courses by field of study (broad ISCED)	53
Table 4.6:	Science/Engineering Awards and potential employment by NFQ level and detailed ISCED field, 2020	54

Table 4.7:	Estimated number of Graduates entering Biopharma Sector in 2020, by NFQ level	55
Table 5.1:	Historical and forecast employment in relevant standard occupational categories 2017-2027 (all sectors)	64
Table 5.2:	Forecast employment growth in Biopharma within high, medium and low growth scenarios to 2027	67
Table 5.3:	Total Recruitment Need – Additional jobs created plus replacement demand 2023-2027	69
Table 5.4:	Forecast growth trend in awards and graduate entry to the Biopharma sector based on analysis of annual graduate data (all disciplines)	70
Table 5.5:	Gap between total recruitment demand (growth plus replacement) and graduate entry 2023-2027	71
Table 5.6:	Employees needing training, reskilling & upskilling (all scenarios) 2023-2027	73
Table 6.1:	Employment trends in the Biopharma sector 2016-2022	78
Table 6.2:	Forecast employment growth in Biopharma to 2027 (medium scenario)	79
Table 6.3:	Total forecast recruitment need 2023-2027: Additional jobs created plus replacement demand (medium scenario)	80
Table 6.4:	Forecast gap between total recruitment demand (growth plus replacement) and graduate entry 2023-2027	81

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The EGFSN Secretariat, based in the Department of Enterprise, Trade and Employment, oversaw the research for the study and was responsible for the management and final writing of the report. The EGFSN Secretariat would like to thank Cruinn Advisory, whose work included the delivery of regional workshops, expert interviews and aspects of the statistical analysis and drafting. Finally, the EGFSN Secretariat also like to thank Dr Jim Ryan for his assistance with the drafting of the final report.

Introduction to the Expert Group on Future Skills Needs

The Expert Group on Future Skills Needs (EGFSN) advises the Irish Government on the current and future skills needs of the economy and on other labour market issues that impact on Ireland's enterprise and employment growth. It has a central role in ensuring that labour market needs for skilled workers are anticipated and met.

Specifically, the EGFSN:

- Carries out research, analysis and horizon scanning in relation to emerging skills requirements at thematic and sectoral levels. Steering Groups comprising of experts from relevant enterprise sectors and the education and training sector may oversee sectoral research studies to be undertaken or commissioned by the EGFSN. Drawing on statistical input and analysis from the SLMRU and consultation with the enterprise/ education experts as part of the study, draft reports setting out the projected needs are prepared by the EGFSN.
- Engages with the HEA, SOLAS, QQI, the Regional Skills Fora, and education and training providers in the course of its research.
- Engage with DFHERIS, the HEA, SOLAS and other relevant bodies to produce agreed action plans to address the skills needs identified.
- Submits the findings of its research and agreed Action Plans to the National Skills Council prior to publication.
- Disseminates its findings to the Regional Skills Fora and other relevant groups.

The Enterprise Strategy, Competitiveness and Evaluations Division within the Department of Enterprise, Trade and Employment provides the EGFSN with research and analysis support.

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Foreword

The Biopharma sector is a central component of the Irish economy and continues to grow strongly, with pharmaceuticals accounting for 32% of Irish industrial exports in 2022, with a value of €42.3 billion. It includes both manufacturing and services activities. Biopharma manufacturing can be divided into so-called Small Molecule (synthetics) and Biologics (large molecule). Services subsectors include Global Business Services, Biopharma Services and Specialty Pharma Services. The report maps the main occupations in a Biopharma company. These include, among others, research and development, production, regulatory affairs, quality control, supply chain planning and occupational health and safety.

This research seeks to provide valuable insights into the current state of Biopharma skills supply and demand, identifying key trends, challenges, and opportunities for growth. By identifying the skills gaps that exist within the industry and offering recommendations for addressing them, we aim to empower stakeholders to take steps towards building a more robust and resilient Biopharma workforce.

The biggest driver of growth in the sector has been the growth of biologic therapies, with employment in this subsector having increased by 98% since 2016, while Advanced Therapeutic Medicinal Products (ATMPs) or Cell and Gene Therapies (CGTs) are emerging as an important area of future growth. Traditional Small Molecule manufacturing has also continued to grow significantly in recent years.

Ireland is also emerging as an important global hub in the provision of services in Biopharma, with employment growth in services subsectors growing more rapidly (11%) than in manufacturing (8%) over the past six years. Also driving skills demand are the increasing need for digitalisation of operations, the growth of personalised medicine, and increased process automation and robotics. The number of employment permits issued to the sector grew by 400% between 2016 and this indicates the scale of the skills demand from Biopharma, the importance of attracting international talent and the challenges of meeting the demand for skills from Ireland's education and training system.

In 2016 the EGFSN published a report on skills in the Biopharma sector predicting substantial employment growth. The sector has grown even more strongly than expected since then, with more than 60% employment growth between 2016 and 2022. There were almost 50,000 people employed directly in the sector by 2022, the base year for this study.

This growth is expected to continue, with international forecasts for the sector ranging between 5% and 9% annual growth globally. The report models future Biopharma employment growth in high, medium and low growth scenarios, and estimates that more than 21,000 additional Biopharma jobs could be created by 2027 in a medium growth scenario. Average annual recruitment into the sector is forecast to be more than 5,600 out to 2027, according to the same scenario. An average annual shortfall of 3,000 is projected between this demand and the predicted number of graduates entering the sector, if nothing changes.

A range of actions will be needed to address the projected recruitment shortfall, as well as the need to upskill and reskill existing staff. Collaboration between industry and the education and training sector will be key to ensuring a good match between the demand for skilled workers and supply. The sector needs to promote careers more effectively, as well as to develop new pathways into careers. The education and training sector must have the capacity to respond to skills needs articulated by industry and additional investment may be needed. Strengthening STEM education in schools is also essential to underpinning progress. Stakeholders interviewed for this study highlighted many other opportunities for increasing skills supply to the sector, including increased use of micro-credentials, growing apprenticeships and the development of a sectoral skills framework. These priorities are reflected in a series of recommendations made in the report.

I would like to thank the project Steering Group for its time, effort and enthusiasm throughout the project. In particular, our thanks go to Patricia Quane who chaired the Group and provided leadership for the process. A sub-group of Steering Group members was instrumental in ensuring that the report was effectively drafted. The EGFSN looks forward to working with an Implementation Group to drive the actions set out in the report's recommendations over the next two years.

Tony Donohoe
Chair, Expert Group on Future Skills Needs

Executive Summary

Introduction: Objectives and Methodology

Biopharma is a strategically important and rapidly growing component of the Irish economy and is well-placed to grow further. International analysts predict global annual growth rates of 5-9% for the industry.

There are over 85 multinational and indigenous companies active within the sector in Ireland which directly employ around 50,000 highly skilled people- with this number having grown by 61% since 2016. A further 40,000 jobs across the wider are estimated to be indirectly supported by the sector. Based on the three growth scenarios (low, medium and high) developed for this report, it is estimated that the additional jobs in the Biopharma sector in Ireland will be in the range of between 14,000 to 26,000 over the next 5 years.

The availability of a highly skilled workforce and supportive skills ecosystem have, together with factors such as a competitive business environment, been pivotal in Ireland's ability to capitalise on the opportunities afforded by growth of the Biopharma sector globally. Ensuring that Ireland continues to benefit requires that staff are available in sufficient numbers with the necessary skills to meet the constantly evolving needs of the sector.

This report is a detailed assessment of current and future skill needs and provides projections of the scale and nature of future needs. It also reviews trends within the sector which may affect these skill needs; graduate availability; the infrastructure for education and training; and other relevant issues. To achieve this, the report adopts a multi-pronged approach, including the following elements:

- Qualitative data from company interviews, surveys and three regional workshops including representatives of industry, academia and training providers and public bodies.
- Statistical analysis of employment trends, skills supply and a forecasting exercise modelling future employment growth for the Biopharma sector and its subsectors to 2027, quantifying gaps between skills demand and supply in the context of high, medium and low growth scenarios.
- A review of relevant reports and studies was carried out to identify global trends and drivers of change; particularly focusing on skills challenges and innovative approaches to their solution.

The Biopharma sector encompasses companies involved in discovery, development, production of both small molecule and large molecule pharmaceutical products and their active pharmaceutical ingredients, and in the provision of a diverse range of service activities. To best reflect Ireland's niches within this global value chain, this study focusses on the skills needs of companies engaged in one or more of the following activities:

1. Small Molecule Manufacturing (including synthetic pharmaceuticals and non-pharmaceutical chemicals)
2. Biologics/Large Molecule Manufacturing
3. Other Manufacturing Activities
4. Services Activities, including:
   - » Global Business Services
   - » Biopharma Services
   - » Specialty Pharma Services

Skills Demand in the Biopharma Sector

Scoping Biopharma skills: Roles and competencies

The continued future growth of companies in each of these subsectors necessitates a continuing supply of both new graduates and experienced staff with the appropriate scientific, technical and transversal skills, and support for companies in upskilling and reskilling existing personnel through internal and external training. The report identifies the main personnel roles and occupations found in a typical Biopharma company and catagorises them into six broad functional areas, namely:

- Research & Development
- Production
- Regulatory Affairs
- Quality Control
- Supply chain/Procurement/planning
- Environmental/Occupational Health & Safety

The distinctive skills needs of the Biopharma Services and Global Business Services subsectors are also evaluated.

Trends and drivers of skills demand

The single most significant driver of growth in, investment, employment and skills demand in the Biopharma sector globally has been, and will continue to be, the growth of Biologic therapies- particularly monoclonal antibodies. This international trend is reflected very well in Ireland. Relatedly, Advanced Therapeutic Medicinal Products (ATMPs), also known as Cell and Gene Therapies (CGTs), are emerging as important areas of future growth opportunity, bringing with them new skills challenges which must be met if Ireland is to fully capitalise on the opportunities represented by these developments in the years ahead. Nevertheless, while much attention has been focussed on the growth Biologics and other advanced therapies, traditional synthetic, small molecule pharmaceutical manufacturing continues to grow nationally and internationally and will remain a major source of skills demand in Ireland. The provision of global business services, Biopharma services and Specialty Pharma services with their diverse skills needs have also experienced high rates of growth since 2016, with this rapid growth expected to continue.

Beyond the major areas of subsectoral growth trends driving skills demand across the Biopharma sector, trends and drivers affecting skills needs include the increasing digitalisation of operations; the growth of personalised medicine, and the consequent increase in more specialised therapies; and increased process automation and robotics which has led to a major need for AI, digital and data skills. There has also been greater use of sub-contracting in manufacturing and the growth of service companies which has increased demand for further types of skills, as has the growing salience of environmental sustainability across the industry as a whole.

Employment trends

Employment in the Biopharma sector in Ireland sector grew by 61% at a rate of 8% CAGR between 2016 and 2022, resulting in the creation of nearly 19,000 bet additional jobs. The highest rates of employment growth were seen in Biologics manufacturing (12% CAGR), followed by Biopharma Services (11%), Global Business Services and Specialty Pharma Services (both 10% CAGR).

In terms of net employment growth, Biologics manufacturing saw highest number of additional jobs created (8,928), followed by small molecule manufacturing (4,367) and Biopharma Services (3,232).

Employment trends in the Biopharma sector 2016-2022					
	Employed 2016	Employed 2022	CAGR	% Change	Total Additional Jobs
Manufacturing	**24,484**	**37,949**	**8%**	**55%**	**13,465**
Biologics	9,152	18,080	12%	98%	8,928
Small Molecule	13,984	18,351	5%	31%	4,367
Other Manufacturing	1,348	1,518	2%	13%	170
Services	**6,311**	**11,621**	**11%**	**84%**	**5,310**
Global Business Services	944	1,752	10%	86%	808
Biopharma Services	4,100	7,332	11%	79%	3,232
Specialty Pharma Services	1,267	2,537	10%	100%	1,270
Grand Total	**30,795**	**49,570**	**8%**	**61%**	**18,775**

Source: IDA/EI

Trends in international recruitment to the sector are also analysed, using employment permit data to highlight the most in-demand occupational categories in the sector and the importance of international recruitment in enabling the sector to meet its skills needs. This analysis found a marked increase in the inflow of skilled personnel from outside the EEA into the sector in Ireland since 2016, with the number of permits issued to Biopharma companies increasing by over 400% between 2016 and 2023. Nearly 3.000 employment permits were issued for over 80 occupational categories across a diverse range of manufacturing and service roles during this period.

Expert insights

Biopharma company interviews, surveys and regional workshops revealed the challenges faced by companies in the sector in attracting and retaining talent, a shortage of new graduates with core skills; difficulty in attracting international talent including senior directors due to housing shortage and other infrastructural issues; shortage of data and digital skills; and greater demands by candidates for flexible working and career development pathways.

The specific skills challenges identified through the industry interviews include:

- Changes in manufacturing technologies, and digitalisation of processes and systems create a need for staff with data management and digital skills in addition to core manufacturing skills.
- Innovation and R&D skills for new product development and for drug delivery
- QC and regulatory skills
- Transversal skills including project management, technical writing and team working, and
- Skills for Digital Transformation

These needs must be addressed through changes in degree course content, and by upskilling of existing staff.

The Supply of Skills

The report outlines the mechanisms that support training; the organisations that coordinate and fund these activities; and the education and organisations providing the training. The National Training Fund supports skill development through funding of programmes and initiatives such as Springboard+, apprenticeships and the Human Capital Initiative. The delivery of this training is mainly provided by the Higher Education (HE) and Further Education and Training (FET) sectors, as well as specialist education providers such as Biopharmachem Skillnet, NIBRT, GetReskilled and Innopharma. The number of suitable graduates that were available for employment in the sector in 2020 is estimated at between around 1,750 and 1,900, depending on the calculation used.

Stakeholder engagement highlighted several challenges in terms of skills supply, including:

- The availability of new talent
- The continuing development of the talent pool
- Competition for skills between Biopharma firms and other economic sectors
- Promoting STEM and careers in Biopharma at primary and post-primary levels
- Growing apprenticeships

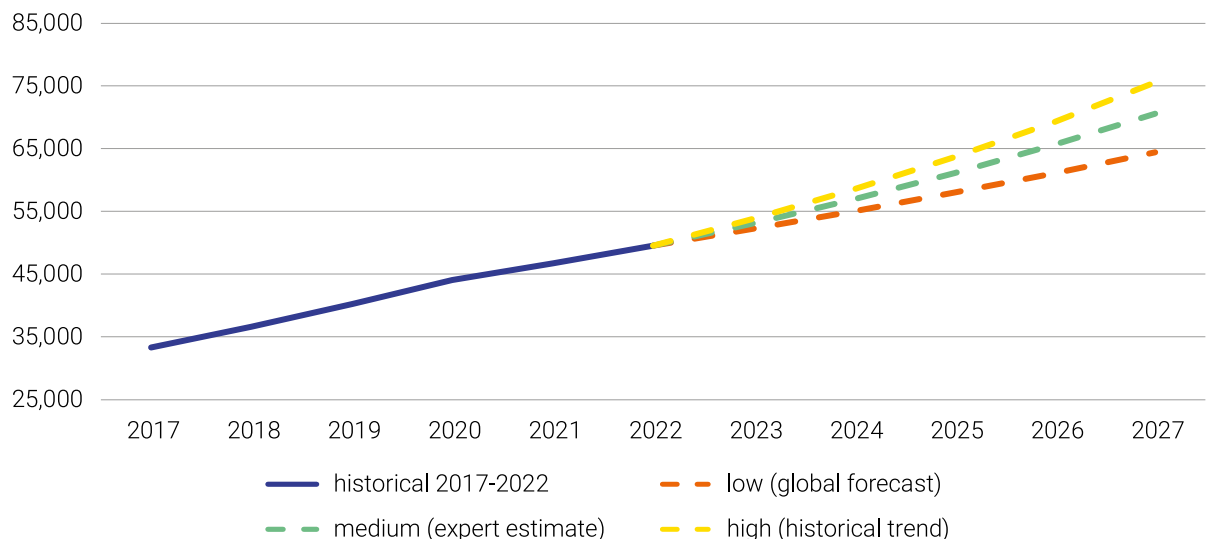
Significant opportunities for enhancing skills supply are also identified, including:

- Increased collaboration between industry and academia to better understand the skills needs of the sector and to develop new pathways into the sector, such as apprenticeships tailored to meet the needs of the industry and new and more responsive and flexible models of education and training delivery.
- The development of a skills and career pathways framework for the sector
- Increased use of micro-credentials
- Creating new pathways to Higher Education

Forecasting Gaps Between Skills Demand and Supply 2023-2027

Modelling skills demand 2023-2027: Employment growth, replacement demand and reskilling/ upskilling

Historical and forecast Biopharma employment growth 2017-2027 (high, low and medium growth scenarios)



Source: EGFSN analysis

The report presents forecast models for future demand for skills using three scenarios for sectoral growth factoring in both net additional jobs generated by the growth of the sector, and replacement demand estimated at 2.4%. The forecasts are based on analysis of current employment trends, patterns of graduate employment, and other wider trends in the labour market and in the industry. Low, medium and high scenarios of future growth (from 5.39 – 8.3% CAGR) were modelled. Based on these models, the average annual recruitment needs of the sector in 2023-27 will range from 4,372 (Low growth) to 6,744 in a high growth scenario. Within this total, the major areas for skill demand will be in manufacturing (ranging from 3,347 to 4,820 in the three scenarios) while the service companies need will range from 1,025 to 1,924. This analysis is complemented by output from company interviews and surveys.

Total forecast Biopharma recruitment need 2023-2027: Additional jobs created plus replacement demand (medium scenario)				
	Total Additional Jobs	Total Replacement Jobs	Total Recruitment Needed	Average Annual Recruitment
Manufacturing	**14,119**	**5,516**	**19,635**	**3,927**
Biologics	11,038	2,914	13,952	2,790
Small Molecule	2,923	2,408	5,331	1,066
Other Manufacturing	158	193	351	70
Services	**6,912**	**1,861**	**8,774**	**1,755**
Global Business Services	1,070	282	1,352	270
Biopharma services	4,476	1,182	5,658	1,132
Specialty Pharma Services	1,366	397	1,764	353
Grand Total	**21,031**	**7,377**	**28,408**	**5,682**

Source: EGFSN analysis

In addition to new recruits, firms must also reskill and/or upskill their existing and future employees, particularly as it is forecast that demand for many roles especially relevant to Biopharma will grow significantly across the whole economy in the coming years, generating additional competition within the Biopharma sector and from other sectors in terms of talent attraction. The review suggests that over the period 2023-2027, the sector must invest in formal and informal training for between 43,639 and 48,139 staff, (or 8,728 – 9,628 per annum), depending on the growth scenario.

Modelling gaps between skills demand and supply 2023-2027

Forecast trend in awards and graduate entry to the Biopharma sector (all disciplines)								
	2020	2021	2022	2023	2024	2025	2026	2027
Awards from level 4/5 upwards – all disciplines	134,003	141,507	149,432	157,800	166,637	175,968	185,822	196,228
% entering employment	72%	72%	72%	72%	72%	72%	72%	72%
Graduates into employment (n)	97,089	101,885	107,591	113,616	119,978	126,697	133,792	141,284
Of which 15% entering NACE B-E (n)	14,464	15,283	16,139	17,042	17,997	19,005	20,069	21,193
Of which 14% entering Biopharma (n)	**2,025**	**2,140**	**2,259**	**2,386**	**2,520**	**2,661**	**2,810**	**2,967**

Source: EGFSN analysis of SMLRU and HEA data, 2023

Graduate output and entry into employment in the Biopharma sector to 2027 is modelled in the report, as shown in the table above (all awards, NFQ level 4/5 to 10, all disciplines). Using this supply forecast in combination with the high, low and medium employment growth scenarios, an estimated skills gap- the difference between the forecast recruitment needs of the sector and forecast graduate entry- can be quantified. Based on the medium forecast scenario, the Biopharma sector will need to recruit an average of 5,682 jobs per annum to meet the increasing need and to cover replacement demand. The table below shows that the potential supply of new entrant graduates will average around 2,670 per annum, resulting in an estimated potential shortfall of around 3,000 per annum if the sector were to rely solely on the domestic skills supply pipeline as its source of future skills.

Gap between total recruitment demand (growth plus replacement) and graduate entry 2023-2027							
	2023	2024	2025	2026	2027	Total 2023-2027	Average 2023-2027
Forecast recruitment demand (net growth+ replacement)							
High: Historical Trend	5,550	6,087	6,681	7,337	8,065	33,720	6,744
Medium: Expert Estimate	4,800	5,201	5,640	6,121	6,646	28,408	5,682
Low: Global Forecast	3,926	4,137	4,360	4,595	4,843	21,861	4,372
Estimated annual graduate entry to employment in Biopharma	2,386	2,520	2,661	2,810	2,967	13,343	2,669
Estimated gap between Biopharma demand/graduate entry							
High: Historical Trend	-3,164	-3,567	-4,020	-4,528	-5,098	-20,377	-4,075
Medium: Expert Estimate	-2,414	-2,682	-2,980	-3,311	-3,679	-15,066	-3,013
Low: Global Forecast	-1,540	-1,618	-1,700	-1,786	-1,876	-8,518	-1,704

Source: EGFSN analysis

Not all recruitment to the sector will consist of new graduates produced by Ireland's education and training system, and many vacancies will be filled through international recruitment, recruitment from other sectors, with many positions requiring more experienced personnel. However, the modelling exercise nevertheless highlights the challenge for the industry, public policy and the education and training system in terms of meeting the evolving skills demands of the industry, particularly once the growing demands for the upskilling and reskilling of existing staff is also taken into account- a set of challenges which must be met if the Biopharma sector in Ireland is to realise its full growth potential in the coming years.

Conclusion

The data gathered in this report is used to present historical and projected employment growth and skills supply for the Biopharma sector, and the gaps between the two. Policy and labour interventions are explored which seek to support relevant skill development initiatives and address the skills gap identified in the report. Challenges to fulfilling skill needs broadly centre around the quantity and quality of the available talent pool, and the extent of competition from other sectors for talent, in particular for IT skills. Opportunities explored to meet the needs include greater collaboration between industry and academia; creation of better pathways from FET to HE qualifications, and greater use of Micro-credentials.

Based on all these inputs, the report makes a series of recommendations regarding which specific action must be taken. These recommendations are grouped into ten areas for priority action, namely:

Strengthening STEM Education in Schools

Increasing the Capacity for Education and Training at Tertiary level

Increasing Collaboration between Industry and Academia

Promoting Careers in Biopharma

Promoting New Pathways into the Sector

Developing Leadership and Transversal Skills

Growing Digital Skills

Fostering an Environment of Diversity and Collaboration

Accelerate the Development of Skills for ATMPs

Developing a Skills Framework and Further Skills Mapping

1

Introduction

1.1 Objectives of the Study

A review and forecast of the future manufacturing and services skills needs in the Biopharma sector is vital to ensure that this important industrial sector can realise its full growth potential. To this end the study identifies likely skills gaps (i.e., the difference between forecasted supply and demand) and makes specific, measurable and time-bound recommendations to address these gaps in the period 2023-2027. A combination of economic analyses and qualitative evidence from both primary and secondary sources was used to develop these forecasts.[1]

The study consists of the following elements:

- A profile of the Irish Biopharma sector and its manufacturing and services subsectors in an international context and an analysis of the current and emerging technical, transversal and transformational skill sets and competencies that will be required by the sector up to 2027.
- An assessment of the growth trajectory of the Biopharma sector and its subsectors during this period, and an exploration of the key global and domestic drivers of change.
- A quantitative and qualitative review of existing skills supply channels such as Higher Education (HE) and Further Education and Training (FET) as both a pipeline for new entrants to the sector and means of upskilling and reskilling existing workers. Pathways considered include the outputs of the FET, HE and industry-led training systems from National Framework of Qualifications (NFQ) Level 5 upwards; transitions between these stages; transitions from education and training to industry, and the role of economic migration in skills supply.
- A skills demand and supply forecast within 3 growth scenarios (high, medium and low) to identify and quantify the likely employment growth and gaps between skills supply and demand in the sector over the period 2023-2027.
- A series of specific and measurable recommendations are proposed to address the defined skills gaps; with a lead agency or stakeholder from Government, public body, industry body or the education and training system identified to implement each recommendation.
- A formal group will be established with the administrative support of the EGFSN Secretariat to coordinate and periodically review implementation of the recommendations for a period of two years.

The Biopharma sector encompasses companies involved in discovery, development, production and sale of chemicals, small molecule and large molecule pharmaceutical products and their active ingredients and in the provision of a diverse range of service activities. These activities are further elaborated in Section 1.3. To best reflect Ireland's niches within this global value chain, this study will focus on the skills needs of companies engaged in one or more of the following activities:

1. Small Molecule Manufacturing (including synthetic pharmaceuticals and non-pharmaceutical chemicals)
2. Biologics/Large Molecule Manufacturing (including Advanced Therapeutic Medicinal Products and Cell and Gener Therapies)
3. Other Manufacturing Activities
4. Services activities, including:
   - » Global Business Services
   - » Biopharma Services
   - » Specialty Pharma Services

1. Full project terms of reference can be found in Appendix A.

The study builds on the 2016 report of the Expert Group on Future Skills Needs (EGFSN), Future Skills Needs of the Biopharma Industry in Ireland[2]. Since then, the Biopharma sector in Ireland has seen growth and performance that has outpaced the wider economy in terms of job growth and investment.

1.2 Research Methodology

The study adopted a mixed-methods approach, using both quantitative and qualitative data analysis at different stages[3]. These approaches are elaborated below.

Qualitative Data: Expert Interviews and Regional Workshops

Qualitative data was gathered on the workforces of 25 Biopharma companies in the Manufacturing and Services subsectors. The data collection involved interviews with 75 expert personnel, including Chief executives, managing directors, senior management teams, human resources (HR) and operations leads. These interviews focused on skills development (upskilling/reskilling); learning modalities used (e-learning/in-person); hiring strategies (recruitment/retention); training offerings (on-the-job/outsourced) and on the challenges faced in meeting current and anticipated skills needs. A full list of the companies consulted for this study can be found in Appendix B.

In addition, three regional workshops were organised in Athlone, Cork and Dublin in September and October 2022. These were attended by 87 stakeholders from industry, education and training providers, Government departments and other public bodies. Current and future skills challenges, and potential solutions were discussed. The potential for developing a sectoral and subsectoral skills framework for the industry was also explored. The agendas for these workshops can be found in Appendix C.

Statistical Analysis

Key industry statistics from the Central Statistics Office (CSO) were analysed over a five-year period to identify trends in employment in occupations relevant to the Biopharma sector. The Department of Enterprise, Trade and and Employment's (DETE) Annual Employment Survey (AES) of IDA Ireland and Enterprise Ireland (EI) client firms was identified as the most robust source of data for employment trends for the sector, and for its manufacturing and services subsectors. This data was used to establish the baseline employment levels that informed employment forecasts in high, medium and low growth scenarios for the sector over the period 2023-2027. Supply-side data obtained from the Higher Education Authority (HEA), Quality and Qualifications Ireland (QQI) and the Skills and Labour Market Research Unit (SLMRU) at SOLAS[4] was also analysed. This analysis included estimation of the proportion of graduates between NFQ levels 5-10 entering the sector from the overall supply pipeline; and assessment of gaps between forecast skills demand and supply across the three growth scenarios outlined in Section 5.4.

Additionally, employment permit data from DETE[5] was analysed for the period 2016-2023 to identify the scale of economic migration from outside the European Economic Area into the Irish Biopharma sector. This data is illustrative of both the critical skills shortages within Ireland's labour market affecting the Biopharma sector, and of the value of economic migration as a means of addressing these shortages.

2. EGFSN (skillsireland.ie)
3. Expert interviews, regional workshops and aspects of data collection, statistical analysis/forecasting were delivered by Cruinn Advisory Ltd.
4. Higher Education Authority (www.hea.ie) / SOLAS (www.solas.ie) / Quality and Qualifications Ireland (www.qqi.ie)
5. Department of Enterprise, Trade and Employment (DETE) Critical Skills Occupations

Literature Review

A review of relevant reports and studies was carried out to identify global trends and drivers of change; particularly focusing on skills challenges and innovative approaches to their solution. This review sought to identify practices that Ireland might usefully employ to ensure a sustainable and resilient pipeline of future talent to meet sectoral growth.

Project Governance and Validation

The project was overseen by a steering group representative of industry, academia, education and training providers and relevant Government departments and state agencies. This group reviewed the research findings and validated the recommendations of the report. A list of steering group members can be found in Appendix D.

1.3 Outline of the Biopharma Sector in Ireland

Biopharma is a term used to describe the wide sector comprising pharmaceutical and chemical industries and their service suppliers. For the purposes of this report, the Biopharma sector comprises firms involved in: (a) manufacture of small molecule chemical pharmaceuticals by chemical synthesis or extraction; (b) manufacture of large molecule pharmaceuticals, or biologics; and (c) the provision of services.

The Biopharma industry is one of the most important and successful sectors of the Irish economy and it has seen significant growth in the past ten years. There are over 85 companies active within the sector which directly employ around 50,000 highly skilled people, with perhaps over 40,000 additional jobs across the wider economy supported by the sector[6]. Based on the three growth scenarios (low, medium and high) developed for this report and detailed in Chapter 5, it is estimated that the additional jobs in the Biopharma sector in Ireland will be in the range of between 14,000 to 26,000 over the next 5 years.

In considering sectoral growth issues, it is useful to place the Irish pharma sector activities in a global context. This is further elaborated in Section 1.4. The pharmaceutical development and production pathway is long and expensive and is mainly concentrated within very large companies. These companies typically divide the drug development pathway into separate functions which are distributed in different locations. The pathway starts with 'discovery', which is the identification of potential new therapies using internal or external R&D resources; promising leads from this stage are subjected to extensive trials of efficacy and safety at successive levels from animal to human; this is followed by a process of seeking regulatory approval for the output of these trials; followed by their manufacture and sale. While all these functions require mutual interaction and coordination, they are typically distinct and (within the large companies) may be located in different countries. Ireland's main strength within this global network is in manufacture, and in certain service functions.

Manufacturing Companies

In the very early phase of the development of the Irish sector, companies were predominantly engaged in manufacture of small molecule pharmaceuticals, with a small number engaged in non-pharma chemicals. These early entrant companies mainly used chemical processes to make Active Pharmaceutical Ingredients (APIs), which are the small molecules that are the basis of a particular therapy. Some were also involved in combining the API with other ingredients to manufacture a finished pharmaceutical product, generally administered in oral solid dose form (tablet, capsule etc.).

However, the nature of pharmaceuticals rapidly changed during the latter part of the 20th century. Advances in biological science and biotechnology facilitated the creation of significantly different therapies, which necessitate completely novel manufacturing and finishing techniques. As a result, the Irish manufacturing base has expanded to include both small molecule manufacturing and biologically based large molecule production.

6. Based on a conventional multiplier of 0.8 indirect jobs supported by 1 person directly employed in the sector. In the case of Biopharma, IDA Ireland suggests that this is likely to be an underestimate of the total jobs across the economy supported by the industry.

The resulting products, called biologics, are based on living organisms (e.g., micro-organisms, cells, or tissues), by-products or components of living organisms, or new constructs which mimic biological functions (e.g., vaccines or antibodies). Manufacture of these biologic products requires a diverse range of skills, most of which are not shared with the chemical synthesis industries. Because of the exciting new therapies being created, biologics are a major global area of sectoral growth. Ireland has made significant strides to become a globally recognised centre of excellence for innovation and development, and for manufacture, of such biologic products. In 2003 Ireland hosted only two biologics manufacturing sites, whereas now there are over 20 such sites within the country and they employ over 18,000 staff.

In summary, Irish manufacturing activity began in the 1960s when Irish company Elan Corporation was formed to develop drug delivery technologies; and Pfizer established their plant in Cork. The industry base has now grown to comprise over 85 multinational companies, including plants for 8 out of the 10 largest global biopharmaceutical and chemical companies. It also comprises many indigenous Biopharma businesses including TopChem Pharma, EirGen, APC/VLE, Chanelle and Shorla and their number is expected to increase.

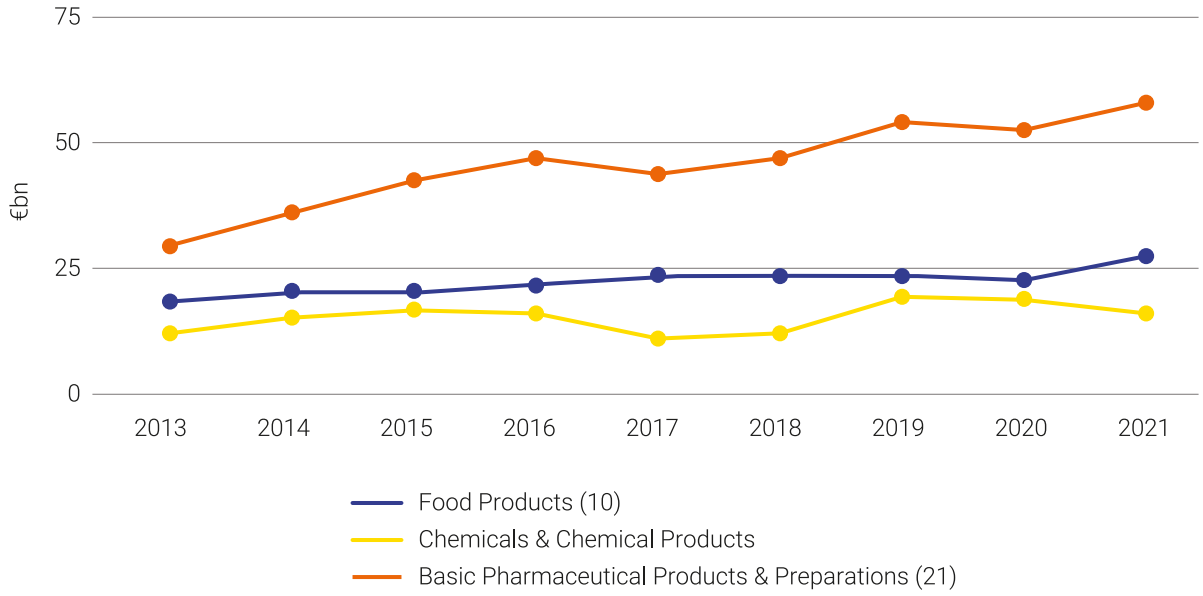
The value of Irish-manufactured pharma products (see Figure 1.1) doubled from €29.0 billion to €58.1 billion between 2013 and 2021. Ireland now accounts for more than 5% of global pharmaceuticals production and recorded a 25% increase in value added output in 2021. The Pharmaceutical sector reported the highest Net Selling Value (NSV)[7] of €58.1 billion in 2021.

Service Companies

Over the years, the presence of manufacturing activity and expertise in Ireland resulted in the creation of specialist service industries (many of which are indigenous) which now operate globally. Of the approximately 50,000 people directly employed in the sector, around 12,000 are engaged in service subsectors, and this is growing rapidly. Although these companies are highly diverse in size and in the nature of the services they provide, they are generally classified into Global Business Services, Biopharma Services and Specialty pharma services. These service companies grew from the expertise developed within the sector and include a highly diverse portfolio of business and technical services in a wide range of pharma industry subsectors. The nature and range of services now offered by the many firms operating in this subsector are elaborated in Section 2.2.2.

7. Net Selling Value is defined by the CSO as "the net selling value i.e., the net amount (excluding VAT) invoiced to customers (including transport and packaging) but excluding:
duties and taxes payable on the goods e.g., excise duties
separately charged freight costs
any discounts granted to customers
goods resold with further processing i.e., goods merchanted or factored

Figure 1.1: Total Net Selling Value of production in selected sectors 2013-2021



Source: CSO, 2021

In summary, Ireland continues to be highly successful in attracting major international capital investments. These companies are active in many areas of manufacture and services provision, but particularly in manufacture and development of biotech products[8]. A highly skilled talent pool is key to maintaining this competitive advantage, as is maintenance of the established Science and Technology ecosystem (see below), and the strong culture of collaboration between Government, education and training providers and industry. Significant investments by firms operating in Ireland announced in 2022-2023 include:

€1.2 billion	Pfizer	Dublin
€440 million	Abbott	Donegal/Kilkenny
€440 million	Merck	Cork
€927 million	Eli Lilly	Limerick
€150 million	Janssen	Cork
€140 million	MSD	Tipperary
€100 million	AMGEN	Dublin
€36 million	Takeda	Dublin/Dundalk
€27 million	Ipsen	Dublin
€329 million	AstraZeneca	Dublin
€12 million	Horizon	Waterford
€1 billion	MSD	Swords[9]

It is also noteworthy that these jobs are widely spread within the country. Although Cork and Dublin are long-established locations for biopharma plants, Biopharma clusters have developed in other regional locations in recent years. This regional diversity broadens the range of options for a company looking to set up a facility in Ireland. They can avail of a broad talent base, accessing the skills and experience they need almost anywhere in the country.

8. BPCI Strategy 2022.pdf
9. Source: BPCI

Biopharma in Ireland: Key Industry Statistics

85+
Biopharma companies

8
of the world's top
10
Biopharma companies

12
of the world's top medicines manufactured in Ireland

5%
of global pharmaceuticals production

No.3
exporter of complex pharmaceutical goods and medicines in Europe

Over
€116 billion
annual exports

67%
of the total goods exported from Ireland

Over
€10 billion
in capital investment

No.2
exporter of vaccines in Europe

Over
18,000
employed in Biologics
Up 98%
since 2016

Over
18,000
employed in Small Molecules
Up 31%
since 2016

12,000
employed in Services
Up 84%
since 2016

Source: BPCI and IDA/EI, 2023

Infrastructural Supports to the Sector

The success in attracting foreign direct investment has been driven by a combination of factors, including a highly skilled workforce, favourable taxation policies, and strong Government support for innovation and research.

Companies will typically have a range of products at different stages of development and production. Ideally, they will have a pipeline of new products progressing through the stages from early discovery to efficacy and toxicity trials, to regulatory approval, to pre-production and finally production and sale. Products in production will generally be patented and there will be products at different stages of patent life. When patents expire, the companies lose their exclusive right to the product and rival companies will produce generic versions. A balanced pipeline of products at these stages is important for the viability of each company. In recent decades, large companies have tended to enhance their pipelines of new products by purchasing small companies with promising drugs in development, or by licensing such products from research institutions.

Government investment in research and development in the HE sector is relevant to the industry because (a) it produces graduates with understanding of relevant biological science and technology, and (b) it generates facilities and expertise which are accessible to the pharma sector, and (c) it may create technology that can be directly used by the industry. For all these reasons, Irish investment in science and technology is provided through agencies such as Science Foundation Ireland (SFI), Enterprise Ireland and the IDA. This has helped to create a thriving innovation ecosystem relevant to the Biopharma sector, supported by research centres such as NIBRT and SSPC, the Science Foundation Ireland Research Centre for Pharmaceuticals[10], helping to drive increases in the commercialization of Irish-developed products and services.

1.4 Review of the International Biopharma Sector

The International Biopharma sector is dominated by large global players. This is mainly because of the huge costs and long lead-times required to bring a new pharmaceutical product from discovery to market launch. The steps in this development pathway are described in Section 1.3 and they involve high cost and high risk. Whereas the market for pharma products is huge and growing, it is also characterised by disruptions due to emergence of new innovative drugs, and expiring patents on existing drugs which allow generic versions to enter the market. Drug discovery, which involves large R&D costs as well as high risks, is a main market driver as it is the basis for the new therapies entering the market. The market is also highly regulated with strict approval processes and strongly competitive patent activity between companies. Re-imbursement processes, and periods of market exclusivity also vary greatly from country to country.

In 2021, the major global Biopharma markets were the USA (49% market share) and the EU (23%), with China (9%) and Japan (6%) also playing significant roles globally[11]. The different segments have been affected very differently by the COVID-19 pandemic, but growth rates are back to pre-pandemic levels in most segments[12].

Looking ahead, businesses face turbulent times, and the Biopharma industry is no exception. Although often labelled as 'recession-proof' because medicines are essential products, the industry is now dealing with increased drug development costs; financial pressures affecting its margins; increasing regulation and an uncertain economic outlook.

10. Home – SSPC
11. https://www.efpia.eu/media/637143/the-pharmaceutical-industry-in-figures-2022.pdf
12. A country-by-country overview of the global Biopharmachem sector can be found in Appendix E.

Some of the key trends in the sector are:

The growth in new therapies, particularly Biologics: The dramatic expansion in our understanding of biological systems has greatly enhanced understanding of disease cause and function. This has greatly enhanced the discovery process and has greatly increased the number, and changed the nature, of new therapies. This has resulted in therapies for previously unmet clinical needs, and/or the replacement of older, less effective therapies. The nature of these therapies has also fundamentally changed from chemical entities to 'biologics' which use components of living organisms to achieve their therapeutic purpose. Examples include monoclonal antibodies, mRNA vaccines, and Advanced Therapeutic Medicinal Products (ATMPs), the latter of which include therapies based on cell and tissue transplant, and gene therapies.

The continuing importance of Small Molecule manufacturing: Despite the growth in biologics in Ireland and globally, small molecules remain a vital part of the drug portfolio. Indeed, half of the entries listed in Clarivate's annual 'Drugs to Watch' for 2023[13] are small molecule pharmaceutical products.

The move from 'Blockbuster' to Personalised Medicine: Traditional drugs were 'one-size fits all' which allowed huge markets for individual products. The greater understanding of biological processes has revealed important differences in individual response to specific therapies. New therapies are often only for use by restricted patient groups (defined by their genetics or other factors). In addition, some biologic therapies are custom designed for individual patients based either on their genetic make-up, or because they involve extraction and re-implantation of the patient's own tissues or cells. These factors have reduced the market size of individual products, and increased market costs due to the need for patient pre-screening, and smaller scale of manufacture.

Social Medicine: New and personalised therapies are extremely expensive, and public health organisations in many countries struggle to meet their costs. There has therefore been a focus on containment of the cost of healthcare by national agencies. This has resulted in more demanding processes for approval of re-imbursement of drug prices; pressure on the sale price of new drugs due to national or international purchase agreements; and the growth of biosimilars (i.e., biologics with similar function but lower cost) and generics. Socialised medicine is also increasingly focussing on disease prevention with consequences for drug sales.

The growth of external contracting: A further feature of the sector is the growth in the nature and extent of operations which may be contracted to external providers. Some of this is technology driven. For example, new biologic processes require entirely new skill sets and facilities. There has therefore been a growth in contract manufacturing as outlined in Section 2.2.

AI and Big Data: Application of artificial intelligence and data management are widely expected to have a profound impact on the global Biopharma industry. This is driven by increased process automation and robotics in manufacturing and logistic processes; and the application of data analysis to enhance clinical and market understanding. These changes require either that existing staff become familiar with the resultant process changes, and to understand the resulting datasets, or that some of these services are externally provided.

These economic, industrial and technological trends, along with the overall growth of the sector both globally and nationally and the increasing salience of the sustainability agenda, have significant implications for the skills needs of the industry over the next five years and beyond. Given the scale of change taking place across Biopharma, now is an appropriate time to revisit and update the analysis and recommendations made in the EGFSN's 2016 report, Future Skills Needs of the Biopharma Industry in Ireland[14].

13. https://clarivate.com/blog/the-drugs-to-watch-in-2023/
14. EGFSN (skillsireland.ie)

2

Skills in the Biopharma Sector

This chapter outlines the diverse and complex range of current and future skills needs of the Biopharma sector in Ireland. It begins by outlining the current distribution of employment across different Biopharma manufacturing and services subsectors (2.1), followed by an analysis of the business functions undertaken in each of these subsectors (2.2). The chapter then scopes the roles, skills and competencies required in these areas of activity (2.3), before analysing the new and emerging skills which will be required by the sector in the future (2.4).

2.1 Employment by Biopharma Subsector

The Biopharma sector is a significant employer and is also highly diverse in relation to the skills required by its companies. These roles are typically high skilled and well paid. Average salaries in the sector are significantly higher than the national average. Table 2.1 below shows the distribution of jobs within the major Biopharma subsectors.

Table 2.1: Distribution of Biopharma employment by subsector

Sector/Subsector	Employment 2022
Manufacturing	37,949
Biologics	18,080
Small Molecule	18,351
Other Manufacturing	1,518
Services	11,621
Global Business Services	1,752
Biopharma Services	7,332
Specialty Pharma Services	2,537
Total	49,570

Source: EGSFSN analysis of EI/IDA AES data, 2023

This distribution of jobs reflects the sectoral description in Section 2.2. Manufacturing is the core activity of the Irish Biopharma industry, and a significant proportion of the service industry jobs relate to supports for manufacturing.

2.2 Business Functions in Biopharma Subsectors

As a basis for reviewing skill needs, a profile of the major activities of the Biopharma sector in Ireland is presented below.

2.2.1 Manufacturing

Small Molecule Manufacturing: Small molecule drugs or synthetic pharmaceuticals are substances with a low molecular weight that are generally manufactured using chemical synthesis. They can enter cells easily and interact with specific molecular targets to achieve some therapeutic effect. The component that gives the medication its therapeutic effect is termed the active pharmaceutical ingredient/API, or the Drug Substance (DS). During the manufacturing process, the API undergoes various stages of synthesis, purification, and characterization to ensure its quality, potency, and safety. It is then combined with other inactive ingredients, or excipients, to create the finished dosage form. The finished drug product can be administered orally via tablet, capsule or powder (oral solid dose), or via injection. The manufacturing process can therefore be very broadly broken down into sequential stages of manufacture of API, manufacture of a drug product containing the API, and the final fill, finishing and packaging.

Examples of small molecule drugs include Penicillin which is used to treat bacterial infections, Aspirin which treats pain, fever, and inflammation and many other drugs that are used for the treatment of high blood pressure, high cholesterol, and many more health needs. Small molecule drugs account for 90% of global sales in the pharmaceutical industry and about 50% of new drug approvals. Small molecule manufacturing accounts for approximately half of pharmaceutical manufacturing employment in Ireland in 2022.

In addition, the small molecule subsector includes a small number of companies engaged in manufacture of traditional non-pharmaceutical chemicals. Examples include BASF in Cork and Henkel in Dublin. While these companies employ a relatively small number of people overall (approximately 500), they are nevertheless important employers of chemists and chemical engineers (particularly at PhD level), and they are engaged in advanced R&D activity.

Biologics, or Large Molecule Manufacturing: The active pharmaceutical ingredients in biologics are typically based on molecules found in living organisms and are generally produced using one of many diverse biotechnological processes. These processes can include production of living organisms or cells (which may be genetically modified); extraction of components of living organisms, such as proteins or nucleic acids; or other biological process. They are designed to target specific molecules or cells in the body, and their biological origin allows them to have a more targeted effect than traditional small molecule drugs. Biologic drugs are used to treat a wide range of diseases, including cancer, autoimmune disorders, infectious diseases, and rare genetic disorders.

Current biologic products include monoclonal antibodies, cytokines, growth factors, modern vaccines, recombinant hormones, and proteins. The manufacturing processes (and skills) required are distinctly different and more complex than those used in small molecule manufacturing. Emerging products also include ATMPs which encompass engineered cells and tissues, and gene therapies which have revolutionary applications across infectious diseases, oncology, immunology, and autoimmune diseases. Most Irish sites engaged in large molecule manufacturing produce monoclonal antibodies. These proteins can bind, with extreme specificity, to targets in the body such as cancer cells or other molecules.

Large molecule APIs are grown in host cells (upstream) and then harvested and purified (downstream) to produce the final drug product. As a biologics drug product is generally injected, the final drug product must be put into containers such as vials, ampoules, or syringes which are then sealed or closed in a sterile manner. This is carried out in aseptic conditions to prevent contamination and maintain the sterility of the finished product. These biologics drug product sites are called sterile fill finish operations which require specialized facilities, equipment, and trained personnel to maintain a sterile environment and ensure the integrity and quality of the final product.

It is often efficient for Biopharma companies to contract manufacturing to specialist companies. This is particularly so for products that are complex to manufacture (e.g., Biologics), and/or where a low volume of product is required. This has given rise to the development of specialist companies that provide Contract Manufacturing (and other) services to the sector. Some of these contract manufacturing companies also provide other services (see below). The market for pharmaceutical Contract development and manufacturing organizations (see Section 2.2.2) has been valued at around €85.5 billion, growing at approximately 7% CAGR.

Other Manufacturing Activities: The business area of some companies within the sector cannot be categorised into small or large molecule manufacturing. Some of these focus on producing the reagents, excipients, ingredients or process equipment uniquely used in pharmaceutical manufacture. For example, Merck KgAa in Cork manufacture membranes used in processing, and Repligen manufacture single use equipment used in Biopharmaceutical manufacturing.

2.2.2 Services

As noted in section 1.3, the production of pharmaceutical products is a long and complex process. Many functions within the Biopharma value chain such as discovery, production, approval and distribution are therefore often provided by external service providers. Sometimes these services may be provided by discrete units within the global company, whereas others are provided by an external provider. Companies providing these services are a growing area of economic activity in Ireland. Service providers in Biopharma can be difficult to classify due to their size, ownership and the diversity of the services provided. The broad classification of service providers used in this report is summarised below, and is further elaborated upon in Section 2.3.2:

Global Business services (GBS) which are business functions that are not pharma-specific (e.g., Finance, treasury, IT and HR) and are often provided by a separate entity within the pharmaceutical company's global operations.

Biopharma Services which include services to enable industry specific outcomes such as clinical trial management, general medical affairs, and support for regulatory and commercial operations.

Specialty Pharma Services is a term which captures a variety of generally smaller companies that provide a mix of finance and technical operations. In the Biopharma sector, Technical Operations (Tech Ops) is the function responsible for the process design as well as for end-to-end manufacturing and supply of the final medicine product that is delivered to patients. This includes the quality operations and management of the relationship with the external manufacturers that smaller companies generally use. As they grow, they may establish their own manufacturing operations as Regeneron, Biomarin, Horizon and Jazz have done. There are a range of both multinational and indigenous companies providing services under this general heading.

An illustration of the difficulty in classifying services companies is provided by the Contract manufacturing entities mentioned above. Some of these only provide manufacturing services, while others also conduct R&D, clinical trials, or product development services. Examples of Irish Contract Research and Manufacturing Companies (CRAMS) include ICON and PPD. Another set of companies, Contract Development and Manufacturing Organizations (CDMOs) provide manufacturing and a wide range of related development services. Examples of Irish CDMOs include Hovione and Thermo Fisher.

Ensuring availability of the skills required by the services sector is vital to the success and global competitiveness of the broader Biopharma industry in Ireland.

2.3 Scoping Biopharma Skills – Roles and Competencies

2.3.1 General Biopharma Roles

The main personnel roles in Biopharma industries are set out below within the broad functional areas of a typical pharmaceutical company. These are the roles within the wider manufacturing and service elements (in 2.3.2) of the drug pathway (as elaborated in Section 1.3). However, note that not all are equally important in the Irish industry.

Research & Development (R&D) is conducted by the industry primarily (in terms of investment) for discovery of innovative therapies. The early phases of discovery are often conducted in collaboration with research institutions (e.g., universities). Promising candidate drug compounds may also be obtained through licence from research organisations, or through acquisition of small companies. It is reported[15] that up to 80% of new drug molecules in development originate from small companies rather than from research within big pharma. Further research (either internal or through external contracting) may also be conducted on delivery technology, and on enhancement of manufacturing processes.

15. www.lonza.com/knowledge-center/smallmolecules/a/small-molecule-trends-and-challenges

Key personnel necessary for this activity include:

- Research Scientists engaged in drug discovery, formulation, delivery and process technology
- Biostatisticians and Bioinformatics Scientists
- Project Managers and Leaders

Production roles, and associated Process Development roles are integral to the pharmaceutical industry. These roles are variously involved in the development of the processes through which a pharmaceutical product will be manufactured and delivered; implementation of the manufacturing, finish and packaging processes; and support roles to ensure timely delivery, and adherence to regulatory and quality standards. Process development focuses on designing and optimizing the manufacturing steps, ensuring efficiency, scalability, and product quality, while ensuring staff and patient safety.

The following roles are necessary:

- Bioprocess Engineer/Technician
- Process development Scientist/Engineer
- Validation Engineer
- Manufacturing Technician/Operations
- Technical Support Specialist
- Operational Excellence (OE) Specialists
- Business Excellence Specialists
- Process Chemists
- Analytical Chemists
- Engineers

Regulatory Affairs scientists work across all stages of drug development to ensure that products meet regulatory requirements. Specific roles needed here are:

- Regulatory Affairs Specialists
- Regulatory Compliance Officer
- Labelling and Packaging Specialist
- Regulatory CMC (Chemistry, Manufacturing, and Controls) Specialist
- Clinical Trial Regulatory Coordinator
- Pharmacovigilance Specialist
- Regulatory Intelligence Specialist
- Regulatory Affairs Writer
- Regulatory Affairs Coordinator/Scientist
- Clinical Research Associate (CRA)

Quality Control personnel are responsible for testing and monitoring the quality of raw materials, intermediate products, and final drug products to ensure they meet regulatory standards and process needs. Specific roles here are:

- Quality Control Analyst/Technician
- Analytical Chemist
- Documentation Specialist
- Validation Specialist
- Stability Coordinator

- Compliance Officer
- Quality Assurance Auditor
- Data Integrity Specialist
- Quality Control Coordinator
- Qualified Person

Supply Chain, Procurement and Planning specialists are responsible for managing the flow of goods and services into the company. Specific roles required are:

- Demand Planner/Analyst
- Procurement Specialist/Manager
- Inventory Manager/Analyst
- Logistics Coordinator/Manager
- Distribution Manager/Supervisor
- Supply Chain Analyst
- Compliance Officer
- Vendor Relationship Manager
- Supply Chain Coordinator

Environmental / Occupational Health & Safety (EHS) personnel ensure compliance with regulations, safeguard employee health and safety, manage hazardous materials, and work to reduce environmental impacts. EHS programs promote sustainable practices, protect workers, and maintain high standards of safety and quality in Biopharma manufacturing. Specific roles include:

- EHS Manager/Director
- Occupational Health and Safety Specialist
- Environmental Compliance Specialist
- Hazardous Materials Manager
- Ergonomics Specialist
- Industrial Hygienist
- EHS Compliance Officer
- EHS Training Coordinator
- Sustainability Specialist
- EHS Data Analysts
- Process Safety Specialist

In addition to these roles, there are also management roles to ensure coordination and interaction between all these functions, and with external collaborators and stakeholders.

2.3.2 Biopharma Service Roles

The Irish Biopharma sector is highly diverse in terms of product types, ownership, scale and in many other ways. A notable feature is that the major players are global companies that conduct only a portion of their process functions within Ireland. The major function is manufacturing, but services account for approximately 20% of total employment of IDA clients in the sector in Ireland.

The main roles in Biopharma services are set out below under the three subsector headings described in section 2.2.

Global Business Services provide centralised and shared services to support various functions within client companies. They are not pharma-specific and typically serve a range of sectors with services such as finance, treasury, IT and HR functions.

Relevant roles include those relating to the following:

- Global Process Owners
- Global centres of excellence (COE) leads
- Environmental, social and governance (ESG)
- Data and digital privacy and security
- Enterprise infrastructure
- Generative AI and machine learning
- Advanced analytics
- Cloud-optimized solutions
- User experience (UX)
- Expertise in transfer pricing, VAT, international corporate tax
- International treasury
- US GaaP and international statutory Financial Accounting
- Transformation and project management
- Multi-lingual skills
- Compliance
- Social media

Biopharma Services are operations whose services are specific to the Biopharma industry such as clinical trial management, regulatory affairs, medical affairs and commercial support for global operations. Some of these providers are units of global companies that are based in Ireland because their centralisation can create greater value for these corporations. Others are indigenous companies which provide essentially the same services to both Irish and global clients. Examples include APC, Simotech and ICON. The skills they provide to the Biopharma industry are in short supply across the world. Roles relating to the following are essential for this subsector:

- Product regulatory
- Digital health and digital commercial enablement – Market facing solutions
- Procurement and supply chain
- Commercial operations: Healthcare professional and patient engagement, sales and marketing operations
- Market access, health economics and real-world evidence
- Global Medical Affairs
- Trial management operations, including regulatory and scientific writing
- Pharma legal and compliance

Specialty Pharma Services. Given the diversity of companies and activities captured under this heading (as discussed in section 2.2.2), job roles relevant to this subsector would include skillsets relating to general Biopharma, manufacturing and services roles, depending on the specific activities of individual firms.

2.4 Future Skills

According to the World Economic Forum's Future of Jobs report[16], 50% of workers will need to learn new skills by 2025. What are now considered core skills will also change, impacting 40% of current workers within less than a year. This annual assessment has listed critical thinking and problem-solving as critical new skills each year. In the latest report, self-management skills such as active learning, resilience, stress tolerance and flexibility have also been added.

A March 2020 article in The Irish Times noted gaps between the skills that employers are looking for and graduate competences. That same article highlighted a sought-after mix of skills and competences characteristic of an **"increasing confluence between sectors such as information and communications technology (ICT), business and engineering, which were once considered to be unique disciplines in their own right"**[17].

That confluence can be readily observed in an industry profile of the advanced manufacturing sector published by the World Economic Forum in October 2020. The profile identifies the top ten skills considered a priority for reskilling and upskilling programmes in advanced manufacturing, as below:

- Technology use, monitoring and control
- Analytical thinking and innovation
- Complex problem-solving
- Technology installation and maintenance
- Critical thinking and analysis
- Technology design and programming
- Quality control and safety awareness
- Service Orientation
- Management of financial, material resources
- Leadership and social influence

Multiple national and international publications suggest that by 2025 more than 85 million jobs will be displaced by a shift in the division of labour between humans and machines. Notably, 97 million new roles are predicted to concurrently emerge that are more adapted to the new division of labour "**between humans, machines and algorithms"**[18].

Such figures highlight the need to prepare workforces for these new and emerging roles. Education and training opportunities must be designed to facilitate the upskilling of the current manufacturing workforce. The crucial role that upskilling opportunities will play in the coming years is highlighted in PwC Ireland's 2020 CEO Survey. 57% of CEOs responded that upskilling is the most important action to close the skills gaps within their organisations, up 30% from the year before.

16. World Economic Forum (2020) The Future of Jobs Report, p. 121
17. The Irish Times (10th March 2020) Matching skills with labour market demand. Retrieved from: Matching skills with labour market demand – The Irish Times
18. World Economic Forum (2020) The Future of Jobs Report, p. 5

Digitalisation processes and a move towards Industry 5.0, are reconfiguring the boundaries of manufacturing in Ireland and around the globe[19], and reshaping the skills required from workers in the sector. An August 2020 publication by McKinsey & Company notes that the wave of automation and digitisation in operationally intensive companies has now entered a new stage, accelerated by the Covid-19 pandemic. The report suggests that up to 58% of the work activities in the manufacturing sector alone could become automated using currently demonstrated technologies[20], creating an acute reskilling challenge. A 2021 Bloomberg report echoes the predictions of greater automation in manufacturing to compensate for labour shortages, noting that within this context growth is anticipated for **"enterprises providing the skills of the future to the next generation of workers, many of whom could be working alongside robotic counterparts"**[21].

The factors at work in the Biopharma sector have been outlined in different ways above. There is a clear general need for employees with a broader knowledge base. People previously engaged in managing production processes will need to understand digital processes, and to be able to manage and use the data emerging to create efficiencies.

In terms of technology, biologics will continue to grow and the diversity of its therapies and of their mechanisms of production will create challenges for manufacturing staff. Some personalised therapies will require greater interaction between those manufacturing products and clinicians involved in their administration to patients. Staff will therefore need to have the social skills required to communicate with other colleagues who are users or generators of data within the company.

2.5 Conclusion

Biopharma is growing in scale and in diversity, both of which have implications for skills needs of the sector. The growth of companies in the core area of manufacturing necessitates additional staff with engineering, chemical and biological expertise combined with data and digital technology skills, the demand for the latter being driven by changes in manufacturing processes. Rather than a need for additional ICT professionals *per se* however, this entails developing employees with the right mix of the above skills. Biopharma manufacturing roles can be considered under five broad process headings, as follows: R&D; production and process development; regulatory affairs, quality control, and supply chain, procurement and planning.

Similarly, there has been continued growth in the numbers and types of companies providing services to the sector. Biopharma services companies fall under three main subsector headings: Global Business Services, Biopharma services and Specialty Pharma Services. Their growth has increased demand for a wide range of other skills. These may be provided by training, by the expansion of relevant graduate supply or by economic migration.

19. McKinsey & Company (2020) Digital performance management: From the front line to the bottom line. Retrieved from: Digital-performance-management-From-the-front-line-to-the-bottom-line.pdf (mckinsey.com)
20. Ellingrud, Gupta & Salguero (2020) Building the vital skills for the future of work in operations, McKinsey & Company. Retrieved from: https://www.mckinsey.com/business-functions/operations/our-insights/building-the-vital-skills-for-the-future-of-work-in-operations
21. Bloomberg (2021) How will digitalization create a more resilient post-pandemic world? Retrieved from: How Will Digitalization Create a More Resilient Post-Pandemic World? (bloomberg.com)

3

Trends and Drivers of Biopharma Skills Demand

This chapter outlines some the major trends and drivers in influencing the future growth and development of the Biopharma sector globally (3.1), and the implications of these international trends for the sector in Ireland, particularly in relation to employment and skills needs (3.2). A thematic analysis of findings from industry stakeholder engagements is presented which highlights some of the main current and emerging skills challenges encountered by the industry in Ireland in a changing international context (3.3), followed by a closer examination of the specific skills shortages faced by the sector (3.4), the need for skills to support the digital transformation of the industry (3.5), and the experiences of Biopharma manufacturing and service companies in relation to talent attraction and retention (3.6).

3.1 Growth Prospects and Trends for the Global Biopharma Sector

3.1.1 Global Growth Prospects

A range of estimates by different forecasters see the global Biopharma industry growing by between 5.39% and 9.2% per annum over the next five or more years. Statista[22] estimate that the market will be worth $1,435 billion by 2027, at a compound growth rate of 5.39% per year. P&S Intelligence[23] predict that the market will grow by 7.1% a year to 2030. They estimate a market size of $389.3 billion in 2021 and $720.8 billion by 2030, a growth of 85% over the decade. Market Data Forecast[24] define the sector differently and estimate its value at $229.5 billion in 2023, rising to $356.3 in 2027, a compound growth rate of 9.2% a year.

Pharmaceutical Technology are predicting 4.4% growth in the global healthcare and Biopharma market for 2023, despite current inflationary pressures. Global Data Healthcare reports continuing growth in market capitalisation by the top 20 global Biopharma companies, amounting to 5.4% from 2021 to 2022, with some subsectors expected to grow markedly faster. Fortune Business Insights[25] see biopharma contract manufacturing growing by 12.6% out to 2028.

3.1.2 Global Trends

McKinsey[26] recommend a shift in focus from continuous improvement to **"longer-term external challenges",** including inflation, complexity and risk. They report that **"cell and gene therapy and mRNA vaccine technology have increased from 11 to 21 percent of the drug development pipeline – the fastest growth ever seen in the sector".** They also point to talent shortages and cite a **"20 percent increase in demand for STEM-related roles"** across life sciences in the US. Additionally, the rise of remote working has led to employees now expecting more flexibility in their jobs. They recommend that talent strategy be embedded in operations strategy rather than HR-led. They also recommend strong talent retention strategies to deal with the effects of automation as well as workers' increasing current preference for portfolio careers. They suggest that increasing wages will not be enough, but that **"long-term reskilling and upskilling of the existing workforce"** will be needed. Against these challenges, they see significant opportunities in digital and analytical tools as well as robots, sensors, edge computing and cloud analytics.

EFESO Management Consultants[27] identify several factors which will have a material effect on the Biopharma industry in the coming years. They start with the importance of increasing regulatory compliance for pharma firms. They recommend strong quality monitoring and increasing control of the supply chain – volatility in the supply chain will require new practices to ensure robust and continuous production. They expect that there will be increasing requests for smaller or specific batches which will, again, have implications for production planning and scheduling.

22. Pharmaceuticals – Worldwide | Statista Market Forecast
23. Biopharmaceutical Market Size and Growth Forecast Report, 2030 (psmarketresearch.com)
24. Global Biopharmaceuticals Market Size, Share, Growth | 2023 to 2028 (marketdataforecast.com)
25. Biopharmaceutical CMO Market Size, Growth & Report [2028] (fortunebusinessinsights.com)
26. Six new pharmaceutical industry trends | McKinsey
27. Major trends & business drivers in the pharma industry (efeso.com)

Anzen[28] list nine **"factors driving innovation and growth in the pharmaceutical industry".** These include a focus on both R&D and government regulations as well as paying attention to consumer demand and researching drug trends and innovations. Changing lifestyles also feature on their list.

EY[29] identify five driving forces at work in the broader life-sciences sector. These include the importance of investing in people and embracing new operating models and digital enablement. They recommend allocating resources to mRNA applications and paying attention to how decentralised clinical trials are organised and regulated. They also point to the importance of conducting market research to understand the drug price expectations of customers.

Deloitte[30] point to six drivers in the life-sciences sector. Improving the productivity of R&D processes and accelerating industry collaboration is their first priority. The importance of investing in talent and the workforce follows in second place. On top of this, firms should keep on top of regulatory change, they should ensure that their operations are future-proofed, and they should pay attention to ESG (Environmental, Social and Governance) issues.

According to the 2021 Global Biopharma Resilience Index which surveyed 1,165 biopharma executives from 20 countries, access to talent was identified as the primary weakness in the resilience of the global biopharma industry and key determinant of future success. The survey highlighted the importance of employee-focused policies on topics such as hybrid working, organisational culture, environmental, social and governance (ESG), and equality, diversity and inclusion (EDI) in terms of recruiting and retaining the best talent[31].

3.2 Growth Prospects and Trends for the Biopharma Sector in Ireland

3.2.1 Trends in the Biopharma Sector in Ireland

In terms of product opportunities, perhaps the most significant area of development globally lies in Biologics. For example, the Future of Pharma—Looking Ahead to 2022[32] report forecasts that global sales of biologics will overtake small molecule sales over the next five years, with monoclonal antibodies being the dominant component in this shift. This broad international trend is very much reflected in Ireland. Biologics manufacturing- and the production of monoclonal antibodies in particular- saw the highest jobs growth of all Biopharma subsectors in recent years. Employee numbers in Biologics manufacturing in Ireland doubled between 2016 and 2022, and the number of employees in Biologics had equalled those employed in small molecule manufacturing by 2022. As noted above, Ireland is now host to some 20 biologics facilities, and biologics is forecast to be the largest and most rapidly growing subsector in Ireland over the next five years.

In the longer term, Advanced Therapy Medicinal Products (ATMPs)-defined by the EU as **"medicines for human use that are based on genes, tissues or cells"**- represent another significant large molecule product opportunity for Ireland. The global market for cell therapies was estimated at €2.6 billion in 2017 and is expected to more than treble in the next 5 years. The technologies on which these products are based are diverse but are primarily based on gene therapy, on somatic-cell therapy or on tissue-engineering.

28. Factors driving innovation & growth in the pharmaceutical industry | Anzen Exports
29. Five driving forces changing the life sciences landscape | EY – US
30. 2022 Global Life Sciences Outlook | Deloitte
31. What are the future trends for Ireland's biopharma industry? (siliconrepublic.com)
32. Future of Pharma Industry – Looking Ahead to 2023 (globaldata.com)

This diversity presents challenges at all stages of the medicine's development cycle from discovery to delivery, including regulatory assessment, manufacture and clinical usage. These products are significantly different to current therapies, and this presents challenges in gaining access to skills, facilities, and regulatory and medical competences. Despite some commonalities, ATMP manufacturing processes will be different to those used in current Biopharma operations in Ireland. While numbers currently employed in the ATMP/CGT area in Ireland are small – approximately 200 in 2022-23 as reported by IDA Ireland, there is significant opportunity for long-term future growth. For example, Catapult UK's 2023 **Cell and Gene Therapy UK Skills Demand Report**[33] found that UK employment in the field of advanced therapies doubled between 2019 and 2021, with surveyed businesses expecting this to grow a further 63% by 2028. To fully benefit from this broader trend, Ireland will need to develop skillsets and specialist facilities that are different to those currently available to the Biopharma industry and demonstrate technical competence in all aspects of ATMPs from commercialisation, regulatory compliance, delivery mechanisms and clinical applications in addition to their manufacture.

While biologics are growing significantly, it is nevertheless important to highlight that small molecule pharma product sales are also still growing globally. Market Research Biz predicts a global CAGR of 5.9% from 2023 to 2032 for this subsector. Factors driving this growth include the fact that small molecule therapies are less expensive, and many are now available as generics. New manufacturing technologies are also reducing costs of production. In addition, small molecule products are effective in major areas of medical need including oncology, diabetes, autoimmune, and respiratory disease. A further factor is the increasing demand for affordable therapies in regions like Asia-Pacific, Africa and Latin America. Employment in small molecule manufacturing in Ireland grew by over 30% between 2016 and 2022 and is forecast to continue growing over the next five years. It is also worth highlighting that some therapies, such as anticancer antibody drug conjugates, require a small and large molecule component so expertise in the production of both are required. As such, small molecule manufacturing will remain a significant employer and a driver of skills demand in Ireland.

Employment trends in both small and large molecule manufacturing subsectors, along with the high rates of employment growth in Ireland's Global Business, Biopharma and Specialty Pharma services subsectors are explored in greater detail in section 3.2.2 below. Other broad industry trends shaping the evolution of the Biopharma sector in Ireland include[34]:

1. **Continued growth but increased competition:** Ireland remains the number one European destination for Life Sciences capital inward investment, ranking number two globally behind USA[35]. The UK's withdrawal from the EU has also created additional opportunities with the Common Travel Area allowing open access to the Irish job market for UK nationals without the need for visas. Nevertheless, while Ireland remains well positioned to attract biopharma investments, there is a requirement for a continued focus on the core manufacturing value proposition, including addressing cross-sector capacity constraints and competitiveness challenges. While the strong base of the Biopharma sector in Ireland provides significant opportunities for diversification and future growth, there is no scope for complacency.
2. **More diverse and complex product pipelines:** There is a considerable opportunity for Ireland-based organisations to lead global efforts to create standardised manufacturing platforms for advanced therapies. It is highly likely that future manufacturing investments for advanced therapies will increasingly be dependent on strong association with R&D operations.
3. **Advanced manufacturing agility and resilience:** Digitalisation has the potential to be a key enabler of competitive advantage in manufacturing. However, significant barriers remain particularly in terms of access to end-to-end, high-quality data management from research to manufacturing operations. To remain competitive there will be continued demand for new efficiencies, standardisation, improved quality, and cost reductions in manufacturing processes.

33. Catapult UK Cell and Gene Therapy UK Skills Demand Report (November 2023)
34. What are the future trends for Ireland's biopharma industry? (siliconrepublic.com)
35. Life Sciences Competitiveness Indicators (2022) https://www.gov.uk/government/publications/life-science-sector-data-2022/life-science-competitiveness-indicators-2022 (p.27)

4. **Sustainability as a strategic objective:** Most sites in Ireland have policies in place to address issues such as net-zero commitments, sustainable sourcing, circular lifecycles, product packaging, energy-efficient fixtures and equipment, waste minimisation, reduction of carbon emissions, green chemistry manufacturing techniques, reduction of plastic waste from single-use technology, water efficiency and local environmental impact. However, it is inevitable that governance, regulatory, employee and consumer imperatives will continue to exert positive pressure on manufacturing and supply chain operations to implement step changes in firms' sustainability strategies.

3.2.2 Employment Trends

Employment in the Biopharma sector in Ireland has grown by 61% since 2016 at a rate of 8% CAGR, resulting in a total of nearly 19,000 additional jobs across all subsectors: see Table 3.1. Biologics manufacturing has seen the highest rate of growth at 12% CAGR, followed by Biopharma services (11%) and Specialty pharma services (10%). Figure 3.1 illustrates the growth for each Biopharma subsector between 2016 and 2022, again highlighting the strong growth in Biologics manufacturing and in the services subsectors, as well as the continuing importance of small molecule manufacturing. Figure 3.2 highlights the net gains in employment for each Biopharma subsector. Future employment growth across the Biopharma sector and its subsectors to 2027 are analysed in Chapter 5, as are the anticipated gaps between skills supply and demand. According to Census 2022, around 40% of those employed in the Chemicals and Biopharma detailed industrial groups are female, unchanged since Census 2016[36].

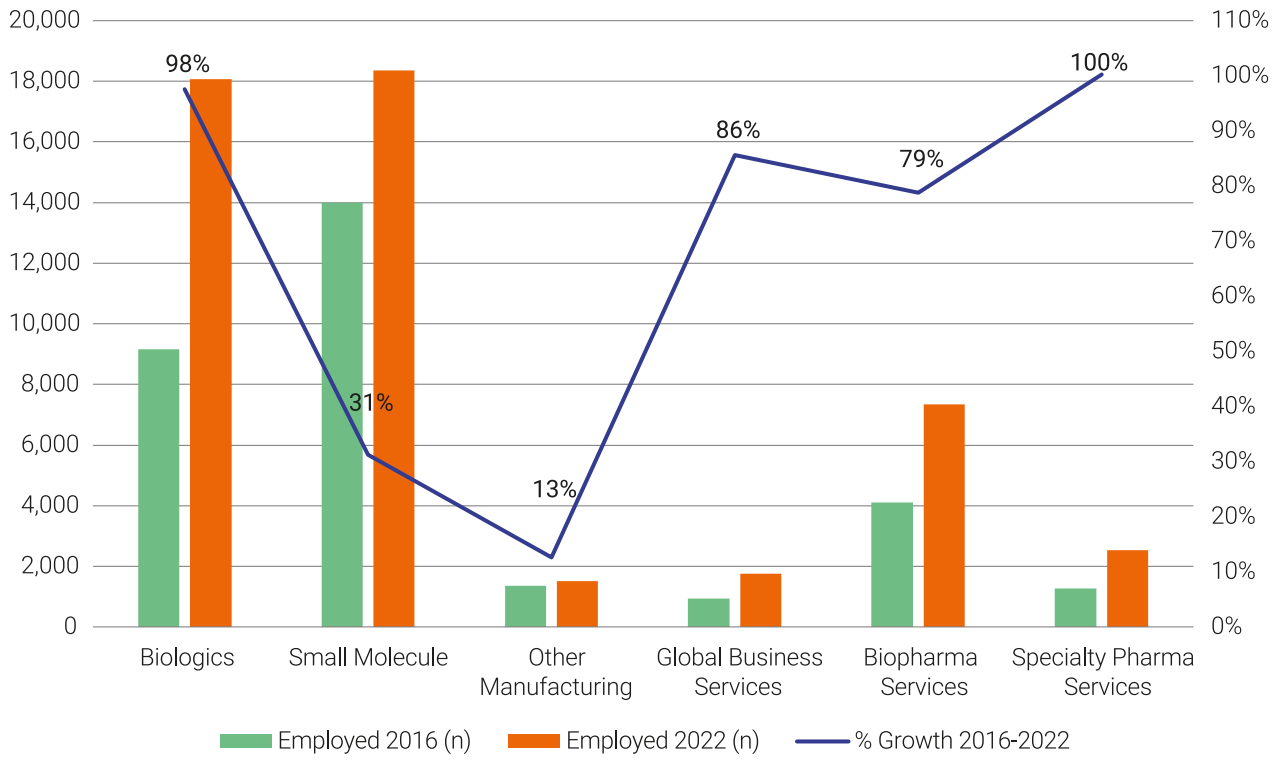
Table 3.1: Employment trends in the Biopharma sector 2016-2022

	2016	2017	2018	2019	2020	2021	2022	CAGR	% Change
Manufacturing	24,484	26,345	28,662	31,074	33,979	35,796	37,949	8%	55%
Biologics	9,152	10,377	11,792	13,481	15,068	16,546	18,080	12%	98%
Small Molecule	13,984	14,584	15,501	16,192	17,354	17,744	18,351	5%	31%
Other Manufacturing	1,348	1,384	1,369	1,401	1,557	1,506	1,518	2%	13%
Services	6,311	6,994	8,027	9,193	10,133	10,979	11,621	11%	84%
Global Business Services	944	1,082	1,390	1,415	1,523	1,674	1,752	10%	86%
Biopharma Services	4,100	4,303	4,841	5,630	6,676	6,871	7,332	11%	79%
Specialty Pharma Services	1,267	1,610	1,797	2,149	1,934	2,435	2,537	10%	100%
Grand Total	30,795	33,339	36,689	40,267	44,112	46,775	49,570	8%	61%

Source: EGFSN analysis of EI/IDA AES data, 2023

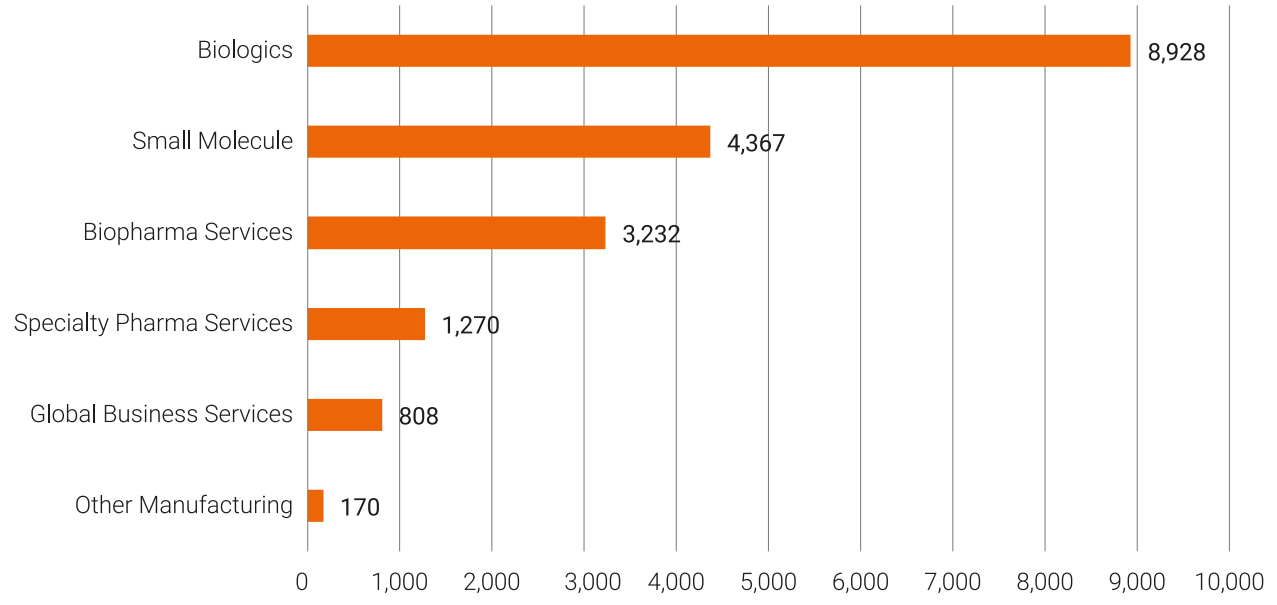
36. F7105 – Population Aged 15 Years and Over in the Labour Force (cso.ie) (NACE C 19-21)

Figure 3.1: Employment growth in Biopharma subsectors 2016-2022



Source: EGFSN analysis of IDA/EI AES data, 2023

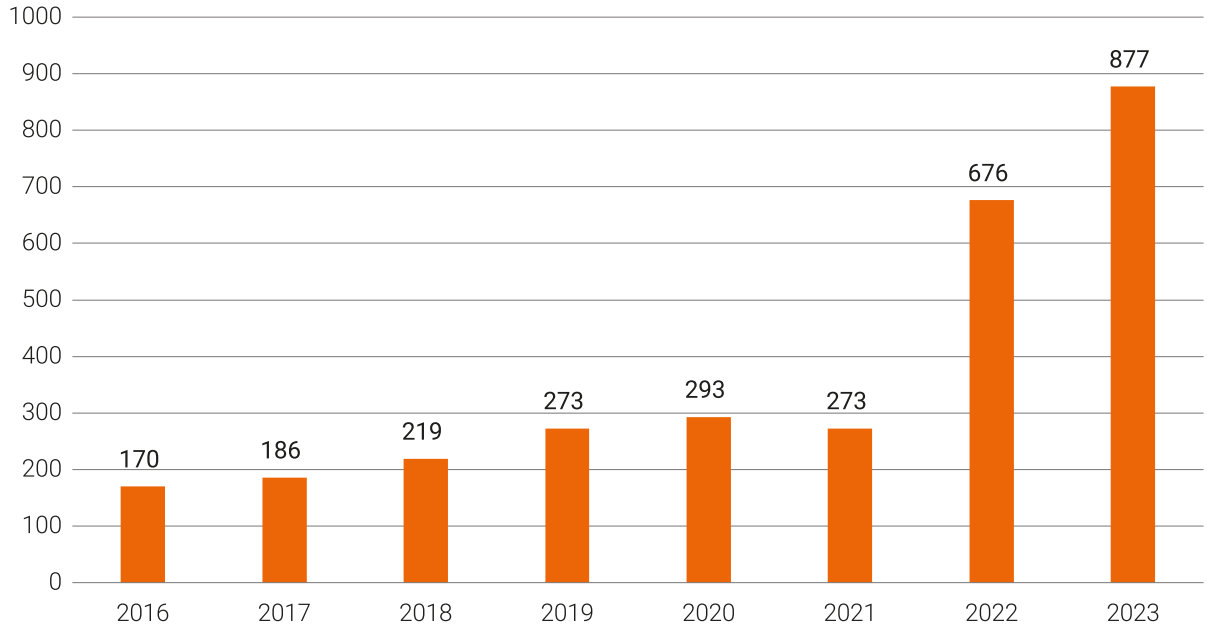
Figure 3.2: Net additional employment by Biopharma subsector 2016-2022



Source: EGFSN analysis of IDA/EI data, 2023

3.2.3 International Recruitment and In-Demand Occupations

Figure 3.3: Employment permits issued to Chemical and Biopharma employers 2016-2023



Source: EGFSN analysis of DETE employment permit data, 2023

Employment permit data shows a marked increase in the inflow of skilled personnel from outside the European Economic Area (EEA) in many of the occupations needed by the Biopharma sector since 2016. Nearly 3,000 employment permits across approximately 80 Standard Occupational Classifications (SOC)[37] have been issued to companies in the Chemicals and Biopharma[38] sectors engaged in both manufacturing and services activities between 2016 and August 2023[39]. In 2016, 170 permits were issued to employers in these sectors, a number which had grown to 877 by the end of 2023- the highest on record- representing an increase of 416%. (see Figure 3.3), with this increase driven by the continued growth of the industry and tight labour market conditions in Ireland.

Table 3.2 shows the most frequently issued permits by SOC title and code to Chemical and Biopharma companies between 2016 and August 2023, and illustrates the diversity of manufacturing and services roles that are in significant demand across the sector. This data highlights the salience of economic migration in addressing current shortfalls in skills supply from Ireland's skills pipeline for a rapidly growing sector and highlights the importance of developing and investing in this pipeline to address skills needs over the longer term.

37. Additional information about Standard Occupational Classification (SOC) codes can be found on the CSO website.
38. NACE C 19-21 Manufacture of Chemicals and Pharmaceuticals
39. EGFSN analysis of DETE Employment Permit data

Table 3.2: Employment permits issued to Biopharma companies by SOC 2016-August 2023										
SOC Title	SOC Code	2016	2017	2018	2019	2020	2021	2022	2023	Total
Production and process engineers	2127	18	20	23	33	40	40	87	109	370
Quality assurance and regulatory professionals	2462	14	9	25	41	42	42	119	73	365
Biological scientists and biochemists	2112	6	21	18	16	36	33	105	58	293
Chemical scientists	2111	12	25	24	21	25	19	81	42	249
Production managers and directors in manufacturing	1121	13	12	12	10	10	18	31	14	120
Chief executives and senior officials	1115	14	2	10	10	5	8	22	44	115
Mechanical engineers	2122	11	15	17	14	14	3	6	3	83
Management consultants and business analysts	2423	5	7	11	10	4	8	21	6	72
Quality control and planning engineers	2461	4	1	0	7	6	14	22	11	65
IT business analysts, architects and systems designers	2135	3	2	10	8	10	9	11	11	64
Business and financial project management professionals	2424	4	5	7	7	4	3	21	8	59
Engineering professionals (other).	2129	4	2	3	8	6	9	11	9	52
Programmers and software development professionals	2136	5	3	5	11	4	8	8	8	52
Design and development engineers	2126	5	5	5	2	9	5	7	13	51
Marketing associate professionals	3543	1	4	3	7	4	4	19	5	47
Physical scientists	2113		5	1	8	6	7	3	2	32
Information technology and telecommunications professionals (other)	2139	5	0	2	7	3	3	5	6	31
Business and related associate professionals (other)	3539	4	2	1	4	2	4	7	5	29
Marketing and sales directors	1132	8	3	4	4	0	3	4	1	27
Natural and social science professionals (other)	2119	3	3	2	3	4	1	7	2	25
IT specialist managers	2133	4	0	1	3	1	1	9	4	23
Financial managers and directors	1131	1	1	5	5	4	4	1		21
Laboratory technicians	3111	6	5		1			3	6	21
Electrical engineers	2123	0	3	1	2	3	2	6	3	20
Sales accounts and business development managers	3545	3	0	4	4	1	3	3	2	20
IT project and programme managers	2134	1	2	4	0	2	1	4	2	16
Electronics engineers	2124		0	1	0	2	1	2	9	15
Research and development managers	2150	2	0	1	0	2	3	5	2	15
Pharmacists	2213	1	0	3	0	5	1	4	1	15
Purchasing managers and directors	1133	1	1	2		1	2	4	3	14
Human resource managers and directors	1135	0	2	2	4	2	1	1	2	14
Business sales executives	3542	0	3	1	2	2	1	2	3	14
Quality assurance technicians	3115	2	3	1	1	0	2	4	0	13
Buyers and procurement officers	3541	0	1	0	0	2	0	6	4	13
Functional managers and directors (Other)	1139	0	3	3	2	0	0	3	0	11
Chartered and certified accountants	2421	0	4	0	2	3	0	1	1	11
Other (fewer than 10 permits issued)		10	12	7	16	29	10	21	8	113
Total		170	186	219	273	293	273	676	480	2,570

Source: EGFSN analysis of DETE employment permit data, 2023

3.3 Broad Expert Insights

A thematic analysis of interview responses and other stakeholder engagements highlighted some broad, demand-related issues. These are detailed below.

Quantity of candidates in the talent pool

Many companies experience difficulty in identifying sufficient candidates to support growth plans and to mitigate staff turnover. As a result, they are accepting candidates where additional training will be required. Sourcing candidates overseas is also a solution being employed. Some respondents suggested that a perceived lack of available skills could result in investment being deprioritised from Ireland and moved elsewhere.

These issues are seen by respondents to be caused by several factors, including competition from other Biopharma companies and other sectors experienced personnel preferring to work as contractors; long lead times on graduate training and hiring; and industry reluctance to hire from other sectors.

Recruitment competition between Biopharma companies and other sectors

Respondents reported that companies are experiencing significant competition with other Biopharma companies for skills, as well as with organisations in sectors such as MedTech and healthcare. This issue is ranked much higher by the manufacturing sector when compared to the Services sector.

Shortages of Senior Directors

As in other sectors; infrastructural issues, such as housing and schools, are a deterrent to attraction of senior management to Ireland. A further issue is availability of senior executives with PhD qualifications.

Lack of availability of higher technical qualifications (NFQ Level 6+)

The increasing need for new product development, innovation and R&D functional skills and more general expansion of the Biopharma sector will be reliant on more advanced skill sets such as data skills and digital skills. Companies have reported concerns regarding potential or actual de-prioritisation of investment for Ireland where global management teams or clients may question skills availability for expansion/new product development and introduction.

Ready-for-industry skill sets

A diverse set of skills is required for Biopharma. As we have seen, companies identified data skills, soft skills, product development, innovation & R&D functional skills, QC and Regulatory skills and digital skills as some of their higher priorities. They also see a need for an increasing focus on chemical, biochemical and automation engineering skills.

Staff attraction and retention: The opportunities and challenges of staff career development, diversity and changing work models

Staff retention was identified as an issue by many companies but is more important to manufacturing firms than to services firms. Companies cited increased competition from other Biopharma companies, and pressures from large FDI projects, and from changing work models. Staff seek improved work life balance through moving to roles that facilitate remote, hybrid and flexible working arrangements; and provide greater opportunities for professional development and expanded career portfolios. New candidates are more likely to consider building a portfolio of roles within different companies rather than wait for career progression within a single company. This potential for reduced long term commitment from new personnel may also impact on employer investment in advanced training. Some companies also cited pressure on skill pools due to early retirement of experienced personnel.

A survey of Biopharma employers and employees carried out in 2022 for Biopharmachem Skillnet (BPC Skillnet)[40] found that a majority of those employed in the sector are keen to advance to the next level and beyond in their careers, with many also expressing contentment with their opportunities for advancement within the sector. The availability of mentors to assist with career development was identified as the single most important factor in assisting staff with their career development, though only 54% of organisations surveyed had a formal mentoring programme in place, with only 27% of surveyed employees having a mentor in place.

Overall, of 32% of employee respondents to the survey who had changed job in the last three years, more than half had left their previous position for reasons relating to expectations around broad terms and conditions of employment, working arrangements, career development and progression.

The survey also found that a significant majority of employee respondents felt that they were supported by their employer in terms of availing of flexible working arrangements including flexible start/finish times and hybrid working, with such arrangements on offer across the majority of participating employers. BPC Skillnet note that hybrid working has continued to feature strongly following the end of pandemic public health measures, suggesting that it is becoming an established part of working life, even in a sector with a strong on-site and manufacturing dimension.[41]

BPC Skillnet highlight the potential of flexible working policies -in conjunction with policies around equality, diversity and inclusion (EDI) more broadly to widen the pool of talent available to employers. However, it is also recognised that work carried out remotely can be carried out anywhere which poses a risk to Ireland and emphasises the need for Ireland to maximise its skills base and 'unique pharma capability' and ecosystem to remain competitive.

3.4 Specific Skills Shortages in Biopharma

The EU **Biopharma Resilience Index**[42] reports that 25% of firms say sourcing talent in technology, manufacturing, and R&D is a substantial or very substantial challenge. Research in the UK[43] suggests that a lack of talent may act as a brake to growth, with significant negative consequences on both commercial growth and inward investment. Various themes had been identified in a recent UK skills demand report[44]: 98% of companies are increasing their headcount within the next 5 years; 83% raised concerns that recruitment and/or retention of skilled individuals will be an issue for growth; and 63% believe digital skills will be critical for their future workforce.

3.4.1 Specific Skills Needs Identified in the Expert Interviews

Interview respondents[45] identified key shortage occupations, skills and characteristics, for the sector in Ireland, including the following.

- Engineers (involved in chemical and/or process control) who understand both digital and pharmaceutical manufacture and can drive processes and efficiencies.
- Engineers who can simulate processes and build digital twins.
- Digital/Data scientists who can create relevant programs and infrastructure for Biopharma manufacturing.
- Chemists/Pharmacists who understand artificial intelligence (AI) and can adapt to and apply new technologies.
- ATMP/Cell and Gene Therapy skills demand shows that the sector is innovative, but skills affecting the speed of progress from early product development through to pivotal clinical trials and commercialisation are a key challenge for firms engaged in this space.

40. BPC Skillnet (2023) Building Action Through Data: An Analysis of & Inclusion (EDI) in the BioPharmaChem Industry in Ireland An-analysis-of-EDI-in-the-BPC-Industry-in-Ireland-BCP-Skillnet.pdf (skillnetireland.ie)
41. The commencement of provisions in the Work Life Balance and Miscellaneous Provisions Act 2023 establishing the right to request remote working for all employees and other forms of flexible working arrangement for parents and carers is also a significant development in this regard.
42. https://www.cytivalifesciences.com/en/ie/about-us/global-biopharma-resilience-index
43. ABPI (2019) Bridging the skills gap in Biopharmaceutical Industry: Maintaining the UK's leading position in Life Sciences
44. UK Cell and Gene Therapy Skills Demand Survey Report (2021) https://cgt.ams3.cdn.digitaloceanspaces.com/2021-Skills-Demand-Survey-Report.pdf
45. 25 interviews took place with 75 individuals including small molecule manufacturing: large molecules/ biologics (including ATMP). A full list of Biopharmachem firms consulted is shown in Appendix B.

Additionally, the thematic analysis of the interview responses revealed the following priority areas for skill development and/or staff retention:

Improved data skills

Improved data skills were ranked as the highest priority need by the 25 firms interviewed for this study. The specific skill needs highlighted in this area include data handling, data visualisation and interpretation, design of experiment. (DoE), multivariate analysis and statistically based modelling techniques. Also highlighted was the importance of understanding of how to structure and interrogate large data sets for subsequent analysis. In addition to data scientists, a need to expand data skills for science and engineering personnel was also identified.

New product development, innovation, and R&D skills

An additional focus is needed on product and process development skills for new therapeutic entities, and on innovation for delivery of existing commercially licenced products. A more agile mindset is needed to address process development and innovation skills challenges.

Developing and maintaining the QC and regulatory skill base

Companies typically identified higher turnover of quality control analysts and regulatory personnel compared to turnover in other roles.

More transversal skills training

Many companies recognise the need to develop transversal skills in staff, including leadership, project management, technical writing and team working. Transversal skills are ranked much higher by companies in services subsectors than those in manufacturing.

3.5 Skills for Digital Transformation

The shift to digital and IT skills

The increased digitalisation of manufacturing and process development functions was identified by many companies as a key driver. A wider range of IT skills will be required in the future with an emphasis on development and maintenance of IT infrastructure to support data skills, as well as an increasing need to consider cybersecurity.

An increasing focus on Cybersecurity is being driven by changing work practices as remote and hybrid working becomes more prevalent. Cybersecurity skills needs are also likely to increase as increasing patient information is being stored as part of expansion in the ATMP[46] field. To address this need the HEA has created the Cyber Skills project[47]. It provides online, fully flexible university accredited micro-credentials and pathways for IT and other professionals to upskill. The content has been specifically designed and created by industry and academic experts and aligns to the NIST NICE Cyber Security Workforce Framework.

46. Advanced therapeutic medicinal products. Covering cell and gene therapy approaches.
47. https://hea.ie/skills-engagement/cyber-skills/

Digital skills needs were more highly ranked by the services sector than by the manufacturing sector. Future expansion of ATMP manufacturing and increasing automation is likely to further increase the requirement for more general digital & IT skills.

The Digitalisation Transformation

Digital transformation in manufacturing can be seen as having two phases: the digitisation of the physical manufacturing and other industry processes via sensors and the collection of the resulting data; and the analysis of this data to improve the physical processes, such as supply chain, manufacturing or quality control. Overarching this is the management of the digital transformation lifecycle from the initial assessment to ongoing continuous improvement. Three categories of roles or occupations are required to support this:

Digitisation requires suitably qualified Operators, Technicians, Analysts, Product Builders and Documentation Specialists.

Digitalisation requires: Automation Engineers, Commissioning Engineers, QC Specialists, Artificial Intelligence Specialists and Data Analytics Specialists. These should be qualified to Degree level.

Digital Transformation, the overarching management of this process requires: Project Managers, Site Leadership teams, Data Analytics Experts and Automation Experts; These should be qualified to MSc or MEng level.

The need for upskilling and reskilling

As the industry is in a process of transformation, a parallel process of up-skilling of the existing workforce is required to make it possible. It is clear that industry 5.0 will require technical, analytical and business skills. However, skills to understand and map processes as well as to collect and use data effectively are also essential. Additionally, core transversal skills include the ability to make sound value judgements, to be adaptable and agile, to take risks, and to communicate and collaborate well with others. These skills must be developed by the industry on an ongoing basis to support the transformation as it progresses.

3.6 Recruitment and Retention

Workshop participants highlighted that firms struggle both to recruit and retain talent associated with higher level qualifications (NFQ level 8+). The level of difficulty reported by firms in recruitment and retention of staff across manufacturing and services, based on interviews, is illustrated below.

Table 3.3: Recruitment challenges by subsector/functional area

RANKING (0-100: easy to difficult)	Recruitment	Retention
Manufacturing (all)	57.75	36.5
Services (all)	30.25	20.75

Source: EGFSN analysis of expert interview responses, 2022

Currently there are recruitment and retention challenges in both manufacturing and services. A breakdown of specific **recruitment and retention** challenges across functional areas in manufacturing subsectors is shown in Tables 3.4 and 3.5[48] respectively. Expert interviews revealed the areas where recruitment and retention of staff are most difficult for firms. For ease of interpretation, Tables 3.4 and 3.5 convert the data from the Likert scale used in the industry engagements into scores from 0 to 100. Lower scores indicate ease in recruiting or retaining staff; higher scores indicate difficulty. Scores higher than 75 are highlighted to identify areas were recruitment or retention are most difficult.

48. Terms used for Biopharma subsectors in the interview analysis are based on descriptions provided by interview participants themselves and so sometimes differ from those used elsewhere in the report.

Table 3.4: Difficulty/Ease of recruitment and retention in Manufacturing subsectors							
	Production	Quality	Ops	R&D	EHS	IT Automation	On-site services
Ease of recruitment (0-100: easy to difficult)							
Large Molecule	41	85	60	53	66	94	53
Small Molecule	39	64	66	55	44	64	50
ATMP	81	69	69	81	44	56	31
Pharmaceutical	48	60	63	78	38	48	23
Chemical	25	63	63	63	63	63	63
Average of all	47	68	64	66	51	65	44
Ease of retention							
Large Molecule	35	78	47	28	28	85	35
Small Molecule	27	44	17	8	17	27	5
ATMP	75	50	63	50	38	50	38
Pharmaceutical	53	60	23	23	28	28	13
Chemical	13	88	13	13	13	63	13
Average of all	40	64	32	24	25	50	20

Source: EGFSN analysis of expert interview responses, 2022

In terms of **recruitment**, Table 3.4 shows that for firms engaged in large molecule manufacturing, IT/Automation and Quality roles emerge as the most in-demand, while ATMP firms struggle to recruit staff for production roles. Large molecule and ATMP manufacturers also face challenges in filling R&D roles which typically require qualifications at PhD level. Overall, the four most difficult areas for recruit staff (highlighted in orange) are quality, R&D, IT/Automation and operations.

In terms of staff retention, the large molecule firms again struggle with IT/automation and quality roles. ATMP firms again struggle to retain production staff. Chemical firms find it difficult to retain staff for quality roles. Overall, retaining staff appears to be hardest for quality roles and somewhat difficult for IT and automation roles.

Table 3.5: Difficulty/Ease of recruitment and retention in Services subsectors				
	Transactional	Knowledge	Project	Other
Ease of recruitment				
Global business services	0	20	13	-
Biopharma services	25	38	25	-
Specialty pharma services	63	70	78	58
Specialist technology	38	70	70	-
Average of all	33	48	45	-
Ease of retention				
Global business services	0	13	10	-
Biopharma services	38	50	38	0
Specialty pharma services	28	28	40	0
Specialist technology	33	45	33	8
Average of all	25	33	30	-

Source: EGFSN analysis of expert interview responses, 2022

In services firms, Table 3.5 highlights that knowledge and project staff are most difficult to recruit, especially in Specialty Pharma Services firms and specialist technology firms. Overall, however, services firms do not appear to be having as much difficulty recruiting as manufacturing firms. The data derived from industry expert engagement suggests that services firms are not facing particular difficulty in retaining their staff. The highest score for this metric is 50, which is effectively an average level of difficulty.

3.7 Conclusion

All international analysts predict significant growth (ranging from 5-9% globally per annum) in the Biopharma sector. Ireland is well positioned to take advantage of this. The main areas of growth will be in biologics, and in provision of services, while small molecule manufacture will continue to be an important component of the sector. Irish sector employment in these areas can grow by up to 12% but ensuring access to appropriate talent will be critical. Companies report increasing difficulties in attracting talent and cite competition from within and beyond the sector, shortage of new graduates and greater demands by employees for remote, hybrid and flexible working and career development pathways as issues in recruitment. Data from company interviews, industry surveys, and employment data is presented to elaborate on these issues.

4

The Supply of Skills

This chapter outlines the complex skills provision ecosystem currently in place and provides industry views on the scale and adequacy of the outputs of this system. The skill supply system can be divided into three categories:

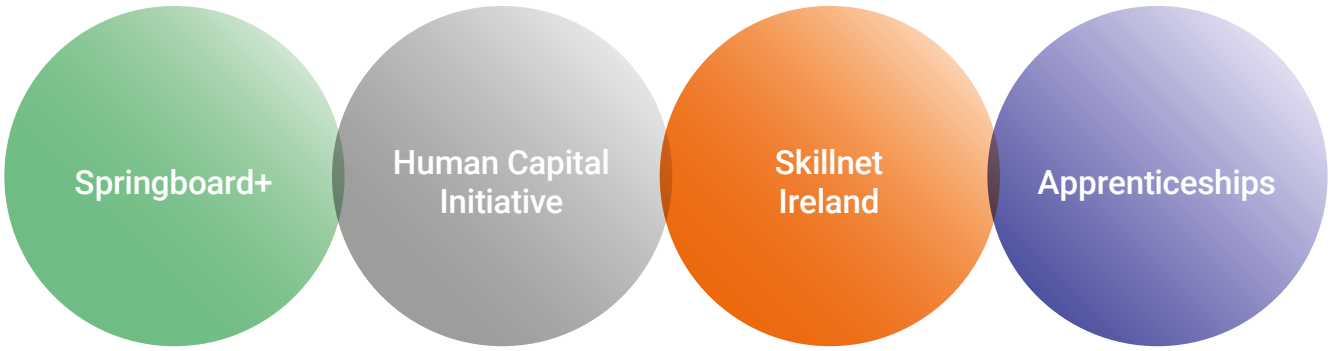
- organisations involved in funding training initiatives and providing inputs and oversight to skill development activities (4.1)
- Specialist Biopharma training providers (4.2)
- Further Education and Training and Higher Education providers (4.3)

The section then reviews current skills demand and supply (4.4. and 4.5) and presents conclusions on current supply issues and opportunities (4.6).

4.1 Funding and Oversight

The **National Training Fund (NTF)** is a Government initiative aimed at supporting workforce skill development. The NTF was established by the National Training Fund Act 2000 as a dedicated fund to support training of employees, and those seeking employment. It is managed by the Department of Further and Higher Education, Research, Innovation and Science. The Fund is resourced by a levy on employers as a percentage of employees' earnings.

Originally NTF funding was predominantly directed to SOLAS training programmes. Although SOLAS remains the major beneficiary, over time it has evolved to become a broadly-based fund that provides funding to many programmes and initiatives, delivered within different Government Departments, agencies and other bodies. These include the Springboard+, the Human Capital Initiative (HCI) apprenticeships, vocational training, work-based learning, and lifelong learning programs. Some of NTF initiatives of most relevance to the Biopharma sector are detailed below.



Support for programmes and initiatives is guided by the National Skills Council, together with inputs from the Skills and Labour Market Research Unit (SLMRU), Regional Skills Fora, the NTF Advisory Group, and the Expert Group on Future Skills Needs, as well as direct inputs by employers.

A significant source of industry input is **Biopharmachem Ireland** (BPCI)[49] which is the leading representative body for the Irish Biopharma and Chemical sector. BPCI influence, support and represent the sector in realising its ambition by highlighting sector needs and by promotion of member company interests. This includes communication of skill needs to all relevant agencies, and support for implementation of skill initiatives to members. Biopharmachem Ireland is the promoting organisation for BPC Skillnet and the Lab apprenticeship scheme (see below).

49. Biopharmachem Ireland – IBEC

Springboard+

Launched in 2011, Springboard+[50] is managed by the HEA and funded by NTF and the EU European Social Fund. Through collaboration with industry partners, it has supported over 117,000 learners in acquiring new skills and qualifications in the Biopharma sector through a diverse range of courses.

Human Capital Initiative

The Human Capital Initiative[51] fund, also managed by the HEA, was launched in 2019 and promotes innovative models of programme delivery, to help the HE system to respond rapidly to changes in skills requirements and in technology. The investment is made within 3 pillars:

- Pillar 1 Graduate Conversion Courses
- Pillar 2 Additional Places on Existing Undergraduate Provision
- Pillar 3 Innovation and Agility

Almost 4,000 learners have enrolled in HCI-supported programmes since 2019, of which over 700 have acquired new skills and qualifications in the Biopharma sector.

CASE STUDY

Enabling Future Pharma[52] is a HCI-funded project led by RCSI which is developing a suite of programmes aimed at creating graduates skilled in emerging and future pharma technologies to address skills gaps in industry and enable future growth. As the life sciences sector embraces the fourth industrial revolution in health and healthcare, characterised by the fusion of the digital, biological, and physical worlds, there is an increasing need for certain specialist skills to enable and support future career pathways. This project seeks to provide a range of programme options, including micro credentials, which deliver flexible pathways to prospective learners to develop these specialist skills. HCI funding has already enabled research expansion in areas including precision medicine, data analytics, and computational biology. Expansion of these areas into the undergraduate teaching space represents a significant body of expertise of national value. The project is delivering many new innovations including:

- Curriculum content which provides students with practical training in precision medicine techniques and tools.
- Innovative student assessments focus on demonstrations of competency rather than solely testing knowledge.
- Learners complete a full block dedicated to transversal/power skills development, focused on contemporary issues.
- An innovative learning platform has been developed to facilitate student access to large data sets on a 24-hour basis.
- Undergraduate learners complete an 8-month work placement within Industry to enhance their preparedness for professional scientific practice. Learners have the option of completing their research projects with industry partners and are provided with industry mentors to ensure graduates are workplace ready.

50. https://www.gov.ie/en/service/find-out-about-the-springboard-initiative/
51. Human Capital Initiative | Skills and Engagement | Higher Education Authority (hea.ie)
52. Enabling Future Pharma | Skills and Engagement | Higher Education Authority (hea.ie)

Biopharmachem Skillnet

Biopharmachem Skillnet[53] is funded by the NTF through Skillnet Ireland. BPC Skillnet was established in 2006 to foster a climate of whole-company learning and development through the provision of industry specific technical and non-technical training in the Biopharma and Chemical sectors. It works with member companies to design and deliver enterprise-led, subsidised training solutions. It is actively involved in promotion of the value of lifelong learning and the importance of ongoing professional development; and seeks to address gaps in existing educational provision while also working with industry to identify future skills requirements. BPC Skillnet trained 2,783 people in 2022, totalling 14,849 training days[54].

Apprenticeships

Apprenticeships is a statutory based programme of structured 'earn while you learn' education which formally combine learning in the workplace with learning in an education or training centre. The completion of an apprenticeship prepares the participant for a specific occupation and leads to a qualification recognised under the National Framework of Qualifications at levels 5-10. Apprentices are employed under a Contract of Apprenticeship. SOLAS serves as the coordinating provider for craft apprenticeships and works with the HEA to jointly manage the National Apprenticeship Office (NAO) to oversee national apprenticeship schemes.

Craft Apprenticeship curricula are periodically updated in consultation with industry to include future technologies relevant to specific industries. Apprenticeships help bridge the gap between academic knowledge and real-world application. While theoretical education provides a solid foundation, it is through apprenticeships that individuals acquire the practical skills and expertise necessary to excel in industry.

Since 2016, traditional craft apprenticeships have been supplemented by consortia-led apprenticeships. These apprenticeships are developed by industry-led consortia that include representatives of employers, sectoral bodies, employees, education and training institutions and public bodies and offer programmes between NFQ levels 5 -10 and vary in duration from 2 to 4 years. Programmes combine both on- and-off the job learning and a combination of online and blended learning. The employer continues to pay the apprentice a wage for the duration of the 'off-the job' phases. Consortia-led apprenticeship programmes must demonstrate that they are in key skill need areas and have innovative and agile methods of delivery to meet the needs of industry to gain approval and funding.

Table 4.1 illustrates the growth in enrolments in selected apprenticeships identified as being relevant to Biopharma between 2019 and 2022. While the apprentice population has increased notably in recent years, there remain challenges in terms of maximising the potential of the apprenticeship system as a source of skills for industry. These challenges are discussed further in section 4.5.1.

53. BioPharma, Chemical and Medical Device training courses – BioPharmaChem Skillnet (bpcskillnet.ie)
54. Data supplied by BPC Skillnet, 2023

Table 4.1: Enrolment trends in selected apprenticeships relevant to Biopharma 2019-2022							
Apprenticeship	**2019**	**2020**	**2021**	**2022**	**2023 (forecast)**	**% Change 2019-2022**	**% Change 2021-2022**
Biopharma							
Laboratory Analyst	21	18	18	14	0	-33%	0%
Laboratory Technician	10	12	12	37	30	270%	270%
Engineering							
Manufacturing Engineer (Level 7)	27	20	53	48	52	78%	-9%
Manufacturing Technology (Level 6)	29	30	42	90	112	210%	114%
ICT							
Cybersecurity	13	30	6	53	66	308%	783%
Cybersecurity Practitioner	0	0	0	2	10	-	-
Network Engineer Associate	44	22	11	33	71	-25%	200%
Software Developer Associate	66	42	53	148	173	124%	179%
Logistics							
Logistics Associate	34	53	74	79	80	132%	7%
Supply Chain Associate	0	0	13	15	15	-	15%
Supply Chain Manager	0	0	0	21	40	-	-
Supply Chain Specialist	0	10	22	15	15	-	-

Source: NAO, 2023[55]

CASE STUDY

The **Laboratory Apprenticeship** is a consortia-led apprenticeship consisting of two distinct programmes:

- Higher Certificate in Science Laboratory Technician, NFQ Level 6
- Ordinary Bachelor of Science Degree Laboratory Analyst, NFQ Level 7

The programmes were developed by industry in conjunction with the lead education provider TU Dublin, Tallaght in 2018. The first intake was in October 2018, where 11 companies were involved in employing 15 apprentices. The programme expanded to South East Technological University, Waterford in 2019 and to Munster Technological University , Cork in 2022. In 2023, 37 companies were involved, with 90 apprentices actively enrolled in the Level 6 and Level 7 across years one, two and three. A total of 55 apprentices have graduated from the programme to date.

55. https://content.apprenticeship.ie/f/83224/x/17217314b4/nationalapprenticeshipoffice_annualreport2022plans2023.pdf

4.2 Specialist Biopharma Training Providers

In addition to NTF-funded initiatives, other organisations are also key to maintaining a focus on current and emerging skill needs and to implementation of skills strategies and upskilling initiatives aimed at the Bio-pharma sector.

National Institute for Bioprocessing Research and Training

NIBRT[56] was established on the University College Dublin (UCD) campus with academic sponsorship from UCD, University College Cork, University of Limerick and Atlantic Technological University in 2006 to provide training for the Biopharma manufacturing workforce. It currently trains approximately 4,500 people per annum in person, and a further 6,200 via its Online Academy[57]- of which around 2,980 are registered in Ireland. NIBRT also hosts the Cell and Gene Therapy and Vaccine Manufacturing Forum[58]. This group was constituted in 2019 and now comprises over 120 members drawn from the large molecule Biopharma ecosystem. The forum meets quarterly with activities distributed across eight working groups, including a working group focused on the skills agenda and methodologies needed to develop the academic infrastructure to support manufacturing. NIBRT has produced detailed job ladders and competency profiles for the large molecule subsector and contributes to several national Biopharma training initiatives, including:

- NIBRT delivers Biopharma and biotech modules, funded through the Springboard+ programme, in partnership with various Higher Education Institutions (HEIs). Course placement and associated funding are offered to 750–800 students on NFQ level 6-9 programmes annually.
- CGT Advanced Therapeutics Facility Extension (€21 million investment in 2022) is available as a training facility for staff intending to work in the biologics and ATMP industry.
- Manages the 'Careers in Biopharma' annual event which promotes opportunities within the sector as part its wider portfolio of community engagement.

SSPC, the SFI Research Centre for Pharmaceuticals

SSPC began as an SFI Research Cluster in 2008 with 20 PhD students, hosted by the University of Limerick, in partnership with University College Cork, University College Dublin, University of Galway, and Trinity College Dublin. It grew to a full SFI Research Centre in 2013, and added South-East Technological University, the Royal College of Surgeons in Ireland, Dublin City University, and Maynooth University to the consortium. SSPC is a distributed national centre which conducts fundamental research with academic partners in collaboration with over 50 industry partners to build R&D excellence, capability and capacity for Ireland's Biopharma sector.

The Biopharma sector is a very significant employer of PhD researchers in Ireland. SSPC has educated and trained over 250 PhD graduates, with a further 120 currently in progress[59]. Over two-thirds of SSPC graduates transition from academia to industry[60], providing a critical pipeline of NFQ level 10 talent for the sector. SSPC is the largest provider of PhD graduates for the sector, offering a bespoke structured PhD programme with industrial secondments as a key feature to bridge the gap between research and practice. Over two-thirds of all international PhD students educated by SSPC are retained in employment in Ireland. Additionally, SSPC offers opportunities for employees in the sector to upskill via research-led Masters and PhD programmes nationally, while also contributing to national initiatives such as the NIBRT-led Cell & Gene Therapy and Vaccine Manufacturing Forum, and BPCI and BPC Skillnet.

56. NIBRT – National Institute for Bioprocessing Research and Training
57. Online Academy – National Institute for Bioprocessing Research (nibrt.ie)
58. Cell and Gene Therapy and Vaccine Manufacturing Forum – National Institute for Bioprocessing Research (nibrt.ie)
59. As of January 2024.
60. Average transition rate from academia to industry across Europe is 20-30%, reference is below: Hnatkova, E., Degtyarova, I., Kersschot, M., & Boman, J. (2022) 'Labour Market Perspectives for PhD Graduates in Europe.' European Journal of Education, 57(3), pp.395-409. 10.1111/ejed.12514

Innopharma

Innopharma[61] is a private Higher Education Institute which supports learners seeking to enter/re-enter the Biopharma, MedTech and Food manufacturing sectors; or existing staff who are seeking new skills or a formal qualification. A broad range of programmes are offered through blended and distance learning, including short 1–2-day targeted programmes, micro-credentials, and full QQI awards (NFQ levels 6-9). As well as equipping graduates with in-demand and industry specific skills, all programmes contain accredited modules aimed at enhancing key transversal skills, necessary to work in high tech, process-driven regulated environments.

Table 4.2: Innopharma Enrolments 2022-2023				
NFQ Level	5	6	7	8
Domestic Student Enrolments (2022-23)	479	244	176	150

Source: Innopharma, 2023

GetReskilled

GetReskilled[62] is an on-line education company dedicated to retraining or upskilling in the Biopharma and medical device industries, as well as in engineering and validation consultancies. Training is offered in collaboration with HE partners.

Over 3,000 adult learners (approximately 600 per annum) have taken Biopharma-related courses from 2018 to 2022 (Table 4.3). Half of these participated in QQI certified courses (15 ECTS at Level 7), of 10-months duration, requiring 10-12 hours per week of self-directed part-time study. The remainder took shorter skills specific courses, of 3-4 months duration, also requiring 10-12 hours per week of self-directed part-time study. Areas addressed include GMP (Good Manufacturing Practices), Risk Management Tools, Equipment Validation Protocols, Installation Qualification, Operational Qualification and Computer System Validation.

Table 4.3: GetReskilled Awards 2018-2022						
	2018	2019	2020	2021	2022	TOTAL
QQI Certificates	336	350	284	260	238	1,468
Skill Specific	245	286	396	388	245	1,560
TOTAL	581	636	680	648	483	3,028

Source: GetReskilled, 2023

4.3 Further and Higher Education Providers

4.3.1 Higher Education (HE) Sector

The Higher Education (HE) sector comprises of 19 Higher Education Institutions[63]-including Universities, Technological Universities and specialist colleges- offering courses from NFQ level 6-10. Undergraduate and postgraduate degree courses are offered in all the areas of technical skills need identified by this study: Engineering, Biological Sciences, Chemistry, Information Technology, and digital technologies, with postgraduate level master's and PhD courses offering participation in research in areas of interest and innovation in the Biopharma industry. The Technological Universities also offer a variety of Special Purpose Awards and upskilling/ reskilling focussed programmes across all disciplines from NFQ levels 6-9. Graduate output is outlined in Section 4.4.1. The HE sector is also becoming increasingly involved in the provision of apprenticeship programmes at NFQ Levels 6-10.

61. https://www.innopharmaeducation.com
62. GetReskilled – Retraining & Validation Courses for the Pharma Industry
63. Our Universities | Irish Universities Association (iua.ie)

The Higher Education sector is governed by the HEA which interacts with other national agencies, and with industry, in defining and funding courses and facilities that reflect industry need. For example, the conditions attached to funding of both Human Capital Initiative and Springboard+ courses are that all course submissions must demonstrate they have engaged with enterprise on skill needs, either regionally or nationally, and courses must be in key skill need areas for the economy. Programmes must be accessible through innovative and agile methods of delivery to meet the needs of industry.

In recent decades agencies such as Science Foundation Ireland, IDA Ireland and Enterprise Ireland have been focusing on development and funding of research projects and centres in collaboration with HEIs which address areas of scientific interest and need identified by industry. One major focus has been on R&D related to issues of interest to manufacturing industry. In addition to technology development, these types of centres also produce high-level expertise in new areas of industry interest. Examples include:

- **ABMER**, SFI's Centre for Advanced Materials and Bioengineering Research[64]
- **SSPC**, SFI's Research Centre for Pharmaceuticals[65]
- **PMBRC**, the Pharmaceutical and Molecular Biotechnology Research Centre, an Enterprise Ireland Technology Gateway[66]
- **PMTC**, the Pharmaceutical Manufacturing Technology Centre, an Enterprise Ireland Technology Centre[67]

4.3.2 Further Education and Training (FET) Sector

The Further Education and training (FET) sector offers a wide variety of life-long education options, including options aligned with NFQ Levels 1-6 as well as options outside the NFQ framework. FET options apprenticeships, traineeships and other courses. SOLAS has responsibility for funding, planning and coordinating FET.

Table 4.4: FET major awards in STEM disciplines 2019-2022

	2019	2022	Change (n)	Change (%)
Major awards (all fields)	29,538	25,225	-4,313	-15%
Engineering, manufacturing and construction	2,241	3,227	986	44%
ICT	549	568	19	3%
Natural sciences, mathematics and statistics	402	391	-11	-3%
Total STEM (n)	3,192	4,186	994	31%
Total STEM (%)	11%	17%	6%	

Source: QQI, 2023[68]

Through the 16 Education and Training Boards (ETBs) and other providers, the FET system offers access to a wide range of learning opportunities. It currently serves a base of approximately 200,000 learners every year. Much of FET is technical, vocational and practice-based by nature and as such science, technology, engineering and mathematics (STEM) education is a core part of the offering. Approximately 20,000 learners go through specific STEM courses each year. In 2022 for example, 186,740 people enrolled in FET courses of all award types (major, minor, special purpose etc.) and across all fields of study. Of these, 10% (or 18,487) enrolled in STEM-related courses, including 8,030 in engineering, manufacturing and construction; 8,030 in ICT; and 1,307 in natural sciences, mathematics and statistics[69]. The number of NFQ-aligned FET major awards in STEM subjects grew by 31% between 2019 and 2022. During this period, the proportion of STEM-related major awards as a proportion of all awards grew by 6%, as shown in Table 4.4 above, despite the significant disruption caused by the pandemic.

64. See: Homepage – Amber Centre
65. Home – SSPC
66. PMBRC – Pharmaceutical and Molecular Biotechnology Research Centre
67. Home | PMTC
68. Annual Analysis of Awards Made by QQI in 2022 (2023), p.11, QQI Certification Data and Analysis 2022_0.pdf Annual Analysis Made by QQI in 2019, qqi-award-certification-data-2019.pdf
69. This is FET Facts and Figures 2022, (Solas), solas_facts_report_2022.pdf

Numbers of learner completions- certified and uncertified in selected science and manufacturing FET courses identified as being relevant to Biopharma- many of which are organised in collaboration with the industry- can be found in Appendix F.

CASE STUDY

Cork Education and Training Board's Life Science Training Facility

This Life Sciences centre was opened in 2006. It is a 'hands on' training facility providing students with the practical skills required to work in Life Sciences companies which includes Pharma, Biopharma, and MedTech. The facility was developed in response to the identified needs of these industries for continual and flexible training supports due to changes in technology, regulatory demands and other factors. This facility provides effective systematic training in a mimic production environment. Learners develop and enhance their practical hands-on diagnostic skills and related knowledge training in complex inter – related technologies.

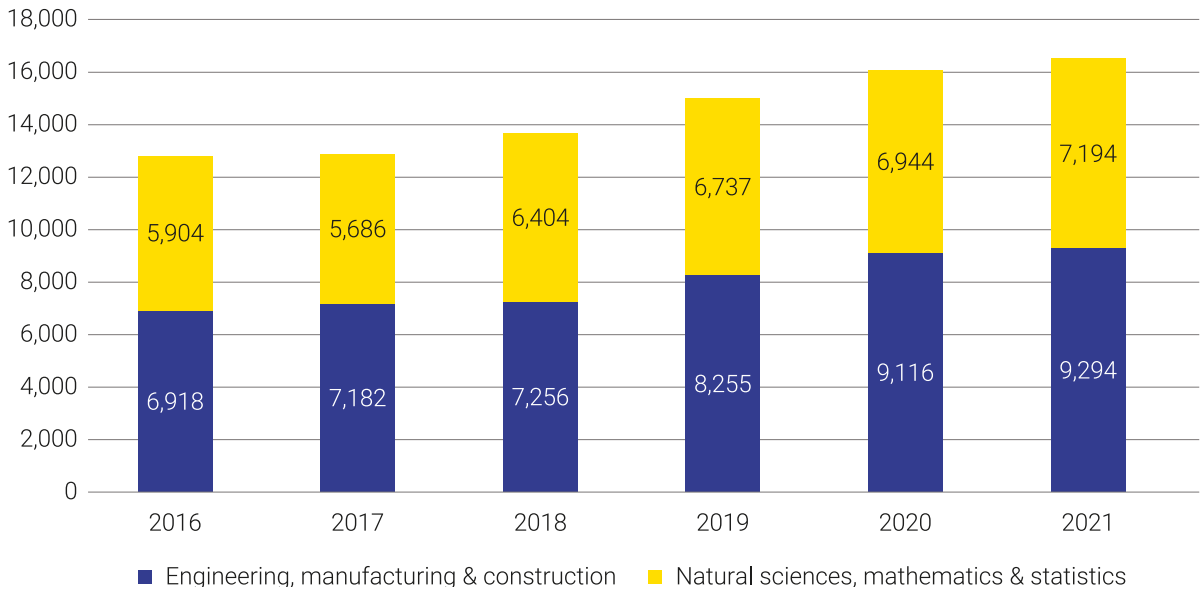
The primary course delivery is a Life Sciences Traineeship, which has 8 components and leads to a QQI level 5 major award. Learners attend full-time for 31.25 hours per week for 37 weeks followed by a 16-week work placement in a relevant company. The centre starts two programmes per year and approximately 60 students progress through the programme in a calendar year (accounting for those in placement). The success in transition to employment in the life science sector is over 90%. Additionally, the centre engages directly with local industry to provide upskilling opportunities for their employees, either through bespoke short duration practical skills delivery or completion of accredited components from the major award.

4.4 Graduate Numbers from HE and FET

4.4.1 HE and FET graduates by relevant broad field of study

The HEA and QQI report that nearly 100,000 people graduated from Higher Education courses across all disciplines in Ireland during 2021. Of these, over 9,000 and 7,000 respectively were from courses within the broad areas of study (broad ISCED classification) identified as being of particular relevance to the Biopharma sector, namely: (a) Engineering, manufacturing and construction; and (b) natural sciences, mathematics and statistics (See Figure 4.1). Over that period, the number of graduates in these broad categories increased by 34% and 22% respectively (see Table 4.5).

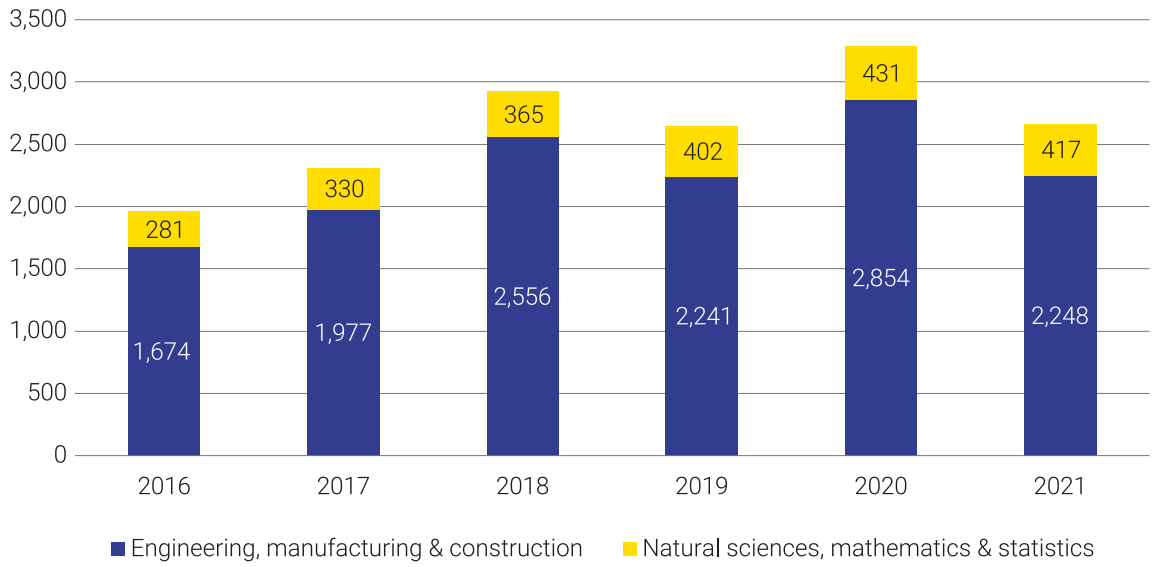
Figure 4.1: HE Graduates in relevant fields of study (broad ISCED classicisation, NFQ Level 6-10)



Source: SLMRU (2016-2020)[70]. Figures for 2021 use HEA[71]/QQI[72] data are indicative only.

The other major national source of skills is through FET courses. Trends in the numbers graduating with FET major awards in the broad ISCED classifications of Engineering, manufacturing and construction, and natural sciences, mathematics and statistics are shown in Figure 4.2. While exhibiting greater year-on-year unevenness in terms of numbers graduating than the HE sector, numbers of FET major awards in the broad engineering, manufacturing and construction category grew by 34% between 2016 and 2021, while major awards in natural sciences, mathematics and statistics grew by 48%.

Figure 4.2 : FET major awards in relevant fields of study (broad ISCED classification)

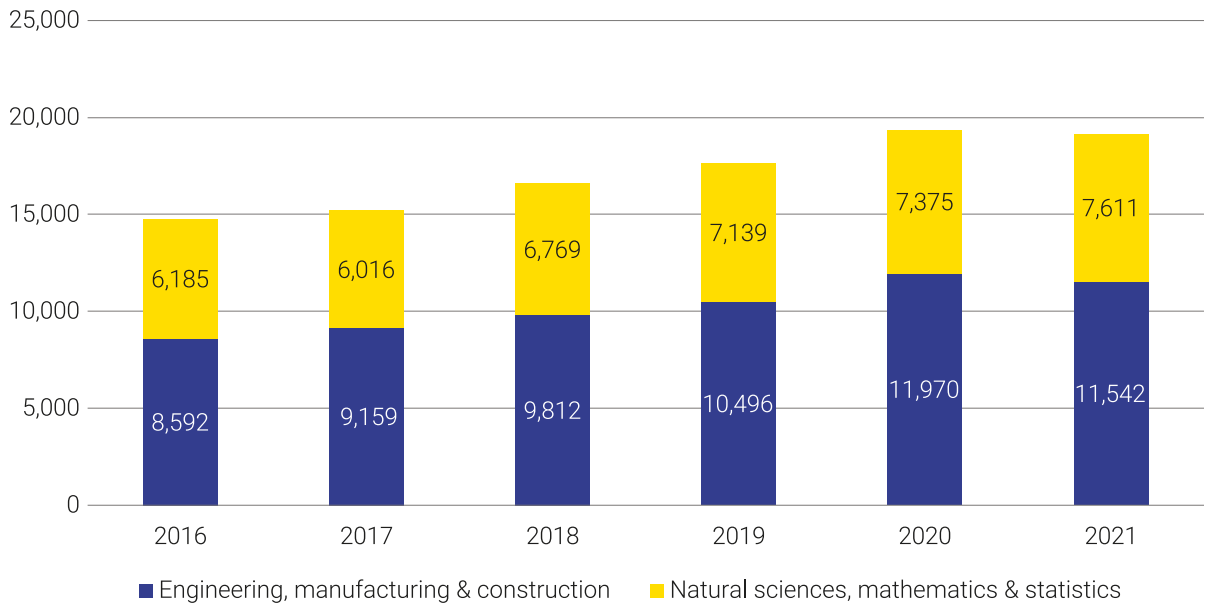


Source: EGFSN analysis of SLMRU (2016-2020), QQI (2021-indicative only).

70. Monitoring Ireland's Skills Supply 2022, SOLAS, Tables 3.2 and 5.2
71. Key Facts and Figures | Statistics | Higher Education Authority (hea.ie)
72. QQI Certification Data and Analysis 2022_0.pdf

Figure 4.3 below shows the combined total growth in the number of HE and FET major awards in engineering, manufacturing and construction and in natural sciences, mathematics and statistics. Between 2016 and 2021. Table 4.5 meanwhile compares the annual and overall growth rate across for HE and FET major awards over the same period. Taken together, they show the steady and significant growth over recent years in awards being made across all NFQ levels in these broad relevant areas of study potentially available to the Biopharma sector in Ireland.

Figure 4.3: Combined FET and FET awards in relevant fields of study (broad ISCED classification, all NFQ levels)



Source: EGFSN analysis of SLMRU (2016-2020), HEA/QQI (2021-indicative only) data

Table 4.5: Change in graduate numbers from HE and FET courses by field of study (broad ISCED)						
Field of Study	**2017**	**2018**	**2019**	**2020**	**2021**	**'17-21**
Natural sciences, mathematics & statistics (HE)	-4%	13%	5%	3%	4%	22%
Natural sciences, mathematics & statistics (FET)	17%	11%	10%	7%	-3%	48%
Engineering, manufacturing & construction (HE)	4%	1%	14%	10%	2%	34%
Engineering, manufacturing & construction (FET)	18%	29%	-12%	27%	-21%	34%

Source: EGFSN analysis of SLMRU (2016-2020), HEA/QQI (2021) data, 2023

4.4.2 HE graduates by relevant field of study

The SLMRU, the HEA and QQI provide data on HE awards at NFQ levels 6 to 10 by detailed field of study (detailed ISCED classification)[73]. Data for HE awards in 2020 in the disciplines most relevant to the Biopharma sector (biology, biochemistry, chemistry and chemical engineering) are shown in Table 4.6. This shows that there were 2,929 awards at NFQ level 6 to 10 in these disciplines in 2020.

The HEA 2021 Graduate Outcomes Survey estimated the proportion of biology, biochemistry, chemistry and chemical engineering graduates that were in employment nine months after their graduation. Specifically, it is estimated60% of graduates in these fields of sudy; 1,749 individuals, are likely to have entered employment in 2021 across NFQ level 6-10. There is some variation between NFQ levels as is shown in Table 4.6. Given the nature of the fields of study discussed in this section, it is likely that a significant proportion of these graduates entered employment in the Biopharma sector.

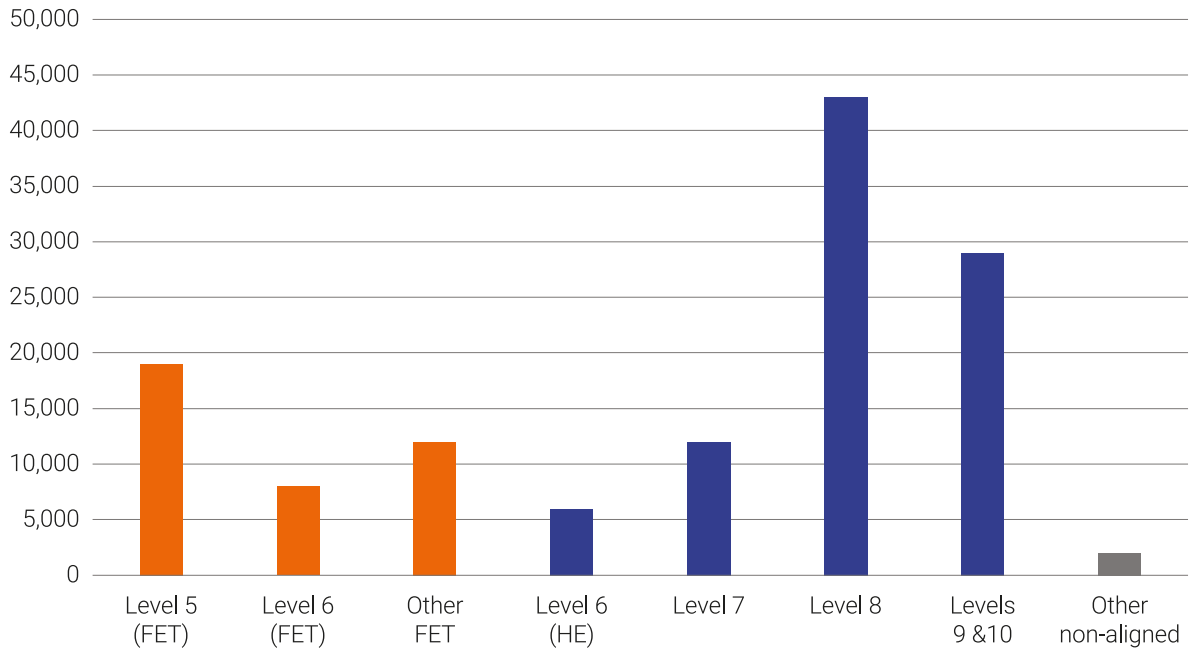
73. See Monitoring Ireland's Skills Supply – monitoring-irelands-skills-supply-2022.pdf (solas.ie)

Table 4.6: Science/Engineering Awards and potential employment by NFQ level and detailed ISCED field, 2020					
2020 HE awards[74]	NFQ 6 (HE)	NFQ 7 (HE)	NFQ 8	NFQ 9/10	Total
Biology	*[75]	134	625	118	888
Biochemistry	31	76	393	168	668
Chemistry	55	104	490	186	835
Chemical Engineering	65	102	122	249	538
Total awards	151	416	1,630	721	2,929
Of which estimated entering employment (%)[76] [77]	17%	17%	64%	85%	60%
Of which estimated entering employment (n)	26	71	1043	613	1,749
Biology	0	23	400	100	530
Biochemistry	5	13	252	143	399
Chemistry	9	18	314	158	499
Chemical Engineering	11	17	78	212	321

Source: EGFSN analysis of SLMRU/HEA data, 2023

4.4.3 HE and FET Graduates – All fields of study

Figure 4.4: Awards by NFQ Level 2020 (all fields of study)



Source: SLMRU,2022[78]

Data for all awards (rather than for specific fields of study) can be used to identify the likely proportion of all graduates who are available for employment in the Biopharma sector. The steps of this analysis are described below. The result is a similar estimate to that calculated based on specific disciplines in Section 4.4.2. The analysis (See Table 4.7) suggests that around 2,025 HE and FET graduates entered the Biopharma sector in 2020.

74. Monitoring Ireland's Skills Supply 2022, SOLAS, Tables 3.1 and 5.1
75. Small number, redacted for confidentiality.
76. Estimated graduate employment rates are those for the relevant broad ISCED classification found the HEA's 2021 Graduate Outcomes Survey. See Graduate Outcomes 2021 | Statistics | Higher Education Authority (hea.ie)
77. Relatively low percentages of graduates in science disciplines entering employment from Level 6-7 reflect a high proportion of such graduates engaging in continued study, training or research as per above HEA data. (59.1% full time, 21.3% part time)
78. monitoring-irelands-skills-supply-2022.pdf (solas.ie) page 14.

Table 4.7 presents the awards data along with graduate destination figures. The table shows the total number of awards made in 2020 across all disciplines by NFQ level, representing the total potential available supply of graduates. This is followed by the estimated percentage of these graduates entering employment, and in turn the proportion of these who entered employment in Industry broad industrial group (NACE B-E). The final estimate is the number of these employed graduates entering the Biopharma sector. Since 14% of employment across this broad NACE category is in the Biopharma sector, it is assumed that 14% of potentially available graduates who enter employment in Industry will work in this sector. Following these steps, the estimated number of graduates entering Biopharma in 2020 is 2,025. This represents a significant proportion of the sector's employment growth for that year, with the remainder being of that growth coming from sources such as recruitment from other sectors and economic migration.

Table 4.7: Estimated number of graduates entering Biopharma Sector in 2020, by NFQ level

2020* Awards	Level 4 & Level 4/5	Level 5-6 (FET)	Non-aligned (Other FET)	Level 6-7 (HE)	Level 8	Level 9 & 10	Prof	Total
Awards by NFQ level	2,809	26,577	12,384	18,121	42,939	29,333	1,840	134,003
Estimated entering employment (%)	44%	60%	60%	73%	77%	83%	100%	72%
Estimated entering employment (n)	1,236	15,946	7,430	13,228	33,063	24,346	1,840	97,089
Estimated entering employment in Industry NACE B-E (%)	21%	21%	21%	21%	11%	11%	11%	15%
Estimated entering employment in Industry NACE B-E (n)	260	3,349	1,560	2,778	3,637	2,678	202	14,464
Estimated entering Biopharma (%)[79]	14%	14%	14%	14%	14%	14%	14%	14%
Estimated Entering Biopharma (n)	36	469	218	389	509	375	28	2,025

Source: EGFSN Analysis of SLMRU/HEA and CSO data, 2023

4.5 Challenges and Opportunities

4.5.1 Challenges

The availability of new talent: The company interviews (see Section 1.2) highlight the difficulty in identifying enough candidates to support their growth plans and to mitigate staff turnover. This shortfall appears to be substantiated by the analysis (Chapter 5) showing that demand currently exceeds the number of graduates entering the sector. As a result, companies are hiring candidates who require additional training. Alternatively, companies report looking to EU and non-EU countries for suitable candidates.

Some multinational firms also reported that skills availability is a key factor when planning expansions and progressing investment. A perceived lack of skills in Ireland by global leadership could result in future investment decisions favouring other global locations over Ireland.

The continuing development of the talent pool: Developing relevant skills to ensure the success of the sector has never been so critical. Globalisation, the digital and technological transformation of the industry, the green agenda, hybrid working, and dispersed workforces combine to create a major change in skill needs. As the workforce expands in this changing context, more managers and leaders are required, and this too is a skills challenge. The risk to many traditional jobs due to changes in technology has already been highlighted. The growth of biologics will require new roles and skills to support this adaptation. Companies worldwide are alluding to a skill mismatch which urgently needs to be addressed.

79. We find that 14% of Industry (NACE B-E) employment is in Biopharma (NACE 20, 21)

In addition to a change in the technologies used to manufacture drug products, there is also a parallel growth in the digitalisation of processes and systems within companies. There is therefore a need for staff to have data management and digital skills in addition to their core skills in manufacturing technologies. Firms interviewed for this report stated that the majority of candidates were only proficient in the specific technical skills they studied. The implications of this are (a) the need to adapt degree programmes to address new and emerging skills needs through module changes and additions to existing courses, and (b) the need to upskill existing personnel in the sector with the new skill requirements.

Therefore, although there is a drive towards increasing the quantity of candidates, there is concern that the scope of new graduate skills may not be as 'rounded' as the sector needs. Key implications of this include the need to adapt degree programmes to incorporate new skills via module changes/additions and the need to upskill existing staff and graduates in the sector currently lacking these skills.

The 2022 **National Skills Bulletin** anticipates that future demand for scientific and engineering occupations will be strong and with some shortages likely to persist, and for some occupations this shortage will relate to those with experience in niche areas[80]. Many Biopharma firms express a preference for industry experience as a pre-requisite to employment, and graduates may struggle to meet this need.

This is reflected in the industry view that training course content and facilities should more closely reflect industry conditions. In essence, universities should educate graduates to understand the underlying principles, and industry should train staff (with appropriate supports) to apply these principles to their needs. Collaborative strategies adopted by industry and academia to address this include industry set projects, industry lectures, site visits and work placements- including the potential of paid sandwich years in industry for third level students.

A further area of need is in the soft skills required for effective in-company social interaction. This challenge was highlighted in an analysis undertaken by the iEd Hub, which is an initiative by University College Cork and Munster Technological University to meet the regional skills needs of the Health & Life Sciences sectors, and to share lessons learned. iEd undertook a mapping of courses by course content, and compared these with the recruitment needs of local firms. This highlighted a strong need for more transversal, soft skills and emotional intelligence and leadership skills. The study suggests that students are not being taught the transversal and soft skills that companies increasingly need[81].

Recruitment competition between Biopharma firms and with other sectors: In interviews and workshops, companies report significant competition for the recruitment of suitably skilled and qualified personnel from both other Biopharma companies and from other sectors- including Ireland's large and growing healthcare sector, which in many cases offers comparable career opportunities and employs many similar skillsets to those found in Biopharma[82]. Movement of staff between employers is more prevalent in the Manufacturing sector than in the Services sector, but in general this movement is higher than has been historically noted.

To mitigate this risk, firms have introduced a range of strategies and interventions including career development pathways and workplace flexibility, such as remote and hybrid working, and portfolio careers. Companies also report that they are considering the transferability of skills from other industries and business areas such as Information Technology, Medical Devices and healthcare. As this develops, it may see the sector widen its sources of supply for skills beyond those it has traditionally accessed such as those profiled in this chapter.

Promoting STEM and careers in Biopharma at Primary and Post Primary levels: Firms surveyed also feel that there needs to be a more concerted effort to promote careers in Biopharma at all levels considering the competitive recruitment challenges outlined above, including at primary and post-primary level. This will also require working with both primary and post-primary education to improve STEM skills at earlier stages in learners' educational journeys to help build secure future pipelines of talent and skills into the future and to actively promote greater awareness of the diversity of roles and multiple points of entry in and to the industry among young people.

80. National Skills Bulletin (2022) https://www.solas.ie/f/70398/x/3554445a46/national-skills-bulletin-2022.pdf (p.120)
81. iEd Hub (UCC/MTU/Health & Life Sciences Sector Cork) https://www.ucc.ie/en/med-health/iedhublaunch/
82. According to the Q2 2023 Labour Force Survey, close to 350,000 people are employed in the Human Health and Social Work sector in Ireland, up from around 270,000 in Q2 2018.
See: QLF03 – Persons aged 15-89 years in Employment (cso.ie)

Ireland's National Skills Strategy 2025[83] identifies a need to increase STEM participation at all levels. A new primary school curriculum featuring greater emphasis on STEM subjects, is currently under development and is expected to be rolled out from 2025-26 the school year, and it is envisaged that a new specification for STEM education will be finalised in early 2025.[84]

The Irish Government's STEM Education Policy Statement 2017–2026[85] sets out the goals and actions required to improve the STEM education experiences and outcomes for all learners, regardless of background, ability and gender, from early years to post-primary level. It recognises the need to nurture STEM in learners from a young age to ensure they have the required skills such as curiosity, inquiry, problem-solving, creativity, ethical behaviour and persistence to operate in the emerging world of work. The second STEM Education Implementation Plan to 2026, published in March 2023, calls for **"a range of quality professional learning experiences for early years educators and teachers across primary and post primary schools to support staff with STEM content knowledge, in planning and implementing integrated STEM activities"** at all levels of education.[86] In particular, the actions in the implementation plan will help to prepare the primary school system for the implementation of the new curriculum area of science, technology, engineering and mathematics in the 2025-2026 school year.

Examples of current initiatives involving collaboration between industry and the education sector to raise the profile of STEM in general and careers in Biopharma amongst both students and teachers at primary and post-primary include levels include:

- The STEM Teacher Internship (STInt)[87] provides paid summer internships in STEM roles for teachers in industry settings, including with industry partners in the Biopharma sector. The programme is coordinated by Dublin City University (DCU) and since 2016, a total of 177 STInt internships have been awarded to pre-service and early career teachers from 32 degree programmes in DCU, Maynooth University, TCD, UCC, UCD, University of Galway and University of Limerick.
- AMGEN's Biotech Experience,[88] delivered in collaboration with NIBRT, provides free training to secondary school teachers in molecular biology.
- NIBRT has been hosting an annual Transition Year programme since 2016[89]. A nationwide competition is held each year, and 5 students are selected (including a student from a DEIS school) to attend a week of structured activities at NIBRT. The TY programme is part of a wider NIBRT programme of community engagement, which also includes hosting the annual Careers in Biopharma fair which attracts an average of 25 biopharma companies annually exhibiting to around 1,000 attendees[90]. In 2023 NIBRT hosted its inaugural Culture Night tours to boost public awareness of the sector, with 60 members of the public attending.

83. gov – Ireland's National Skills Strategy (www.gov.ie)
84. STEM Education | NCCA
85. gov – STEM Education Policy (www.gov.ie)
86. STEM Education Implementation Plan to 2026 (p.11)
87. Home – STEM Teacher Internship Programme (stemteacherinternships.ie)
88. Home | ABE Ireland (amgenbiotechexperience.net)
89. NIBRT Transition Year Programme 2024 – National Institute for Bioprocessing Research
90. https://www.siliconrepublic.com/jobs-news/nibrt-biopharma-careers-companies-hiring

- SSPC has a robust and varied STEM promotion and engagement programme,[91] which has attracted €1.7 million in EU Horizon funding, enabling the upskilling of over 800 teachers in 14 counties, including Ireland, in Inquiry-based science education (IBSE) approaches. Additionally, SSPC developed a STEM Communication & Engagement module,[92] which has enabled the centre's community (including academia and industry) to develop and deliver pedagogically sound STEM communication and public engagement. SSPC developed 'A Day in the Life of a Scientist'[93] videos to boost public awareness of the work of biopharmaceutical researchers, which has garnered over 14,000 views on YouTube. SSPC has also been hosting an annual Transition Year programme[94] since 2013. This programme runs twice a year for approximately 40 students and offers structured activities such as bespoke Medicine maker workshops[95]. Elements of SSPC's 'Innovation in Medicines' Transition Year module (co-created with teachers, students, academics and industry) includes a site visit to industry. More recently, SSPC is leading EU programmes aimed at improving diversity in science, working with DEIS schools and minority groups to enhance meaningful representation in STEM.

An important dimension of promoting STEM in education and careers, including those in Biopharma, is securing greater gender balance, particularly in earlier stages of life and education. Pillar 1 of the STEM Education Implementation Plan to 2026 emphasises for example that we **"must ensure that learners have a positive engagement with STEM education, while also increasing the uptake of STEM related subjects for learners of all backgrounds, ability and gender."**[96]

While emphasising that there has been improvement in female representation in STEM fields in recent years, with more than 40% of doctoral graduates in physical sciences being awarded to women (HEA Figures, 2021), STEM Women Ireland note that a **"large gender gap in STEM at both university and workforce level"** continues to exist. For example, according to CSO data, only around 25% of those employed in STEM-related fields in Ireland are women and that while 43% of men entering higher education study STEM subjects, compared to only 19% of women- a 24-percentage point difference. STEM Women Ireland identify the gender imbalance in STEM in both education and employment as a contributory factor in shortages in STEM-related occupations for which demand is rapidly increasing, and something which needs to be addressed to meet Ireland's future economic and infrastructural needs.[97] IDA Ireland has produced a compilation of over 71 programmes and initiatives aimed at attracting, promoting and retaining women to/in STEM across all stages of their education and careers in order to meet this challenge.[98]

Growing apprenticeships: As noted above, there have been challenges in terms of maximising the growth potential of apprenticeships as a source of skills supply, including for the Biopharma sector. While the overall apprentice population has grown since 2016 and targets for those engaging in craft apprenticeships have been met, targets for participation in Consortia led apprenticeships have not-although the number of learners participating in these have grown since their introduction. Barriers to uptake of the latter from an employer perspective include their relatively recent introduction, issues relating to funding and costs- including the need to pay the full salary of the apprentice for time spent both working and learning 'off the job' and the need to cover this time by other staff. More broadly, while the inclusion of apprenticeships in the CAO system, along with promotion of apprenticeships in the media since 2022 has improved awareness of these amongst school leavers and their families, guardians and teachers, there continue to be gaps in awareness of apprenticeships as a viable career pathway, particularly compared to traditional third level career pathways.

91. https://sspc.ie/education
92. https://sspc.ie/race-raw-communications-and-engagement/
93. 'A Day in Life of a Scientist' highlighting the everyday lives of our scientists – SSPC
94. https://sspc.ie/sspc-transition-year-ty-work-experience-week/
95. https://sspc.ie/what-science-goes-into-making-medicine/
96. STEM Education Implementation Plan to 2026 (p.11)
97. Women in STEM Ireland: Statistics and Key Findings – Stem Women
98. https://www.idaireland.com/latest-news/infographics/women-in-stem/

4.5.2 Opportunities for skills enhancement

Increased collaboration between industry and academia: As identified above, there are many established relationships between sector firms and academic bodies focussed on skill development. Examples of these include:

- Apprenticeships specifically designed to address company needs have been developed in collaboration with SOLAS, the HEA and national industry groups.
- Regional partnerships, such as iEd Hub have been created between industry and academia, to support firm needs at a local level.
- The Human Capital Initiative and Springboard+ are funding the development of new models of education delivery to help the HE system to respond rapidly to changing industry skill needs.
- NIBRT provides responsive training programmes for company staff in specific process technologies and has actively responded to new technology needs indicated by Irish industry.
- NIBRT has completed an expansion to its pilot CGT Advanced Therapeutics production facility with 1,8002 of new space allocated for training and research into ATMP manufacture. This facility represents a significant opportunity for the development of new programmes focused on ATMP manufacture. NIBRT has begun to roll out initial programs in cell, gene and vaccine manufacturing[99].
- SSPC's structured graduate training programme involves over 28 companies via a membership model, ensuring a sectoral voice (through, for example, module delivery, training, industrial secondments and research days) in the development of Master's and PhD graduates. This programme spans the continuum from fundamental to applied research, ensuring that graduates have transversal skillsets.

In the expert interviews and workshops, many companies report extensive use of such external training initiatives. NIBRT and Skillnet Ireland's contribution to technical training and development in Biopharma manufacturing and services sectors was specifically noted. Nevertheless, companies report a need to expand these links, and to improve the scale and nature of the engagement between Industry, Government and the wider education sector in relation to skills.

For example, a noted industry concern is that academic bodies can be slow in responding to the pace of changing skills needs. The delivery of new skills through academic courses at higher levels has overly long lead times. In addition, it was noted that some of the laboratory teaching facilities are not at the standard necessary to fully prepare graduates for work in industry facilities. Development of a skills framework for the Biopharma sector would be useful in continually providing inputs to the process of course co-creation and customisation.

Nevertheless, the workshops and interviews noted good examples of 'world-first' partnerships, such as that which co-created a Master of Science (Level 9) course in Global Business Services[100].

99. The Advanced Therapeutics Ireland website includes specific links to training, research and clinical/regulatory affairs. See: https://www.atmp.ie/
100. https://www.ictskillnet.ie/training/msc-in-gbs-grant-aided/

CASE STUDY

The **iEd Hub**[101] is an HCI-funded educational consortium featuring the Cork region's universities, enterprise stakeholders, and companies in the Health and Life Sciences sector. The project aims to co-design and deliver a suite of new postgraduate programmes for the Health and Life Sciences sectors including indigenous and multinational companies. iEd education targets both technical, non-technical and innovation skill sets, with students dividing their time between industry sites and academic campuses. Operations of the iEd Hub platform are iterative and based on a 'Design-Build-Test-Learn' approach. iEd Hub's bespoke content and orchestration framework includes individual module content, delivery method and their combinations to achieve a qualification aligned with industry needs. The iEd project team collaborates with 13 industry partners in the MedTech and Biopharma sectors, including some of Ireland's largest employers in these areas. Industry has been very vocal about the joint capabilities of the consortium, such as the UCC's networks and in the health domain, coupled with MTU's engineering and applied teaching track record.

Developing a Skills Framework for the Biopharma sector: BPC Skillnet is developing a career pathways and skills framework for the Biopharma sector in Ireland. The Framework will feature information on trends and workforce profiles across the industry, along with a map of company locations and their supply chains. Occupations, job roles and aligned skills and competencies (both technical and generic) will be mapped, as will career pathways showing individuals' potential options for vertical and lateral career progression and growth. The Framework will consider both existing and emerging skills needs and will highlight the education and training options available for the upskilling and reskilling of both new entrants and existing in-service personnel.

This Framework will enable companies in the sector to identify, map and retain talent while enabling individuals to make informed decisions about and take responsibility for their skills development and career planning. Individuals will be able to discover employment opportunities, prepare for desired jobs and find avenues to identify and address gaps in their own skills and expand their skills set.

The development of a skills framework for the sector was strongly supported by the industry and featured prominently in the industry engagement undertaken for this study and represents a significant opportunity for collaboration between industry, academia and training providers.

Increased use of Micro-credentials: Micro-credentials are short "bite-size" accredited courses which can be stand-alone or stackable to achieve a full award. Courses are designed to provide the learner with specific knowledge, skills or competences which can be tailored to industry demands. 2016 Eurostat data highlights that the two key barriers to participation in lifelong learning[102] were time and cost. Many Universities and HEIs in Ireland are now offering a range of such courses delivering a more flexible and transformative learning experience. This initiative, which widens access to learning, empowers learners to advance their careers whilst providing employers with a knowledgeable and agile workforce.

For example, MicroCreds[103] is a 5-year, €12.3 million project (2020-2025) led by the IUA in partnership with seven universities: University College Dublin, University College Cork, University of Limerick, Trinity College Dublin, Dublin City University, University of Galway and Maynooth University. The initiative is being developed in collaboration with business representative organisations, enterprise agencies, private sector companies and state bodies with responsibility for skills.

101. See: iEd-Hub (iedhub.ie)
102. Eurostat (2016[17]), Adult Education Survey 2016: Population wanting to participate in education and training, by reason for not participating and sex: https://ec.europa.eu/eurostat/databrowser/view/trng_aes_176/default/table?lang=en
103. MicroCreds Project Overview | Irish Universities Association (iua.ie)

The project is funded through Pillar 3 (Innovation and Agility) of the Human Capital Initiative, with funding drawn from the National Training Fund. The project means that Ireland will be the first European country to establish a coherent National Framework for quality assured and accredited micro-credentials. IUA project partner universities are collaborating to develop, pilot and evaluate the building blocks required for a transformation in lifelong and life-wide learning through micro-credentials, with a particular focus on learners who are seeking to upskill, reskill, return to employment or change careers.

A further useful example is the M.Sc. in Analytical Science from SETU[104] which was designed in association with industry and provides standalone modules for industry employees. These can be done separately, resulting in a minor award, or combined with an industry-based research project resulting in an M.Sc. award.

Creating new pathways to HE: New models of progression, linking FET and HE in a more structured way, are now being discussed. Students will be able to start their degree programmes through a FET qualification which leads seamlessly to a HE qualification outside of the CAO system. This would be welcomed by the companies consulted for this study. It is important to emphasise that many of the emerging options described above are at an early stage of development. As such, Government and industry support and strong engagement between industry, academia and training providers in developing these initiatives will be vital for their success.

4.6 Conclusion

This chapter details the range of funding mechanisms that support training in the sector, and the nature of the coordinating bodies and providers of training to the sector. It is clear that there are many diverse and relevant courses available from Further Higher Education institutions and initiatives. However, growth in employment in the sector over the past five years has exceeded the growth in outputs from these education and training courses.

The number of graduates available to work in the sector has been estimated in two ways:

Firstly, by focusing on the discipline areas of greatest relevance to the sector technology base– sciences (biology and chemistry) and chemical engineering. Graduate destination data indicates the number of graduates that enter employment. It is estimated that approximately 1,800 graduates were available to the sector in 2020.

A second approach seeks to estimate the availability of other skills to the sector. The job role requirements of the sector are clearly much wider than just biology and chemistry. They have been set out in Chapter 2. By assessing the total number of graduates across all disciplines, broken down by NFQ level, it is possible to estimate the proportion that are likely to enter employment in the broad Industry sector[105]; and what proportion of this group is likely to work in the Biopharma sector[106]. This approach estimates that just over 2,000 are likely to have taken up employment in the Biopharma sector in 2020. This is very similar to the number obtained through graduate destination data.

Finally, several challenges are described. These broadly centre around the quantity and quality of the talent pool and competition with other sectors. Opportunities include greater collaboration between industry and academia; creation of better pathways from FET to HE qualifications, and greater use of Micro-credentials.

104. www.wit.ie/courses/postgraduate_diploma_msc_in_analytical_science_with_quality_management_part
105. (NACE B-E)
106. We find that 14% of Industry (NACE B-E) employment is in Biopharma (NACE 20, 21)

5

Forecasting Biopharma Skills Needs and Supply

This chapter seeks to model and quantify the likely future demand for skills in the sector (as described in Chapter 2) over to 2027 across three growth scenarios (high, medium and low). It considers both the potential net growth of employment in the sector deriving from its expansion and personnel replacement; and the potential of forecast graduate output to meet these recruitment needs. The chapter also considers future demand for upskilling and reskilling of existing and retained workers, and future trends in demand for occupational categories relevant to Biopharma.

5.1 Forecasting the Growth of In-Demand Occupations

Historical employment data and graduate destinations offers only broad insight on future skills requirements of the Biopharma sector and the capacity of current pipelines and policies to meet these needs, this data does not inform estimates for the current and future growth in demand for specific occupations and associated skillsets.

Considering the intense competition for talent already identified by firms through the expert interviews, an approach was used to identify potential critical skill gaps that will emerge in the future.

This approach utilised Standard Occupational Classifications (SOC) to categorise the occupations that are prevalent in the sector, and for which there is likely to be increasing demand in the coming years from both Biopharma and from across the wider economy. The SOC data presented here does not relate to any single sector but rather, to the prevalence of occupations across the whole economy. Specifically, this data serves to illustrate how when a particular occupational category is forecast to be increasingly in demand/present in an economy-wide context, it indicates that recruitment to that occupation will be more competitive and challenging in the future. Demand will come from both companies within the Biopharma sector and from across the wider economy, such as (noted earlier) Ireland's large healthcare sector.

To identify the high-demand occupational categories that closely correlate to the needs of the Biopharma sector, an index of SOC codes was created in collaboration with the CSO. These roles were then assigned to a relevant SOC code. Further SOC codes were added based on insights from the expert interviews and workshops.

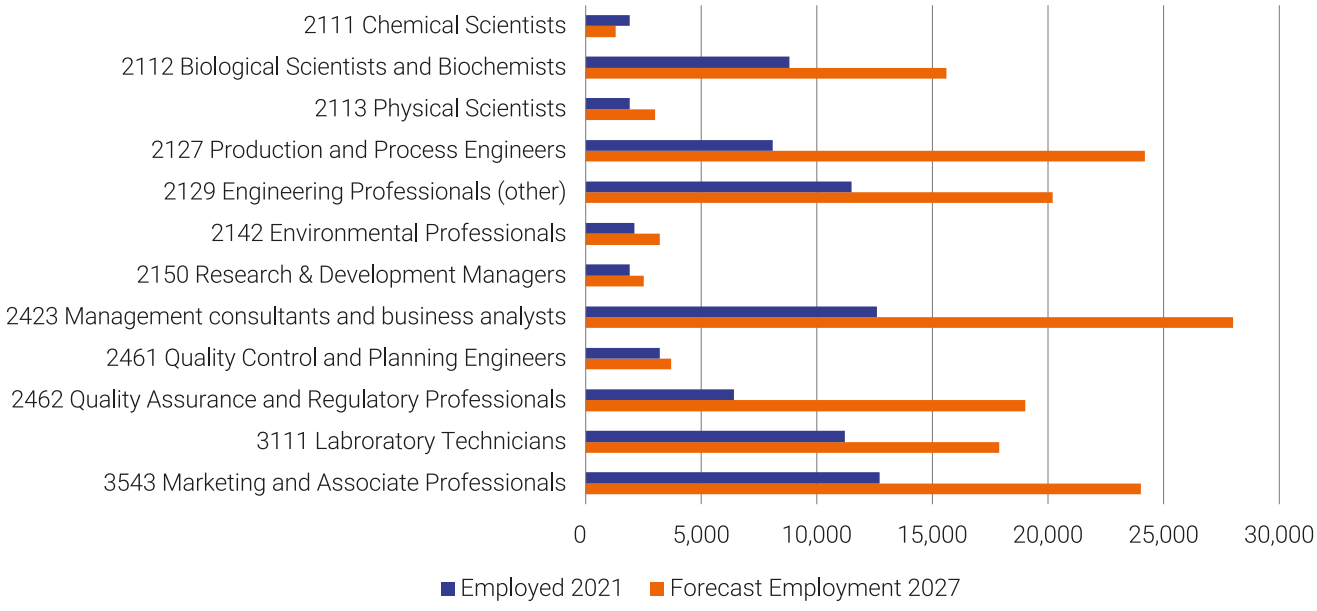
Labour Force Survey (LFS) data was then analysed to identify the historical employment numbers and compound annual employment growth rates for each occupational category across the whole economy between 2017 and 2021. These growth rates were used to forecast employment levels out to 2027, as shown in Table 5.1 and Figure 5.1.

These inputs suggested increasing demand for roles such as Data Analysts, Management Consultants, and roles relating to International Trade and Marketing. These will be needed not only in Global Business Services but also in Manufacturing. The identified additional roles also include those that support global business services. This analysis highlights the extent to which competition for specific crucial roles is likely to intensify in the future.

Table 5.1: Historical and forecast employment in relevant standard occupational categories 2017-2027 (whole economy-all sectors)					
SOC Title	SOC Code	Employed 2017	Employed 2021	CAGR 2017-2021	Forecast Employment 2027
Chemical Scientists	2111	2,400	1,900	-6%	1,300
Biological Scientists and Biochemists	2112	6,000	8,800	10%	15,600
Physical Scientists	2113	1,400	1,900	8%	3,000
Production and Process Engineers	2127	3,900	8,100	20%	24,200
Engineering Professionals (other)	2129	7,900	11,500	10%	20,200
Programmers and Software Development Professionals	2136	26,000	45,900	15%	107,700
Environmental Professionals	2142	1,600	2,100	7%	3,200
Research & Development Managers	2150	1,600	1,900	4%	2,500
Pharmacists	2213	3100	5,600	16%	13,600
Management Consultants and Business Analysts	2423	7,400	12,600	14%	28,000
Quality Control and Planning Engineers	2461	2,900	3,200	2%	3,700
Quality Assurance and Regulatory Professionals	2462	3,100	6,400	20%	19,000
Laboratory Technicians	3111	8,200	11,200	8%	17,900
Business and Related Associate Professionals (other)	3539	5,800	12,300	21%	38,000
Marketing and Associate Professionals	3543	8,300	12,700	11%	24,000

Source: EGFSN analysis of CSO Labour Force Survey data. 2021

Figure 5.1: Historical and forecast employment in selected standard occupational categories 2021-2027 (all sectors)



Source: EGFSN analysis of CSO LFS data, 2023

The expert interviews reported in Chapter 3 highlighted that firms already struggle with recruitment to roles such as those relating to quality, production and R&D. This reflects the historical trend in terms of growing demand for these roles and demonstrates that there is an increasing shortage of available skills. These interviews also identified a recurring theme that there will be increasing demand for data skills and roles across the sector.

The SLMRU's regular research on hard-to-fill vacancies echoes the findings of the interviews, workshops and data analysis undertaken for this study. For example, the SLMRU's 2022 Recruitment Agency Survey highlighted some of the specific roles for which there have been recruitment challenges, including quality control/assurance engineers, R&D, analytical and process scientists; and data analysts[107]. The SLMRU also report that 46% of all science, technology, and engineering firms were experiencing difficulty in recruiting roles in data analysis, process and manufacturing engineering, quality, regulatory issues, and R&D[108]. Similarly, SLMRU's 2023 list of hard-to-fill vacancies includes a range of Biopharma manufacturing and service roles, including: data analysts, engineers (including quality control/assurance, electrical, process, automation, EHS, manufacturing, validation, R&D and chemical), analytical and process scientists, pharmacists, pharmacovigilance specialists, regulatory affairs personnel (including compliance and managers) specialising in pharma, as well as recruitment challenges relating to accountancy, tax specialists and financial controllers[109].

As these roles are already hard to recruit and are forecast to grow in demand, they should logically be the priority focus for any interventions to support the sector in achieving its potential. The upskilling and reskilling of staff in existing roles will necessarily be a significant part of addressing this demand. Success in doing so will require funding support from Government, and cooperation of industry and the education and training system through release of staff and in co-creation of relevant flexible programmes and Micro-credentials.

5.2 Modelling Biopharma Employment Growth 2023-2027

Scenario Modelling was used to forecast the likely future growth in the range and numbers of jobs in the Biopharma sector. Three scenarios for growth over the period 2023-2027 were used as a basis for the models:

Low Growth: Global Forecast

5.39%[110]

CAGR to 2027 based on global forecast growth for the Biopharma sector applied uniformly across all of its subsectors.

Medium Growth: Expert Estimate

7.2%

CAGR to 2027 based on enterprise agency expert estimates of the growth potential of the Biopharma sector and each of its subsectors.

High Growth: Historical Trend

8.3%

CAGR to 2027 based on the Biopharma sector and each its subsectors maintaining their historical post-2016 growth rates.

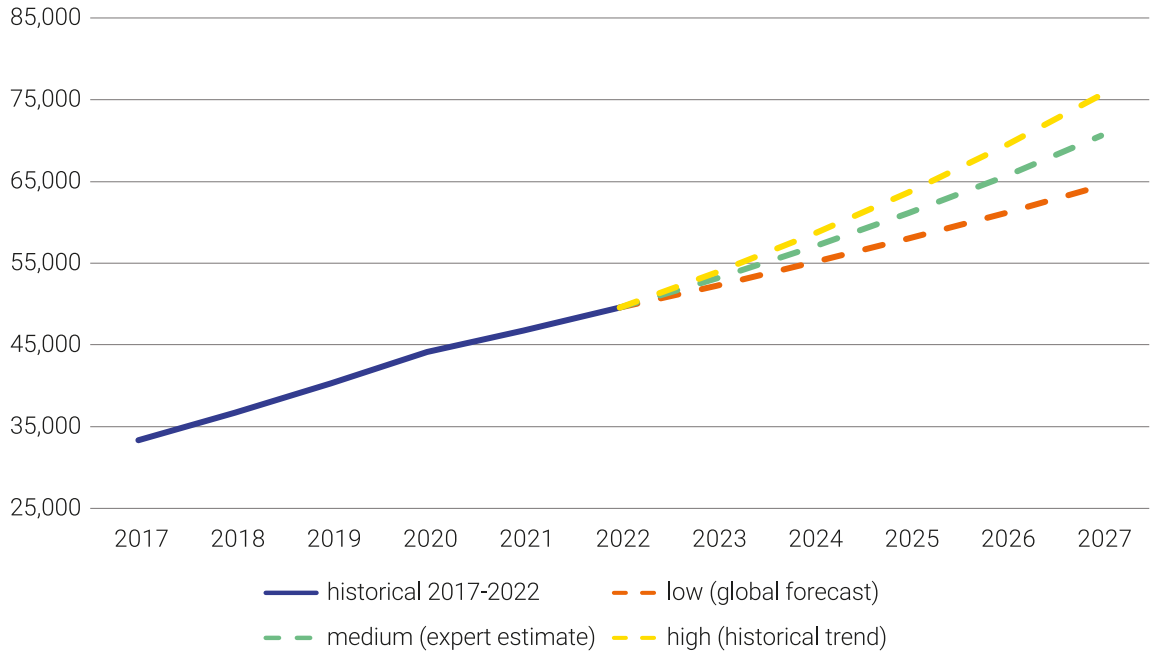
The modelling of scenarios is based on demand-led quantification. It is important to note that such forecasts are subject to external additional forces and/or unforeseen factors which may not have been factored into the assumptions underpinning them. This may affect their accuracy.

Data on overall sector employment is based on that provided by the IDA and EI through the Annual Employment Survey. Figures from these datasets were extracted for the period 2016-2022, for the sector as a whole and for each subsector. These figures were used as the historical baseline for the forecast scenarios.

107. national-skills-bulletin-2022 (2).pdf
108. Ibid.
109. SOLAS (2023) national-skills-bulletin-2023 (1).pdf, p.126
110. Figure of 5.39% global growth for the sector from Pharmaceuticals – Worldwide | Statista Market Forecast

In addition to overall growth, the forecast models also considered replacement demand within the sector, i.e., vacancies arising from factors such as employee retirement, emigration and movement to other sectors. This ensures a more accurate forecast of total recruitment needs. The replacement demand was estimated at 2.4% per annum, based on research undertaken for the EGFSN 2016 report on **Future Skills Needs of the Biopharma Industry in Ireland**.

Figure 5.2: Historical and forecast Biopharma employment growth 2017-2027 (all scenarios)



Source: EGFSN analysis, 2023

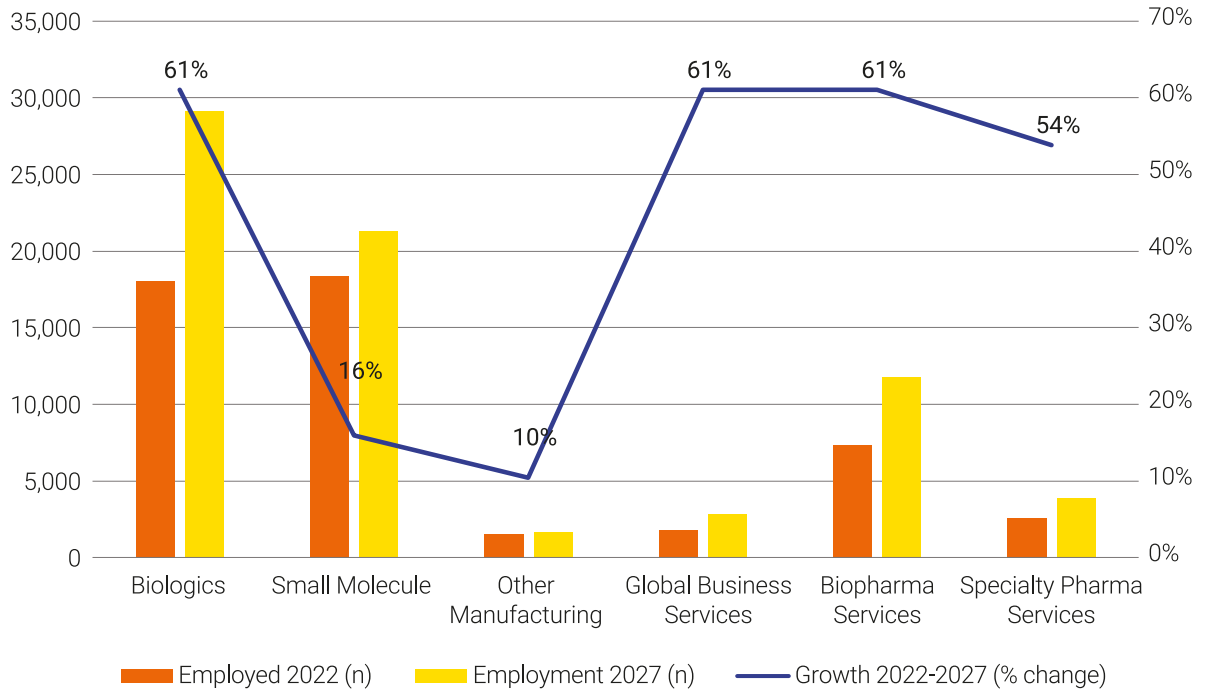
Figure 5.2 shows both the historical and forecast employment growth across the Biopharma sector between 2017 and 2027 under each of the three model scenarios.

Table 5.2 shows the forecast employment growth (2022 to 2027) in the Biopharma sector as a whole and in each of its manufacturing and services subsectors under each of the three forecast scenarios. The table also shows the forecast annual growth rates (CAGR) in each subsector, and the total additional jobs generated in each year. Under the Medium growth scenarios, Biologics manufacturing, Global Business Services and Biopharma Services are all expected to grow at 10% CAGR, while Specialty Pharma Services will grow at 9%. Under the Medium scenario, the highest number of additional jobs over the period 2022-2027 is forecast to take place in Biologics manufacturing (11,038), followed by Biopharma Services (4,476). Figure 5.3 illustrates the growth in numbers employed in each Biopharma subsector, along with the percentage change for each between 2022-2027 under the medium growth scenario.

Table 5.2: Forecast employment growth in Biopharma within high, medium and low growth scenarios to 2027							
	2022	2023	2024	2025	2026	2027	CAGR
High: Historical Trend							
Manufacturing	**37,949**	**40,964**	**44,269**	**47,896**	**51,879**	**56,257**	**8%**
Biologics	18,080	20,203	22,576	25,228	28,190	31,501	12%
Small Molecule	18,351	19,214	20,117	21,063	22,054	23,091	5%
Other Manufacturing	1,518	1,546	1,575	1,605	1,634	1,665	2%
Services	**11,621**	**12,865**	**14,243**	**15,768**	**17,458**	**19,331**	**11%**
Global Business Services	1,752	1,929	2,125	2,340	2,577	2,838	10%
Biopharma Services	7,332	8,157	9,075	10,095	11,231	12,495	11%
Specialty Pharma Services	2,537	2,779	3,043	3,333	3,650	3,998	10%
Grand Total	**49,570**	**53,828**	**58,511**	**63,664**	**69,337**	**75,588**	**8%**
Medium: Expert Estimate							
Manufacturing	**37,949**	**40,338**	**42,925**	**45,728**	**48,768**	**52,068**	**7%**
Biologics	18,080	19,888	21,877	24,064	26,471	29,118	10%
Small Molecule	18,351	18,902	19,469	20,053	20,654	21,274	3%
Other Manufacturing	1,518	1,548	1,579	1,611	1,643	1,676	2%
Services	**11,621**	**12,618**	**13,709**	**14,904**	**16,212**	**17,646**	**9%**
Global Business Services	1,752	1,927	2,120	2,332	2,565	2,822	10%
Biopharma services	7,332	8,065	8,872	9,759	10,735	11,808	10%
Specialty Pharma Services	2,537	2,765	3,014	3,285	3,581	3,903	9%
Grand Total	**49,570**	**53,096**	**56,931**	**61,104**	**65,649**	**70,601**	**7%**
Low: Global Forecast							
Manufacturing	**37,949**	**39,994**	**42,150**	**44,422**	**46,816**	**49,340**	**5%**
Biologics	18,080	19,055	20,082	21,164	22,305	23,507	5%
Small Molecule	18,351	19,340	20,383	21,481	22,639	23,859	5%
Other Manufacturing	1,518	1,600	1,686	1,777	1,873	1,974	5%
Services	**11,621**	**12,247**	**12,908**	**13,603**	**14,336**	**15,109**	**5%**
Global Business Services	1,752	1,846	1,946	2,051	2,161	2,278	5%
Biopharma services	7,332	7,727	8,144	8,583	9,045	9,533	5%
Specialty Pharma Services	2,537	2,674	2,818	2,970	3,130	3,299	5%
Grand Total	**49,570**	**52,242**	**55,058**	**58,025**	**61,153**	**64,449**	**5%**

Source: EGFSN analysis, 2023

Figure 5.3: Forecast Biopharma employment growth by subsector 2022-2027 (medium scenario)



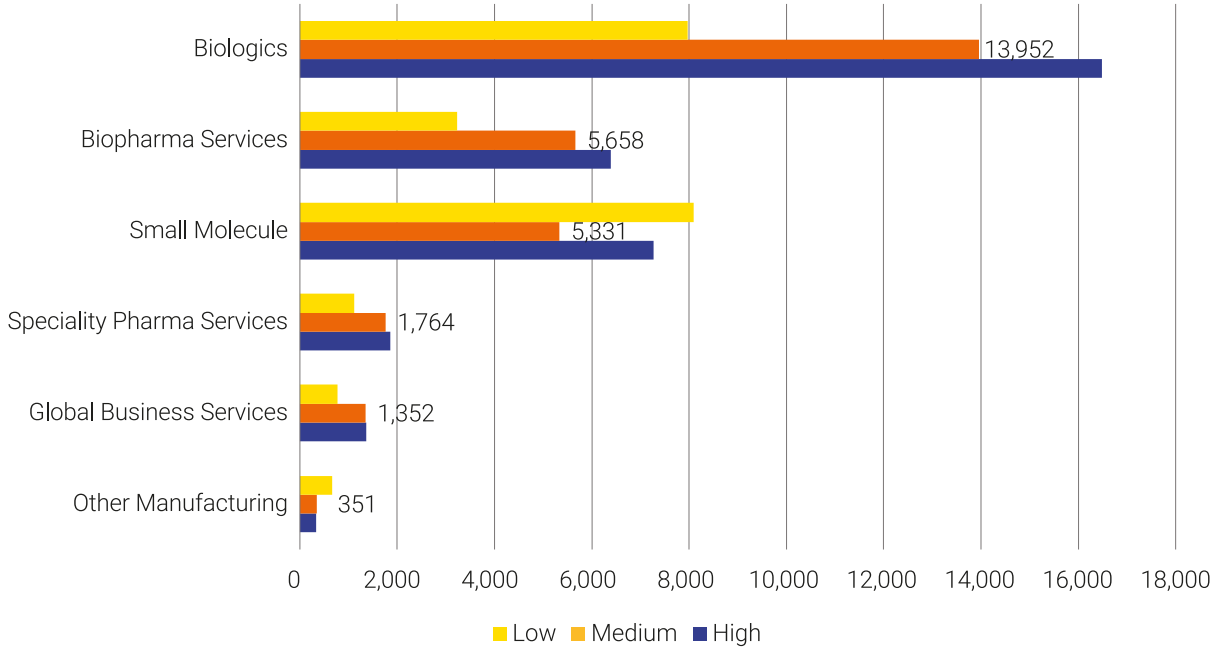
Source: EGFSN analysis, 2023

In addition to forecasting of total jobs in the sector, the models also considered replacement demand i.e., the need for firms to recruit to existing roles that staff have exited through retirement or change of career. A weighting of 2.4% of total workforce was applied to the totals of forecast sector jobs in each of the three scenarios to allow for the consequent recruitment needs of the sector. Table 5.3 shows the total recruitment needs including both additional jobs and replacement demand under each growth scenario for the sector as a whole and each subsector to 2027, along with forecast total annual average recruitment. Figure 5.4 illustrates and ranks the total recruitment need of each subsector over the same period.

Table 5.3: Total recruitment need – Additional jobs created plus replacement demand 2023-2027				
	Additional Jobs 2023-2027	Replacement Jobs 2023-2027	Total Recruitment Needed 2023-2027	Average Annual Recruitment 2023-2027
High: Historical Trend				
Manufacturing	**18,308**	**5,790**	**24,098**	**4,820**
Biologics	13,421	3,065	16,486	3,297
Small Molecule	4,740	2,533	7,273	1,455
Other Manufacturing	147	193	340	68
Services	**7,710**	**1,912**	**9,622**	**1,924**
Global Business Services	1,086	283	1,370	274
Biopharma services	5,163	1,225	6,388	1,278
Specialty Pharma Services	1,461	403	1,864	373
Grand Total	**26,018**	**7,702**	**33,720**	**6,744**
Medium: Expert Estimate				
Manufacturing	**14,119**	**5,516**	**19,635**	**3,927**
Biologics	11,038	2,914	13,952	2,790
Small Molecule	2,923	2,408	5,331	1,066
Other Manufacturing	158	193	351	70
Services	**6,912**	**1,861**	**8,774**	**1,755**
Global Business Services	1,070	282	1,352	270
Biopharma services	4,476	1,182	5,658	1,132
Specialty Pharma Services	1,366	397	1,764	353
Grand Total	**21,031**	**7,377**	**28,408**	**5,682**
Low: Global Forecast				
Manufacturing	**11,391**	**5,345**	**16,736**	**3,347**
Biologics	5,427	2,547	7,974	1,595
Small Molecule	5,508	2,585	8,093	1,619
Other Manufacturing	456	214	669	134
Services	**3,488**	**1,637**	**5,125**	**1,025**
Global Business Services	526	247	773	155
Biopharma services	2,201	1,033	3,234	647
Specialty Pharma Services	762	357	1,119	224
Grand Total	**14,879**	**6,982**	**21,861**	**4,372**

Source: EGFSN analysis, 2023

Figure 5.4: Total recruitment need (additional plus replacement jobs) by Biopharma subsector and growth scenario 2023-2027



Source: EGFSN analysis, 2023

5.3 Forecasting Graduate Inflow to Biopharma 2023-2027

To estimate the number of graduates that might enter the sector in the future, data from HEA, SLMRU and the CSO datasets were correlated with EI and IDA Biopharma employment data (see chapter 4). The analysis uses the historical data on the total potential supply of graduates (total awards made) and the proportions of these graduates that enter employment, which is estimated at 72% across all NFQ levels. Within this total, 15% have historically entered employment into the broad industrial group NACE B-E. More specifically, it is estimated that the proportion of this cohort to take up a position within the Biopharma sector is 14%. These calculations are the basis of the calculation in Table 5.4 which provides a forecast of total graduate entry into the Biopharma companies to 2027.

For the purposes of this model, the proportion of all graduates entering employment remains static at 72% on the assumption that:

- At each level of qualification (below PhD), a consistent proportion of graduates will choose to re-enter full-time learning to gain a higher-level qualification.
- There are no new additional policy interventions to increase the supply of graduates who move into employment either in general or into the Biopharma sector specifically.

Table 5.4: Forecast growth trend in awards and graduate entry to the Biopharma sector based on analysis of annual graduate data (all disciplines)

	2020	2021	2022	2023	2024	2025	2026	2027
Awards from level 4/5 upwards- all disciplines)	134,003	141,507	149,432	157,800	166,637	175,968	185,822	196,228
Estimated % entering employment	72%	72%	72%	72%	72%	72%	72%	72%
Estimated graduates into jobs	97,089	101,885	107,591	113,616	119,978	126,697	133,792	141,284
Of which 15% entering NACE B-E	14,464	15,283	16,139	17,042	17,997	19,005	20,069	21,193
Of which 14% entering Biopharma (estimate)	**2,025**	**2,140**	**2,259**	**2,386**	**2,520**	**2,661**	**2,810**	**2,967**

Source: EGFSN analysis, 2023

In the next section, the above estimates of future graduate inflow to the Biopharma industry will be compared with the projected overall recruitment needs of the sector to quantify the gaps between skills demand and supply to 2027.

5.4 Modelling Gaps between Skills Demand and Supply 2023-2027

Table 5.5: Gap between total recruitment demand (growth plus replacement) and graduate entry 2023-2027							
	2023	2024	2025	2026	2027	Total 2023-2027	Average 2023-2027
Forecast recruitment demand (net growth+ replacement)							
High: Historical Trend	5,550	6,087	6,681	7,337	8,065	33,720	6,744
Medium: Expert Estimate	4,800	5,201	5,640	6,121	6,646	28,408	5,682
Low: Global Forecast	3,926	4,137	4,360	4,595	4,843	21,861	4,372
Estimated annual graduate entry to Biopharma	2,386	2,520	2,661	2,810	2,967	13,343	2,669
Gap between recruitment demand/entry							
High: Historical Trend	-3,164	-3,567	-4,020	-4,528	-5,098	-20,377	-4,075
Medium: Expert Estimate	-2,414	-2,682	-2,980	-3,311	-3,679	-15,066	-3,013
Low: Global Forecast	-1,540	-1,618	-1,700	-1,786	-1,876	-8,518	-1,704

Source: EGFSN analysis, 2023

Forecast graduate output and overall Biopharma recruitment needs (net employment growth plus replacement demand) to 2027 for each growth scenario are shown above in Table 5.5. From these estimates, it is possible to quantify the estimated relationship between graduate demand, potential supply and graduate inflow into the sector to 2027.

For example, based on the medium forecasting scenario, the Biopharma sector will need to recruit an average of 5,682 people per annum to cover both net employment growth and replacement demand, while indicating that the potential inflow of new entrant graduates will average 2,669 per annum- assuming that the proportion of graduates entering Biopharma remains consistent. The potential shortfall in graduate inflow therefore averages just over 3,000 per annum. This analysis indicates that, presuming these estimated rates of sectoral recruitment need and graduate inflow hold true, it is unlikely that the domestic skills system will be able to meet the recruitment needs of the Biopharma sector in the coming years without significant policy interventions.

Not all future recruitment into the sector will consist of new graduates sourced domestically, and a notable proportion of available positions will need to be filled by more experienced personnel, while others will be filled by recruitment from other sectors and/or from abroad. However, this analysis highlights the potential challenge faced by the industry and Ireland's skills pipeline in terms of meeting demand in the coming years, and the importance of addressing these if the sector in Ireland is to realise its full growth potential. This challenge for both industry and the skills system is also further impacted by the need to upskill and reskill existing staff in the sector into the future, which is explored in the next section.

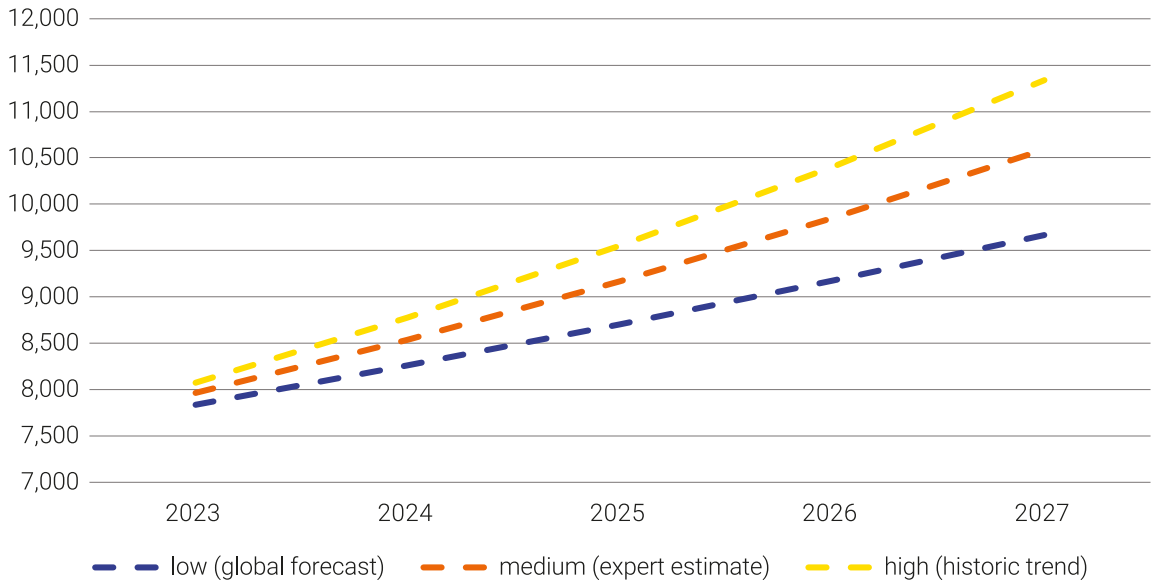
5.5 Forecasting the Demand for Training, Reskilling & Upskilling of Existing Staff 2023-2027

The interviews and other analysis conducted for this study have also identified that skills needs are not limited to additional and replacement jobs. Firms must also maintain their competitive advantage through ongoing training, reskilling and/or upskilling of existing employees.

The National Skills Strategy 2025[111] was used as a reference point to quantify the need to invest in skills development. This sets a target of 15% for engagement of all adults in lifelong learning, which is in line with the wider EU benchmark. Interestingly, recent statistics from SLMRU report that, as of Q4 of 2022, lifelong learning rates are as high as 19% within the cohort holding NFQ level 9-10 qualifications; and up to 17% for all professionals in Ireland.[112]

Nevertheless, a figure of 15% was applied to each year of the growth scenarios (Fig. 5.5) created for future employment in the sector. This suggests that over the period 2023-2027, the sector will need to invest in formal and informal training for between 43,639 and 48,139 staff, which is an average of 8,728 – 9,628 per annum. Table 5.6 sets out a likely breakdown of these trainees within each subsector for the period 2023-2027

Figure 5.5: Forecast number of employees engaged in training, upskilling & reskilling (all scenarios) 2023-2027



Source: EGFSN analysis, 2023

111. gov.ie – Ireland's National Skills Strategy (www.gov.ie)
112. Lifelong learning in Ireland (2023) lifelonglearning-report.pdf (solas.ie)

Table 5.6: Employees needing training, reskilling & upskilling (all scenarios) 2023-2027						
	2023	2024	2025	2026	2027	Total 2023-2027
HIGH: HISTORICAL TREND						
Manufacturing	**6,145**	**6,640**	**7,184**	**7,782**	**8,439**	**36,190**
Biologics	3,031	3,386	3,784	4,229	4,725	19,155
Small Molecule	2,882	3,018	3,160	3,308	3,464	15,831
Other Manufacturing	232	236	241	245	250	1,204
Services	**1,930**	**2,136**	**2,365**	**2,619**	**2,900**	**11,950**
Global Business Services	289	319	351	387	426	1,771
Biopharma services	1,224	1,361	1,514	1,685	1,874	7,658
Specialty Pharma Services	417	456	500	548	600	2,520
Total	**8,074**	**8,777**	**9,550**	**10,401**	**11,338**	**48,139**
MEDIUM: EXPERT ESTIMATE						
Manufacturing	**6,051**	**6,439**	**6,859**	**7,315**	**7,810**	**34,474**
Biologics	2,983	3,282	3,610	3,971	4,368	18,213
Small Molecule	2,835	2,920	3,008	3,098	3,191	15,053
Other Manufacturing	232	237	242	246	251	1,209
Services	**1,914**	**2,101**	**2,306**	**2,532**	**2,780**	**11,633**
Global Business Services	289	318	350	385	423	1,765
Biopharma services	1,210	1,331	1,464	1,610	1,771	7,386
Specialty Pharma Services	415	452	493	537	586	2,482
Total	**7,964**	**8,540**	**9,166**	**9,847**	**10,590**	**46,107**
LOW: GLOBAL FORECAST						
Manufacturing	**5,999**	**6,323**	**6,663**	**7,022**	**7,401**	**33,408**
Biologics	2,858	3,012	3,175	3,346	3,526	15,917
Small Molecule	2,901	3,057	3,222	3,396	3,579	16,155
Other Manufacturing	240	253	267	281	296	1,336
Services	**1,837**	**1,936**	**2,040**	**2,150**	**2,266**	**10,231**
Global Business Services	277	292	308	324	342	1,542
Biopharma services	1,159	1,222	1,287	1,357	1,430	6,455
Specialty Pharma Services	401	423	445	469	495	2,233
Total	**7,836**	**8,259**	**8,704**	**9,173**	**9,667**	**43,639**

Source: EGFSN analysis, 2023

5.6 Conclusion

This chapter presents forecasts for growth in demand for skills in the Biopharma industry over the next five years using three possible models for sectoral growth. The forecasts are based on analysis of current employment trends, patterns of graduate employment, and on other wider trends in the labour market and in the industry.

The analysis particularly focuses on the roles that are experiencing greater demand in the wider sector and subsectors. These roles were identified using Standard Occupational Classification (SOC) codes. This analysis is complemented with the output from expert interviews. These revealed that firms are facing challenges in recruiting, and in retaining, quality staff in scientific and data related roles. The shortage of skills associated with these roles is also reflected in the wider economy. The resulting data is used to present historical and projected compound annual growth rates for various roles. Based on this information, policy and labour interventions are proposed to prioritise support for skill development initiatives relevant to these roles.

Scenario modelling was also used to forecast the growth of jobs. Three scenarios (low, medium and high) were modelled based on the historical and estimated growth rates. The scenarios also accounted for expanded and replacement demand within the sector due to retirement or transitioning of employees to other sectors in the wider economy and highlight the scale of the challenge to meet the skills needs of the Biopharma sector in the coming years.

6

Conclusion

The Biopharma industry is one of the most important and successful parts of the Irish economy. This success has been driven by factors such as a highly skilled workforce, favourable taxation policies, and a strong ecosystem of supports. A review of future manufacturing and services skills needs in the sector is vital to ensure that this important industrial sector can realise its full growth potential. This review has considered current and future skill requirements, global and national trends and issues that will affect future skill requirements, and the current education and training infrastructure. Based on this analysis, some overall conclusions have been drawn.

6.1 The Biopharma Sector and its Skills Needs

The Biopharma Sector in Ireland

The Biopharma sector in Ireland comprises over 85 multinational and indigenous companies which directly employ around 50,000 skilled people and support an estimated additional 40,000 jobs across the wider economy. It is also noteworthy that these jobs are widely spread around the country.

Companies in the sector are active in both manufacturing and service provision and can be broadly classified as below:

The **Manufacturing** of a wide range of pharmaceuticals including:

- Small Molecule (i.e., Synthetic) APIs and drug products, as well as non-pharmaceutical chemicals
- Biologics or large molecule APIs and finished drug products.

The provision of **Services**, comprising:

- Global Business Services
- Biopharma Services
- Specialty Pharma Services

The Biopharma sector, in Ireland and globally, is expected to continue to grow both in scale and in diversity. International analysts predict the scale of global pharmaceutical sector growth to be in the range of 5-9% per annum.

Understanding the Skills Needs of the Biopharma Sector

To assess the specific skill needs of the Irish sector, the EGFSN undertook several approaches.

Mapping the current and emerging skills needs of the sector: The main personnel roles in Biopharma industries within a typical company were identified and listed under the following broad functional areas:

- Research & Development
- Production
- Regulatory Affairs
- Quality Control
- Supply Chain/Procurement/Planning
- Environmental / Occupational Health & Safety

Complimenting this, the distinctive skills needs of the Biopharma Services and GBS subsectors were also evaluated.

Trend analysis: A review of trends in the Biopharma sector including technological advances in processes, products and services and their skills implications, along with broader socio-economic factors were evaluated.

Key global trends reflected in Ireland include:

- **Growth in new therapies:** Advances in science have created new therapies such as biologics which use biologically derived rather than synthetic chemical active ingredients. The manufacture of biologics- and monoclonal antibodies in particular- has been a major driver of growth in the Biopharma sector in Ireland and internationally, with ATMPs/CGTs identified as important areas of future growth opportunity with corresponding skills needs.
- **Continuing importance of Small Molecule Manufacturing:** While the largest source of growth in recent years has been in biologics and in provision of services- a trend forecast to continue to 2027 and beyond, small molecule manufacture will continue to be an important component of the sector into the future.
- The growth of Ireland as an **international hub for Global Business, Biopharma and Specialty Pharma services.**
- **Personalised Medicine:** The traditional 'one-size fits all' blockbuster drug which allowed huge markets for individual products is now a rarity. Most modern drugs are effective only in a defined cohort of users. This has reduced the market size of individual products, and increased market costs.
- **Social Medicine:** public health organisations struggle to meet the high cost of new therapies. This has led to more demanding processes for re-imbursement; more centralised purchase agreements; and the growth of biosimilars and generics.
- **External contracting:** Specialised biologic processes requiring entirely new skill sets and facilities has led to a growth in contract manufacturing.
- **AI and Big Data:** increased process automation and robotics in manufacturing, logistics and marketing has led to greater need for AI and digital skills in the sector.
- **Continued growth** for the Irish Biopharma sector but **increased competition** with other global locations in terms of investment, again highlighting the importance of skills to maintaining Ireland's international competitiveness.
- **Sustainability** as a strategic objective for the sector.

Employment trends in the Biopharma sector as a whole and in each subsector between 2016-2022 were reviewed. These trends are shown in Table 6.1:

- Employment in the sector grew by 61% at a rate 8% CAGR between 2016-2022, resulting in nearly 19,000 additional jobs in total across all subsectors.
- Highest rates of employment growth were seen in the Biologics manufacturing subsector (12% CAGR), followed by Biopharma Services (11%), Global Business Services and Specialty Pharma Services (both 10% CAGR).
- Biologics also saw the highest number of additional jobs created (8,928 additional), followed by Small Molecule manufacturing (4,367) and Biopharma Services (3,232).

Table 6.1: Employment trends in the Biopharma sector 2016-2022					
	Employed 2016	Employed 2022	CAGR	% Change	Total Additional Jobs
Manufacturing	24,484	37,949	8%	55%	13,465
Biologics	9,152	18,080	12%	98%	8,928
Small Molecule	13,984	18,351	5%	31%	4,367
Other Manufacturing	1,348	1,518	2%	13%	170
Services	6,311	11,621	11%	84%	5,310
Global Business Services	944	1,752	10%	86%	808
Biopharma Services	4,100	7,332	11%	79%	3,232
Specialty Pharma Services	1,267	2,537	10%	100%	1,270
Grand Total	30,795	49,570	8%	61%	18,775

Source: EGFSN analysis, 2023

- Analysis of employment permit data also highlighted the marked increase in the inflow of skilled personnel into the Biopharma from outside the EEA in recent years, with nearly 3,000 employment permits issued between 2016 and 2023- an increase of over 400%. These permits were issued for approximately 80 Standard Occupational Classifications across a highly diverse range of manufacturing and service roles, highlighting both the rapid growth of the sector and the recruitment challenges stemming from this.

Stakeholder consultation: Data from company interviews, industry surveys and three regional stakeholder workshops involving industry, education and training provider and public bodies were analysed and showed the following:

- **Many companies have difficulty in attracting staff** to support their growth plans and to mitigate staff turnover. There is increasing competition among Biopharma companies for existing staff, as well as with other sectors such as healthcare. Staff shortages are not specific to Ireland, however. EU and UK surveys also report issues related to sourcing talent.
- **Staff retention was identified as an issue,** particularly by manufacturing firms. Competition between Biopharma companies and from other sectors for talent, along with the potential and challenges of changing work models were cited. Staff seek roles that facilitate remote, hybrid and flexible working arrangements, and roles with opportunities for professional development and expanded career portfolios.
- **There is a shortage of Senior Directors**. Infrastructural issues, such as housing, education and childcare, are seen as a deterrent to attraction of senior management to Ireland.
- **Lack of availability of higher technical qualifications (NFQ Level 6+)** such as data skills and digital skills. This is considered to potentially affect future FDI investment.
- **Ready-for-industry skill sets** such as data management, product development, innovation & R&D, QC and Regulatory skills are required by sector companies, as well as chemical, biochemical and automation engineering skills.

Specific skills challenges identified through the industry interviews:

- **Improved data skills** are a major need, and specifically data handling, statistically based modelling. In addition to data scientists, science and engineering personnel with data skills are required.
- **Innovation, and R&D skills** for new therapeutic entities, and for delivery of existing products. A more agile mindset is needed to address process development and innovation challenges.
- **QC and regulatory skills.** A higher turnover of quality control analysts and regulatory personnel compared to turnover in other roles was identified.
- **More transversal skills training** including project management, technical writing and team working. Transversal skills are in particular demand in services roles.

- Skills for the **Digital Transformation** of the Biopharma sector, including:
  - » **Digitisation skills,** including suitably qualified Operators, Technicians, Analysts, Product Builders and Documentation Specialists.
  - » **Digitalisation skills,** including Automation Engineers, Commissioning Engineers, QC Specialists, Artificial Intelligence Specialists and Data Analytics Specialists.
  - » **Digital Transformation skills** for the overarching management of this process including Project Managers, Site Leadership teams, Data Analytics Experts and Automation Experts.

All these analytical approaches showed that a greater number and range of skills will be required in the future. The SLMRU's reports on 'hard to fill vacancies' echo the findings of the interviews and workshops in relation to the difficulty in recruiting people with specific skills to the sector.

Existing staff must continually enhance their skills to adapt to the rapid changes anticipated. Future core skill needs include critical thinking and problem-solving, as well as self-management skills such as active learning, resilience, stress tolerance and flexibility. Personnel with digital technology and data management expertise will be in greater demand in manufacturing. The roles to be filled are also diverse and include R&D, production, regulatory affairs, quality control, supply chain management etc. The service companies have an equally diverse set of different skill needs.

As these roles are already hard to recruit and are forecast to grow in demand, they should logically be the priority focus for any interventions to support the sector in achieving its potential. The upskilling and reskilling of staff in existing roles will necessarily be a significant part of addressing this demand.

Growth Scenario Modelling

Low, medium and high scenarios of future growth for the sector to 2027 (from 5.39 – 8.3% CAGR) were modelled. These scenarios also accounted for both net employment growth for the industry and each subsector, replacement demand, as well as for an anticipated expansion in transition of employees to and from other economic sectors. Under the Medium growth scenario (shown in table 6.2), Biologics manufacturing, Global Business Services and Biopharma Services are all expected to grow at 10% CAGR, Specialty Pharma Services will grow at 9% while Small Molecule manufacturing will grow at 3%.

Table 6.2: Forecast employment growth in Biopharma to 2027 (medium scenario)

	2022	2023	2024	2025	2026	2027	CAGR
Manufacturing	**37,949**	**40,338**	**42,925**	**45,728**	**48,768**	**52,068**	**7%**
Biologics	18,080	19,888	21,877	24,064	26,471	29,118	10%
Small Molecule	18,351	18,902	19,469	20,053	20,654	21,274	3%
Other Manufacturing	1,518	1,548	1,579	1,611	1,643	1,676	2%
Services	**11,621**	**12,618**	**13,709**	**14,904**	**16,212**	**17,646**	**9%**
Global Business Services	1,752	1,927	2,120	2,332	2,565	2,822	10%
Biopharma services	7,332	8,065	8,872	9,759	10,735	11,808	10%
Specialty Pharma Services	2,537	2,765	3,014	3,285	3,581	3,903	9%
Grand Total	**49,570**	**53,096**	**56,931**	**61,104**	**65,649**	**70,601**	**7%**

Source: EGFSN analysis, 2023

Table 6.3 illustrates the total recruitment needs of the Biopharma sector (additional jobs plus replacement jobs, estimated at 2.4% per annum) under the medium growth scenario. Under this scenario, the highest number of additional jobs over the period 2023-2027 is forecast to take place in Biologics manufacturing (11,038), followed by Biopharma Services (4,476) and Small Molecule manufacturing (2,408).

Based on the modelling, the total average annual recruitment needs of the sector (additional plus replacement jobs) in 2023-2027 will range from 4,372 (Low growth), 5,682 (medium growth) to 6,744 in a high growth scenario. Within this total, the major areas for skills demand will be in manufacturing (ranging from 3,347 to 4,820 in the three scenarios) while the services need will range from 1,025 to 1,924.

Table 6.3: Total forecast recruitment need 2023-2027: Additional jobs created plus replacement demand (medium scenario)

	Total Additional Jobs	Total Replacement Jobs	Total Recruitment Needed	Average Annual Recruitment
Manufacturing	**14,119**	**5,516**	**19,635**	**3,927**
Biologics	11,038	2,914	13,952	2,790
Small Molecule	2,923	2,408	5,331	1,066
Other Manufacturing	158	193	351	70
Services	**6,912**	**1,861**	**8,774**	**1,755**
Global Business Services	1,070	282	1,352	270
Biopharma services	4,476	1,182	5,658	1,132
Specialty Pharma Services	1,366	397	1,764	353
Grand Total	**21,031**	**7,377**	**28,408**	**5,682**

Source: EGFSN analysis, 2023

In addition to new recruits, firms must also reskill and/or upskill their existing employees. The review suggests that over the period 2023-2027, the sector must invest in formal and informal training for between 43,639 and 48,139 staff, (or 8,728 – 9,628 per annum), depending on the growth scenario.

6.2 Modelling Gaps between Skills Supply and Demand to 2027

The Supply of Skills

The skills needs of the Biopharma sector are currently addressed through a diverse range of mechanisms and training providers, including:

Funding and oversight bodies are organisations which fund training initiatives and provide inputs and oversight to skill development activities. The major organisation in this category; The National Training Fund (NTF) is a Government initiative aimed at supporting workforce skill development by providing funding to programmes and initiatives delivered by different agencies. The initiatives most relevant to the Biopharma sector include:

- **Springboard+**, which has supported over 117,000 learners in the sector to date.
- **Human Capital Initiative**, which has supported 700 sector staff since 2019.
- **Biopharmachem Skillnet,** which trained 2,783 people in 2022.
- **Apprenticeships,** which hosted over 500 apprentices in programmes relevant to the Biopharma sector in 2022.

Biopharmachem Ireland (BPCI) is the leading representative body for the Irish Biopharma and Chemical sector and is also a significant source of industry input to training needs.

Specialist providers of education and training relevant to Biopharma, including:

- The National Institute for Bioprocessing Research and Training (NIBRT) which trains 4,500 people per annum in person and others on-line.
- SSPC, funded by Science Foundation Ireland, industry and EU, which has trained over 250 graduates with over 120 more in the pipeline (as of early 2024).
- Private providers such as Innopharma, which has trained over 1,000 food and pharma staff in NFQ levels 5-8 in 2022-23; and GetReskilled which trained 3,000 on Biopharma-related courses from 2018 to 2022.

Further Education and Training institutions made 4,186 major awards in STEM disciplines in 2022, including 3,227 in engineering, manufacturing and construction; 568 in ICT; and 391 in natural sciences, mathematics and statistics. Graduates from FET colleges in engineering, manufacturing and construction, and natural sciences, mathematics and statistics increased by 34% (to 2,248) between 2016 and 2021, while major awards in natural sciences, mathematics and statistics grew by 48% (to 417).

The **Higher Education** sector, governed by the Higher Education Authority (HEA), comprises 19 Universities, Technological Universities and specialist colleges offering courses from NFQ Level 6-10. Degree courses are offered in all the areas of technical skills need including engineering, biological sciences, chemistry, IT and digital technologies. Master's degree and PhD courses also offer participation in research on themes of relevance to the Biopharma industry. The Technological Universities also offer a variety of Special Purpose Awards and upskilling/ reskilling programmes across all disciplines from NFQ Levels 6-9. These institutions are also involved in the provision of apprenticeships at NFQ Levels 6-10.

Over 9,000 and 7,000 awards were respectively made by Irish HE providers in 2021 in broad areas of study identified as relevant to the Biopharma sector, i.e. (a) engineering, manufacturing and construction; and (b) natural sciences, mathematics and statistics. The number of graduates in these categories increased by 34% and 22% respectively during 2021.

Awards identified as specifically relevant to the Biopharma sector (engineering, biological sciences, chemistry and chemical engineering) totalled 2,929 at NFQ level 6-10 in 2020. The HEA 2021 Graduate Outcomes Survey estimated that 1,749 of these graduates are likely to have entered employment in 2021, and a significant proportion of these entered the Biopharma sector.

Combined FET and HE Outputs: Quantifying the Skills Gap to 2027

Total awards made at NFQ levels 4/5-10 made by Irish FET and HE providers across all disciplines in 2020 numbered almost 100,000. As per the analysis undertaken in section 4.4.3, it is estimated that of this total number of graduates, around 2,025 entered employment in the Biopharma sector.

If this proportion is applied to future graduate numbers, the numbers forecast to be entering employment in the Biopharma industry in 2027 will be approximately 2,967, a shortfall of 3,697 in the medium growth scenario. Presuming these estimated rates hold true, and without other interventions, the FET and HE sector alone will not be able to meet the full recruitment needs of the sector in the coming 5-year period- with an average annual deficit of over 3,000 graduates in the medium scenario, even acknowledging that not all recruitment into the sector will consist of new graduates. This is particularly the case when the forecast additional demands on the education and training systems for the upskilling and reskilling of existing staff are considered.

Table 6.4: Forecast gap between total recruitment demand (growth plus replacement) and graduate entry 2023-2027

	2023	2024	2025	2026	2027	Total 2023-2027	Average 2023-2027
Forecast recruitment demand (net growth+ replacement)							
High: Historical Trend	5,550	6,087	6,681	7,337	8,065	33,720	6,744
Medium: Expert Estimate	4,800	5,201	5,640	6,121	6,646	28,408	5,682
Low: Global Forecast	3,926	4,137	4,360	4,595	4,843	21,861	4,372
Estimated annual graduate entry to Biopharma	**2,386**	**2,520**	**2,661**	**2,810**	**2,967**	**13,343**	**2,669**
Estimated gap between Biopharma demand/graduate entry							
High: Historical Trend	-3,164	-3,567	-4,020	-4,528	-5,098	-20,377	-4,075
Medium: Expert Estimate	-2,414	-2,682	-2,980	-3,311	-3,679	-15,066	-3,013
Low: Global Forecast	-1,540	-1,618	-1,700	-1,786	-1,876	-8,518	-1,704

Source: EGFSN analysis, 2023

6.3 Challenges Identified

The major challenges identified, based on all the inputs described above are:

The availability of new talent: There are insufficient numbers of candidates to support industry growth plans and to mitigate staff turnover, and demand currently exceeds the number of graduates entering the sector. As a result, companies are hiring candidates who require additional training or look to EU and non-EU countries for suitable candidates.

A marked gap between forecast skills supply and demand from the sector is expected to exist by 2027, which could- without appropriate policy interventions- hinder the Biopharma sector in Ireland in terms of achieving its full growth potential. Skills availability is a key consideration for companies when planning investments and expansions, and perceived shortage of skills in Ireland by global corporate leaderships could result in future investment projects moving to other locations around the world.

The continuing development of the talent pool: Digital and technological changes, the green agenda, hybrid working, and dispersed workforces combine to create new skill needs among managers and all sector roles.

Changes in manufacturing technologies, and a parallel growth in digitalisation of processes and systems create a need for staff with data management and digital skills in addition to the core manufacturing skills. Degree programmes must meet these emerging skills needs and existing personnel in the sector must be upskilled.

Transversal and soft skills for effective in-company social interaction were also highlighted during stakeholder engagements. It is suggested that students are not currently being taught these transversal and soft skills.

An industry view is that training course content and facilities should more closely reflect industry needs. In essence, universities should educate graduates to understand the underlying principles, and industry should train staff (through appropriate supports and collaboration with academia) to apply these principles to its needs. Collaborative strategies to address this include industry set projects, site visits, work placements and sandwich years. The National Skills Bulletin (2022) notes that future shortages in scientific and engineering occupations are likely partly due to high demand and shortages of personnel with specialist experience in these areas.

Recruitment competition between Biopharma firms and with other sectors: Companies report significant competition with other Biopharma companies for personnel. Movement of staff between employers is more prevalent in Manufacturing than in Services. Firms have introduced career development pathways; and workplace flexibility such as remote and hybrid working, and portfolio careers. Companies also report that they are considering skills transferability from other industries or business areas, such as the Healthcare, Medical Devices and ICT sectors.

Growing Apprenticeships: There have been challenges in terms of maximising the growth potential of apprenticeships as a source of skills supply for the Biopharma sector. Barriers to the uptake of post 2016 Consortia-led apprenticeships from an employer perspective include their relatively recent introduction, issues relating to funding and costs and the need to cover this time by other staff. While awareness and promotion of apprenticeships have improved over time, there remain challenges in terms of apprenticeships being perceived as a viable career pathway compared to traditional third level career pathways among school leavers, parents/ guardians and teachers.

Promoting STEM and careers in Biopharma at Primary and Post Primary Levels: A more concerted effort to promote careers in Biopharma at all levels is required. This will require working with the education sector at primary and post primary levels to improve STEM skills at earlier stages, and to promote awareness of the industry among young people, their teachers, parents and guardians and career guidance councillors. Initiatives to facilitate this include STEM teacher internships and TY programmes for pupils.

6.4 Opportunities for Skills Enhancement

Increased collaboration between industry and academia: There are many established relationships between sector firms and academic bodies focussed on skill development. Nevertheless, companies report a need to expand these links, and to improve the scale and nature of the engagement between Industry, Government and the wider education sector with regard to skills. These could include:

- Apprenticeships designed to address company needs; Regional partnerships, to support firm needs at a local level.
- New models of education delivery to help the HE system to respond rapidly to changing industry skill needs. Industry note that academia is slow in responding to changing skills needs.
- Further NIBRT involvement in responsive training programmes for company staff in specific process technologies.
- Support for enhanced collaboration between SSPC and NIBRT via an expanded research centre, which would cover both small molecule API and Biologics manufacturing research science and talent development in 'hard to fill vacancies' for the sector.

Development of a Skills Framework: The development of a career pathways and skills framework for the Biopharma sector in Ireland will enable the occupations, job roles and associated current and emerging technical and transversal skills needs and competencies in the industry to be mapped in detail, along with the relevant education and training provision to meet these needs. A skills framework for the sector would be a resource to assist individuals with their skills development and career progression through highlighting potential career pathways and relevant education and training provision, while enabling companies to identify, map and retain talent.

Development of a skills framework for the Biopharma sector also has the potential to highlight gaps in education and training provision and continually provide inputs into the process of course co-creation and customisation.

Increased use of Micro-credentials: Micro-credentials are short, accredited courses which can be stand-alone or stackable to achieve a full award. They provide the learner with knowledge, skills or competences which can be tailored to industry demands. This initiative both empowers learners to advance their careers and enhance workforce skills.

Creating new pathways to HE: New models of progression linking FET and HE would be welcomed by the Biopharma industry. New pathways would mean students starting their degrees at FET level and transitioning seamlessly to HE.

6.5 Actions to be Taken

Based on all these inputs, the review team concludes that the areas in which specific action must be taken are highlighted below:

1. **Strengthening STEM Education** at all levels, particularly at primary and post-primary level, and provide the required facilities and teacher training. Enhanced industry interaction, and creation of science programmes, fairs and scholarships will also enhance student awareness and interest.
2. **Increasing the Capacity for Education and Training at Tertiary Level** through ensuring that existing provision across all pathways is evaluated and developed to meet the current and changing skills requirements of the Biopharma sector, subject to consideration of effective investments to support unlocking enhanced capacity. This must include a versatile mix of initiatives from micro credentials to post-graduate opportunities up to PhD level, and the development of a life-long learning strategy for the sector.

3. **Increasing Collaboration between Industry and Academia** through establishment of regular fora for meetings, will enhance mutual awareness of needs, issues and opportunities.
4. **Promoting Biopharma as an accessible and attractive career choice** with multiple points of entry and making sure that people of all backgrounds are aware of the range of opportunities available to them through structured engagement between the industry and the community, the education and training sector and career guidance services at all levels.
5. **Promoting New Pathways into the Sector** through developing apprenticeships, internships and traineeships. Key steps to achieve this include establishing a group to discuss how best to promote and to increase the number and range of apprenticeships (encompassing NFQ levels 6-10) and traineeships to meet both current and emerging skills needs across the sector in general, and through establishing a coordinated national internship programme for the GBS Biopharma and Specialty Services industries in particular.
6. **Developing Leadership and Transversal Skills** though collaboration between industry and academia to ensure that FET and HE providers are meeting the transversal skills needs of the industry, that transversal skills are embedded in technical and scientific courses, as well as ensuring that transversal and leadership skills are cultivated within Biopharma companies themselves.
7. **Growing Digital Skills** is vital in the context of the digital transformation challenges faced by the industry in its manufacturing and services subsectors. Key priorities include supporting the digitalisation across the Biopharma sector through encouraging uptake of the Digital Transformation Fund, ensuring that the required skills are developed to support the development of Industry 5.0 and skills such as those for data science and analytics more broadly. The specific digital skills needs of Biopharma services subsectors should also be addressed. Basic digital literacy should be promoted at all levels, and digital skills should be central to a lifelong learning strategy for the sector.
8. **Fostering an environment of diversity and collaboration** in the Biopharma sector by implementing policies which promote equal opportunities for all and encourage diversity in recruitment practices and the provision of support for education, training, mentoring and career development for people from marginalised communities.
9. **Accelerate the Development of Skills for Advanced Therapy Medicinal Products** (ATMPs) which are a particular opportunity area within biologics, through investment in required facilities and expertise to ensure that Ireland is well placed to capitalise on future growth in this area.
10. **Developing a Skills Framework and Further Skills Mapping of the Sector** to enable the current and emerging skills needs of the industry and relevant education and training provision to be mapped in detail on an ongoing basis. This will enable Biopharma companies to better identify and retain talent and to empower individuals to take ownership of their career development and to better identify the career progression and education and training pathways open to them.

7

Recommendations

An Implementation Group will be established to oversee and coordinate the recommendations and actions listed below. The Group will largely comprise of the organisations and bodies responsible for implementing the actions, as identified in square brackets after each action. A Chairperson may be appointed to lead the Group. The Labour Market and Skills Unit in DETE will provide secretarial support to this process for two years to ensure that the recommendations are implemented effectively.

Below are the recommendations of the group following the findings of the study. The organisations responsible for implementation are indicated at the end of each recommendation.

1. Strengthening STEM Education in Schools	
1.1	Enhance and increase access to digital and STEM (Science Technology Engineering Mathematics) at both primary and post-primary levels. **[D Education]**
1.2	Continue to support the development of digital and STEM skills through industry engagement with schools, such as: BT Young Scientist and Technology Exhibition, ESB Science Blast, Scifest, I-Wish, Science Week, etc. These might include sponsorship of science programmes and fairs, support for third level scholarships, and development of work experience / placement opportunities. **[BPCI (Ibec)**, NIBRT, SSPC, Industry, D Education]
2. Increasing Capacity for Education & Training at Tertiary Level	
2.1	Tertiary education institutions will continue to provide and develop upon existing provision of relevant courses to address the current and evolving skills demands of the Biopharma sector, subject to consideration of effective investments as appropriate to support the unlocking of enhanced capacity. It is recommended that a capacity assessment reflective of the entirety of existing educational pathways support this work. [**HEA** and **SOLAS** in collaboration with: IUA, THEA, SOLAS, HEIs, ETBs, Skillnet Ireland]
2.2	Continue to promote relevant postgraduate study opportunities (e.g., MScs and especially PhDs), including study within specialist research centres as they provide significant competitive advantage by developing the skills base, enhancing technological expertise and by generation of new intellectual property. There is a need for continued support and open pathways from Level 8. Such pathways may include structured PhD programmes and/or Employment-based/Enterprise Partnership PhD programmes. Potential funders of such pathways include SFI, the Irish Research Council, HEA, Universities. **[SFI**, in collaboration with: Industry, HEIs, HEA, NIBRT, SSPC, PMTC]
2.3	Consider investing to extend the current SFI Centre for Research Training PhD programme to embrace the needs of the Biopharma sector. **[SFI**, in collaboration with: DFHERIS, Skillnet Ireland]
2.4	HE and FET providers, in alignment with employers, should drive the development and roll-out of micro-credentials and micro-qualifications for the Biopharma sector, across all NFQ levels, in collaboration with the Irish Universities Association (IUA) and SOLAS. **[IUA, (HCI MicroCreds Project), SOLAS**, in collaboration with: Industry, BPCI, THEA, HEIs, HEA, Biopharmachem and Technology Ireland ICT Skillnets, RSFs, NIBRT, Skillnet Ireland]
2.5	Develop a lifelong learning strategy for the sector with a focus on upskilling and reskilling existing staff to fill future roles. [**BPCI,** in collaboration with: Biopharmachem and Connected Health Skillnets, DFHERIS, SOLAS, NIBRT, Education providers and Industry]

3. Increasing Collaboration between Industry and Academia	
3.1	Establish a national strategic Biopharma stakeholder forum or clearing house on a permanent basis. This should include companies, education and training providers, industry bodies, Government and State agencies, who would monitor and evaluate industry trends and coordinate responses to emerging skills needs across the sector. [**BPCI**, SSPC, Industry, Biopharmachem Skillnet, Connected Health Skillnet, Skillnet Ireland, RSFs, SOLAS, ETBs, in collaboration with relevant stakeholders and Government bodies.]
3.2	Supplement 3.1 with a recurring conference where all the relevant organisations from public and private sectors and education and training come together to educate and inform one another. **[BPCI**, Industry, Skillnet Ireland, SOLAS, ETBs, RSFs, in collaboration with relevant Research Centres (SSPC) and Biopharmachem Skillnet]
3.3	Form a new structured working group focussed on education and skills within the Biopharma services sector, in conjunction with the IDA and BPCI. [**GBS firms**, Biopharmachem Skillnet, Technology Ireland ICT Skillnet, SOLAS, BPCI, IDA, American Chamber of Commerce, NIBRT, SSPC, Regional Skills Fora, TU Dublin]
4. Promoting Careers in Biopharma	
4.1	Industry should promote Biopharma as an accessible and attractive career choice with multiple entry points, ensuring that people of all backgrounds are aware of the full range of opportunities available. This should be done through targeted and structured engagement with the community, the education and training sector at all levels, and through career guidance services. This could include, *inter alia*: • a more structured approach for engagement between 2nd level and industry, including actively engaging with post-primary schools in line with the 'Whole School Guidance' model. This may involve activities such as sharing information, attending school events and orchestrating work experience opportunities; [**BPCI**, D Education, SSPC, Industry] • develop a career promotion strategy for the sector; [**BPCI**, NIBRT, SSPC, Industry, DFHERIS] • creating an online catalogue of jobs available in the industry. [**BPCI**, NIBRT, Industry]
4.2	In addition to the end-to-end manufacturing opportunities, promote the career journeys and options available in Biopharma GBS and services and their global scope and strategic influence. [**GBS Firms**, BPCI, IDA, Industry]
5. Promoting New Pathways into the Sector	
5.1	Both the number and range of apprenticeships need to increase. Use all available delivery modes (flexible, accessible, etc.) to meet existing and future / emerging skills needs in the sector. Apprenticeships should be promoted more effectively as a route into the sector. In particular, it is important to communicate that apprenticeships encompass NFQ levels 6 to 10. [**BPCI**, Industry, DFHERIS, NAO, HEA]
5.2	Establish a group to discuss how best to increase and promote traineeships for the sector. Use all available delivery modes (flexible, accessible, etc.) to meet existing and future / emerging skills needs in the sector. [**ETBs**, HEA, Industry, BPCI, DFHERIS, SOLAS)
5.3	Establish a coordinated national internship programme between the GBS and Services subsectors and relevant HEIs and FET bodies. [**GBS Firms**, BPCI, HEIs, HEA, IUA, THEA, (+ MTU), SOLAS, ETBs]

6. Developing Leadership and Transversal Skills	
6.1	Ensure the development of leadership and transversal skills, through collaboration between industry and academia. This includes ensuring that: • IUA and THEA should have regular meetings with industry to capture the evolving transversal skills needs of the industry; [**IUA, THEA,** in collaboration with: HEIs, ETBs, HEA, SOLAS, BPCI, Industry] • Ensure that those skills are embedded in courses, especially in technical and scientific subjects, including critical thinking and problem-solving; [**IUA, THEA**, in collaboration with: HEIs, ETBs, HEA, SOLAS, BPCI, Industry] • Leadership, transversal and soft skills are developed within companies. [**Regional Skills Fora**, in collaboration with: Biopharmachem Skillnet, Connected Health Skillnet, SOLAS, Industry, Training providers]
7. Growing Digital Skills	
7.1	The Digital Transformation challenges for the sector are significant, and a skills needs analysis of DT skills should be conducted to examine the suitability of offerings with the aim of creating a tailored course addressing the specific needs of the BPC services sector. [**Biopharmachem Skillnet, Technology Ireland ICT Skillnet**, Skillnet Ireland, BPCI, DMI, American Chamber of Commerce, IDA]
7.2	Support digitalisation across the sector. Encourage uptake of the Digital Transition Fund. [**EI, IDA, Industry,** I5.0LN[113], BPCI, DMI, SOLAS, Skillnet Ireland, Biopharmachem Skillnet, HEA]
7.3	Ensure that the required skills are developed to support Industry 5.0 technologies (e.g., AI, Robotics, Automation, cloud computing and cybersecurity) in the sector. Also develop data science and analytical skills, as well as the specific skills needed for digitalisation in the sector, including basic digital literacy. **[SOLAS, HEA, Skillnet Ireland,** ETBs, Biopharmachem Skillnet, BPCI, DMI, NIBRT, SSPC]
8. Accelerate the Development of Skills for ATMPs	
8.1	Accelerate the development of an all island ATMP ecosystem, as a longer-term goal, supporting the development of indigenous ATMP focused enterprises, through investment in facilities, education and training, in conjunction with the NIBRT CGT Forum. [**NIBRT**, in collaboration with: SSPC, HEIs, SOLAS, ETBs, Industry, EI, IDA, BPCI, and others]
9. Fostering an Environment of Diversity and Collaboration	
9.1	Create an inclusive and diverse workforce in the Biopharma sector by implementing policies that promote equal opportunities for all. [**BPCI**, Industry]
9.2	Encourage diversity in recruitment practices, provide scholarships or grants to support education and training for individuals from marginalised communities and establish mentor programmes to support career advancement. [**BPCI**, Industry]
10. Developing a Skills Framework and Further Skills Mapping	
10.1	Develop a skills framework for the Biopharma sector, including both manufacturing and services. [**Biopharmachem Skillnet, NIBRT**, in collaboration with: Industry, BPCI, SSPC, SOLAS, other relevant bodies]
10.2	Having explored options with both the ICT & Biopharmachem Skillnets, the opportunity now exists for elective modules, specifically designed to support the BPC sector's GBS needs to be created and integrated into the MSc & Diploma courses. A needs analysis to define the specific skills gaps in Pharma / GBS areas could collaboratively be carried out by both Skillnets supported by BPCI. [**Biopharmachem Skillnet, GBS Firms, Technology Ireland ICT Skillnet**, in collaboration with: BPCI, Industry]

113. Industry 5.0 Lighthouse Network

Appendix A: Terms of Reference

Aim

The study will forecast the skills needs over a five-year period for the Biopharmachem sector in Ireland, ensuring that the sector embraces, *inter alia*, digital technologies, emerging, disruptive and sustainable technologies, and workplaces of the future, enabling them to realise their full growth potential. The study should identify likely skills gaps (differences between forecasted supply and demand for relevant skills) as well as recommend specific and measurable solutions to these gaps.

Background

In August 2016, the Expert Group on Future Skills Needs (EGFSN) published a report on **"Future skills needs of the biopharma industry in Ireland"**. The objective of the study was to review the supply and demand of skills required to meet the needs of the biopharma sector in Ireland up until 2020. At the time, there was a specific focus on the manufacture of biologics. Since then, there have been step changes across the pharma, biopharma and emerging advanced therapeutics sector, with rapid adoption of potentially disruptive technology such as artificial intelligence (AI), additive manufacturing, advanced automation, coupled with more sustainable and environmentally friendly solutions. Therefore, now would be an appropriate time to update the analysis and the recommendations.

Rationale

Ireland is a leading global location for biopharma, pharma, and chemical product manufacture. Ten out the top-ten global biopharmaceutical companies have a facility in Ireland employing approximately 42,000 directly. It may be assumed that a similar number are employed indirectly as a result of economic activity in the sector. 57% of the employees in the Biopharmachem sector are third level graduates and 25% of all PhD researchers in the Irish industry are employed in the sector. The demand for higher education skilled workers is likely to increase significantly over the coming decade, requiring increased supply from the education sector, and the up-skilling and re-skilling of current employees and the re-skilling of others who can then transfer successfully to the Biopharmachem sector.

The Biopharmachem sector is a major contributor to the Irish export economy, having a total value of €106 billion in 2020, which represents 67% of the total goods exported. Despite the many challenges in 2020, the BioPharmaChem sector continued to see strong investment resulting in 1,143 new high-tech positions created across the sector. There is a strong regional spread of companies in Ireland with clusters in Dublin and Cork – and smaller clusters in the midlands, Waterford, and Limerick.

Recent project announcements across Ireland include:

- **Pfizer** to create 300 jobs in Dublin, Kildare and Cork
- **MSD** announces 240 new jobs with expansion at Dunboyne
- **Allergan** marks opening of new €160 million biologics facility in Westport with 63 new jobs
- **Regeneron** Announces 400 new jobs in Limerick
- **Gilead Sciences** to create 140 jobs at Irish operations in Dublin and Cork
- **MeiraGTx's** announcement of a major expansion in Shannon for plasmid production and viral vector manufacturing
- **Takeda** to invest €36.4 million in Grange Castle site to create 100 Jobs
- **Bio-Techne Corporation (NASDAQ:TECH)** announced the opening of its new Ireland facility in Dublin.

- AstraZeneca to invest $360M in a new manufacturing facility in Ireland, creating 100 jobs.
- APC & VLE Therapeutics to invest €25 million and create 120 jobs in Dublin to accelerate development and manufacture of Covid Vaccines and Advanced Therapeutics

Since the 2016 report, the sector continued to invest in other areas which has enabled the growth in related activities such as global business services, clinical trial management, automation, contract manufacturing, research and supply chain management, all of which require new skill sets.

The sector is also focusing on the next generation treatments, cell and gene therapies, personalised and precision medicine, combination therapies, genomics, connected health and combination therapies. Many of these new and emerging areas may require specialist and hybrid skill sets. Supply disruption due to global events has demonstrated the vulnerability of the industry, therefore there is a growing movement to bring back upstream pharmaceutical production from Asian countries, in particular Active Pharmaceutical Ingredients (API) being re-shored to European territory.

The current global manufacturing transformation cycle – Industry 5.0 – seeks to transform current manufacturing through the adoption of digital, disruptive and sustainable technologies. In order to ensure the Biopharmachem sector has the absorptive capacity to embrace change we need an appropriately skilled workforce. It will be critical to understand how we up-skill and cross-skill the existing workforce with the necessary skills to enable this transformation in addition to understanding the new types of specialist roles the future industry will require. In the longer term, and if projections to increase automation within manufacturing hold true, there may be a need to understand what current roles may be displaced, and to identify how such a displaced workforce can be re-skilled for alternative or new and emerging functions.

According to industry sources, a lack of skills and talent is one of the biggest obstacles to growth, modernisation and digital transformation in the sector. Covid 19 has accelerated the digital transformation, widening the gap between the demand and the supply of tech-savvy employees, and the Biopharmachem sector now competes for the same talent pool as the tech sector.

Threats to the sector include Brexit, new competitors and disruption on the island, global events impacting supply chain (Covid and political instability causing Europe to want to re-shore APIs), erosion of the base industry due to lower cost countries developing, competition for talent in other industries.

Objective

To identify the likely skills needs and skills gaps that will arise in the Biopharmachem sector in Ireland over the next five years by identifying the skills and competencies needed by the sector and forecasting the likely supply and demand of those skills. The study should also make recommendations aimed at resolving any such gaps identified.

Scope

- The skills and competencies needed for the Biopharmachem sector in Ireland from now until 2027, the likely gaps that will arise, and the remedies and solutions that can be adopted.
- The BioPharmaChem sector should be defined to include small and large molecule manufacturing and the developing area of Advanced Therapy Medicinal Products, the manufacture of non-pharmaceutical chemicals, as well as associated services specific to the sector plus shared Financial and IT services and headquarter activities.
- A broad approach to sectoral skills needs should be adopted, to include not only biopharmachem skills, *per se*, but also process engineering, tech ops, and support services, regulatory, clinical and supply chain management skills, as well as skills for the digitalisation of the sector, for the deployment of sustainable technologies, for the development of new plant and facilities, and for the emergence of new subsectors, for example.
- The analysis should include skills and qualifications from NFQ Level 5 and upwards.

- Demand forecasting should focus on quantification but not ignore the quality of skills required. Assessment of demand should not ignore whether the industry itself recognises the skills that will be needed for the future and is taking effective steps to identify these skills and source or develop them in a timely manner.
- Assessment of skills supply should include not only quantification but also discussion of options for improvement in the cooperation, collaboration and communication between providers and industry, the potential for innovative teaching methods, and so on.

Typology of Companies to be Covered[114]

The typology of companies covered in the study includes those that are engaged in one, or a combination of, the following activities:

1. Biologics – "large molecule" biologics drug manufacturing
2. Pharmaceutical – "small molecule" chemical drug manufacturing
3. Manufacture of non-pharmaceutical chemicals
4. Advanced Therapy Medicinal Products (ATMP) manufacturing including cell and gene therapies.
5. Biopharmachem Related Services – BioPharmachem specific services including regulatory affairs, clinical trials management, commercial and medical affairs, supply chain and external manufacturing for the supply of Biopharmachem products globally; also, the Financial and IT shared services and headquarter activities of BioPharmachem companies in Ireland.

Methodology

1. Desk Research may include, *inter alia*:

- Analysis of global / international data and longer-term trends in the sector to establish likely growth and skills demand scenarios.
- Analysis of domestic data sources to reveal historical sectoral trends and likely future trajectories and skills needs.
- Examination of the range of skills supply channels relevant to the sector.
- Comparative analysis of a selection of competing locations internationally with a focus on their competitive advantages, growth trends and solutions to skills-related issues, and so on.

114. Adapted from the 2016 EGFSN study.

2. Data Collection and analysis may include, *inter alia:*

- Surveys, in-depth interviews, and so on, of firms, sector experts, education and training providers, and other stakeholders.
- Regional and / or national workshops and / or focus groups.
- Engagement with the IDA and their Industry 5.0 Lighthouse group on work already undertaken and planned with respect to the sectoral needs to migrate towards Industry 5.0 operations for Pharma manufacturing.
- Statistical or econometric analysis and modelling of national or international data sources, where appropriate.

3. Reporting

- Progress will be reported to a Steering Group on 4 or 5 occasions during the project. The Steering Group will provide guidance and suggestions on the project direction and may be able to assist with identifying participants for workshops or in-depth interviews, for example.
- A report of the above analysis and the required outputs, below.
- Most specifically, the report must include a quantified forecast of likely skills gaps in the Biopharmachem sector in Ireland out to 2027 as well as recommendations to remedy them.

Outputs

- An assessment of the growth trajectory of the sector and its subsectors in Ireland over the next 5 years.
- A granular[115] analysis of the skillsets and competencies likely to be needed by the sector over that period[116].
- A skills demand forecast for the sector for 5 years with 3 scenarios (baseline, high growth and low growth).
- A detailed and quantified assessment of skills supply channels to the sector, including likely future growth.
- Therefore, a forecast of skills gaps in the sector in Ireland over the next 5 years.
- An assessment of the pathways that exist[117], and those that can be established, for skills development for the sector, including, *inter alia*, apprenticeships and the transition from FET to HE, for example.
- Recommendations as to how these skills gaps may be remedied, which may include innovative methods, collaboration, learning from international best practice, and so on. (A responsible body or bodies must be identified for each recommendation. Specific proposals for the establishment of an Implementation Group to oversee the recommendations may be useful.)
- A report containing the analysis, forecasts, recommendations, and so on. See previous EGFSN reports for the general approach and structure.

115. Skills and competencies should be identified in as much detail as possible, along with the required qualification level. This allows the education and training sector to plan more effectively.
116. This NIBRT report may be helpful as part of the analysis: BT-Survey.pdf (nibrt.ie) ; outputs from the IDA's Industry 5.0 Lighthouse project will also be made available.
117. Note, for example, the iEd Hub in UCC.

Appendix B: Biopharma Companies Consulted

Company	Sector	Subsector
Aerie Pharma	Manufacturing	Small Molecule
Alexion	Manufacturing	Biologics
Alkermes	Manufacturing	Small Molecule
Almac Group	Manufacturing	Small Molecule
Amgen	Manufacturing	Biologics
APC	Services	Biopharma Services
Channelle	Manufacturing	Small Molecule
Charles River	Services	Biopharma services
Eli Lilly	Services	Biopharma Services/Global Business Services
Gilead	Manufacturing	Small Molecule/Biopharma Services
GSK	Services	Small Molecule
ICON	Services	Biopharma Services
Innopharma	Services	Training
Janssen	Manufacturing	Small Molecule
Leo Pharma	Services	Small Molecule
Merck	Services	Other Manufacturing
MSD	Manufacturing	Small Molecule
Newlands Chase	Services	Legal Services/Economic Migration
Novartis	Services	Small Molecule/Biopharma Services
Pfizer	Services	Global Business Services
Pfizer	Manufacturing	Biologics
Siemens	Services	Consultancy/Digitalisation
Takeda	Manufacturing	Biologics
WuXi	Manufacturing	Biologics
Xeolas	Manufacturing	Small Molecule

Appendix C: Regional Workshops Agenda

WORKSHOPS (Athlone / Cork / Dublin)
Registration, Tea & Coffee (on arrival)
Welcome & Introductions (DETE/Biopharmachem Ireland) Overview of EGFSN Biopharmachem Skills Study (Cruinn Advisory)
Guest Speaker • 20min Presentation • 10min Q&A
Skills Needs (Current) • What are the main drivers of change impacting on demand for skills and in what way? • What are the current recruitment and retention issues you are facing? • Are there any current critical skills needs and/or gaps that are not being met from across Manufacturing/ Services/Digitisation? • What will be the most effective and/or efficient methods for education providers to co-create/co-design courses, modules or curricula? Open Plenary
Skills Needs (Future) • Over the next 5 years what % change (+or-) do you anticipate in the level of employment – which roles will be in greatest demand? • What are the key skills challenges facing the Biopharmachem industry over the next 5 years? • Which skillsets don't exist that will be required over the next 5 years across Manufacturing/Services/ Digitisation? • What types of courses/learning of the future will be required? • Which modalities will be best used to optimise future skills needs? Open Plenary
Break & Networking
Skills Framework – Manufacturing / Services / Digitisation • What types and levels of qualifications will be needed for Manufacturing/ Services Digitisation to meet future skills needs? • Which job roles/functions will grow more in Manufacturing/Services/ Digitisation? • What technical skills will be required within Manufacturing/Services/ Digitisation? • How will transversal skills be used across Manufacturing/Services/ Digitisation (Breakout Sessions)
Discussion & Recommendations
Summary & Next Steps
Finish & Lunch

Appendix D: Steering Group Members

Name	Organisation
Patricia Quane (Chair)	Formerly Astellas Pharma
Matt Moran	BioPharmaChem Ireland
Siobhán Dean	BioPharmaChem Ireland
David O'Sullivan	Enterprise Ireland
Rory Mullen	IDA Ireland
Louise Sherry	Higher Education Authority
Siobhán Bradley	Regional Skills Fora
Mary Lyons	SOLAS
Emma Francis	Irish Universities Association
Niall O'Reilly	Pharmaceutical and Molecular Biotechnology Research Centre, South East Technological University
Ian Jones	Innopharma
Charlie Dolan	APC
Louis Davis	Chanelle Pharma
Bill Walsh	Janssen Biologics
Claire Ahern	Pfizer
Padraic O'Neill	Pfizer Global Business Services
Ciara O'Connell	Novartis
Don O'Connor (Project Manager)	Department of Enterprise, Trade and Employment
Rhodri Lloyd	Department of Enterprise, Trade and Employment

Appendix E: Global Overview of the Biopharma Sector

United Kingdom

A report by APBI in 2022[118], identified seven disciplines as top priorities for the sector. They included Chemometrics; Formulation Science; Physiological Modelling; Computational Chemistry (including Chemoinformatics); Pharmacokinetic/pharmacodynamics modelling; Epidemiology and Pharmacoepidemiology; and Engineering in Manufacturing. Five of these priorities show the increasing role that data and digital technology is playing within Life Sciences R&D and Manufacturing. However, it is the crossover between these digital skills and scientific experience that is of particular concern. Many UK companies having expressed concerns about their ability to recruit these skills against a backdrop of growing demand for skills in Many sectors in the coming years. Interestingly, each time an annual forecast report is generated, the outcomes in subsequent years are found to surpass it. In addition to numbers of graduates, many of the skills studies highlight the quality of candidates rather than the quantity.

For example, the 'Golden Triangle' in the South-East UK is made-up of world leading universities such as Cambridge, Oxford, UCL, Imperial and King's College London. They offer a massive supply of graduate and post-graduate talent: 185,000 students study Life Sciences, and 55,000 graduate annually, which makes this area the largest pool across Europe[119].

Attracting, recruiting and retaining experienced staff remains a key priority for companies. Given the need for experience and the immediacy of the challenge, a clear focus on retaining staff and equipping candidates with the skills that will see them stay within the industry is crucial.

France

In France there is a shortage of candidates and a government campaign for new talent aims to recruit 10,000 people into Biopharmachem by 2030, and 5,000 into Digital Health by 2026. The sector currently comprises 270 companies that together employ around 103,000 employees. France ranks fifth globally in medicine production, and fourth at the European level, just behind Italy, Germany and Switzerland. French companies invested €2bn in the French industry in 2020, an 11% increase on the previous year. A workforce development initiative includes Campus Digital Biotech which is building virtual and digital training solutions.

Germany

Germany's Biopharmachem sector shrank 6% in 2022. Productivity dropped by 10% and production output fell 40% with key players stating that they have already cut production or expect to in the near future. In 2022, sales were €266.5bn, an increase of 17.5%, of which €162bn (60%) was in exports. The stutter in Germany's industrial production at almost 8% below pre-pandemic levels is in part due to factors including the energy crisis; and reliance of firms on the energy-intensive Biopharmachem sector; back-orders from the pandemic and the war in Ukraine which affected the supply of raw materials[120]. This is despite the sector attracting €2.3bn in investment, the second highest total ever in the industry's 30-year history, following on a record-breaking €3bn in 2020.

118. https://www.abpi.org.uk/media/ya2fjboi/bridging-the-skills-gap-jan-2022.pdf
119. https://www.medcityhq.com/london-and-the-greater-south-east/
120. https://think.ing.com/snaps/german-ip-dec22

BIO Deutschland reported that firms are intent on boosting staff numbers, albeit finding it increasingly difficult to recruit talent needed. This is reportedly due to costs arising from competition within and outside the sector, and current educational pathways not being fully nurturing talent in the ways needed. This has resulted in firms such as Bayer and Boehringer utilising apprenticeship models as their main talent pool of skills supply to develop their Biopharmachem workforces.

Switzerland

Key firms such as Roche and Novartis play a crucial role in the Swiss economy with over 250 Biopharmachem companies based in the country, employing 44,200 people, generating €20.2bn in gross added value each year, constituting 38% of the country's total exports. Switzerland is a country that consistently ranks as the top European country on the Global Index given the infrastructure and expertise already in place with research institutions work side-by-side with Biopharmachem companies, creating optimal value chain conditions for drug development.

United States

In the US, growing demand for new hires and technical skills, as in other countries, has seen a modelling of its current pipeline predict that the US will not be able to satisfy its needs, with gaps in demand for sector skills until at least 2026. NIBRT work with partners in the US including Jefferson Institute for Bioprocessing, Philadelphia[121] and the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMB)[122], in Newark. Both partners recognise the critical need to increase interest in manufacturing careers and to foster connections between industry and academia to meet the growing demand for a skilled workforce.

South Korea

According to the Global Index, South Korea ranks high amongst Asian countries and seventh in the world. However, while showing high scores in the category of R&D ecosystem and government policy, it received relatively low scores regarding talent pool and manufacturing agility. NIBRT announced a partnership as part of the Korean-NIBRT (K-NIBRT) in 2021, to develop a world class biopharma manufacturing training and research centre in Incheon, South Korea. K-NIBRT will develop into Korea's bioprocessing workforce development institute by licensing NIBRT'sworld-leading training and education curriculum in biopharmaceutical manufacturing. The K-NIBRT facility is scheduled to open in 2024 with the aim of establishing industry leading manufacturing training in Asia-Pacific.

121. https://www.jefferson.edu/academics/colleges-schools-institutes/kanbar-college-of-design-engineering-commerce/research-and-innovation/institute-for-bioprocessing.html
122. https://niimbl.force.com/s/workforce-development

Singapore

Singapore is often seen as one of the leading lights in the sector internationally. Singapore employs five times more biomedical researchers per capita than the US. By taking a whole-system approach, Singapore has been able to meet and exceed its value-added targets for the Biopharmachem manufacturing industry, set every five years.

In 2019, Biopharmachem manufacturing employed 24,384 people: 65% in medical technology and 35% in pharmaceutical manufacturing. Together, the value add to Singapore's GDP was €18.5bn. The country has created forecast models for future skills demands, and a skills framework and career progression tracks that span the whole sector[123]. The framework is felt to offer benefit not just by informing policy interventions, but by assisting sector firms to design and manage recruitment and progression of future talent.

China

In 2022, China Government's **'Made in China 2025'** strategy[124] broadly includes a focus on growing its Biopharmaceutical industry to address healthcare needs and to build an internationally competitive and innovative pharmaceutical industry. This is part of wider economic restructuring with 9 agencies responsible for a **5-year plan for the development of its Biopharmaceuticals industry**[125]. The output value of the Biopharmaceutical industry reached €27bn in 2022 and is predicted to grow to €110bn by 2025[126].

Guangzhou International Bio Island opened a training centre for biologics manufacturing in partnership with NIBRT. The Bioprocess Research and Training Academy offers biopharmaceutical manufacturing training and workforce development in the latest biologic drug production processes supported by NIBRT and industry partners. Suzhou is the most economically advanced city in China with the Biopharmachem industry as one of its promising mainstay industries. By the end of 2017, 3,000 pharmaceutical enterprises were located in Suzhou, and the compound annual growth rate was up by 18%. Changshu Institute of Technology (CIT), one of the three undergraduate universities situated in Suzhou is dedicated to the cultivation of students with applied skills. The process of biopharmaceutical engineering at CIT melds with enterprises and the curriculum system is refined according to industrial needs.

123. https://www.skillsfuture.gov.sg/-/media/SkillsFuture/Initiatives/Files/SF-for-Biopharm-Manufacturing/Biopharm-21-Mar/SkillsFrameworkforBiopharmaceuticalsManufacturingFull13.pdf
124. https://english.www.gov.cn/2016special/madeinchina2025/
125. http://www.gov.cn/zhengce/zhengceku/2022-01/31/5671480/files/b2cafa62d001408e8e20acf71ab4bf26.pdf
126. Research on the development of biopharmaceutical industry in Suzhou (2019) https://www.tandfonline.com/doi/full/10.1080/13102818.2019.1676169

Appendix F: FET Learner Completions in Biopharma-related Courses

Total FET Completions (Certified and Uncertified) in Science and Manufacturing Courses Relevant to Biopharmachem				
	2018	2019	2020	2021
Science				
Pharmacy Counter Assistant – Level 5	8	5	2	5
Applied Science – Pharmacy Studies	9	8	3	
Pharmacy Assistant	67	85	81	126
Fundamental Bioprocessing Skills	18			
Practical Introduction to Bioprocessing	18			
Life Sciences Manufacturing Operations	32			
Biomedical Science / Laboratory Studies	19	27	28	37
C&G – L3 Diploma in Pharmacy Service Skills	18			
Diploma in Pharmaceutical Science and Diploma in Pharmacy Skills-Pharmacy Technician		24		
Pharmacy Technician			29	38
Total Science FET	189	149	143	206
Manufacturing				
Manufacturing Supply Chain and Customer Service Logistics	1	20	8	9
Continuous Improvement in Manufacturing L5		13	17	
Quality and Good Manufacturing Practice	16	11		
Quality and Good Manufacturing Practice	24	36		
Cleanroom and Packaging Operations	82	68	20	5
Good Manufacturing Practice	31	21		
Pharma Manufacturing Technologies	15			
Pharma Manufacturing Operations	19	14	12	11
Pharmaceutical Manufacturing Traineeship	3	28	26	
Cleanroom and Packaging Traineeship Operations		9	34	17
Life Sciences Manufacturing Operations	34	48	32	14
Life Sciences Manufacturing Operations Traineeship		8	3	7
Intro to cGMP for the Bio Pharmaceutical Industry				5
Total Manufacturing FET	225	276	152	68

Source: SOLAS, 2022

Appendix G: Glossary of Terms

AES	Annual Employment Survey (conducted by DETE)
AI	Artificial Intelligence
API	Active Pharmaceutical Ingredient
ATMP	Advanced Technology Medicinal Products
ATU	Atlantic Technological University
BPCI	BioPharmaChem Ireland
BPC Skillnet	BioPharmaChem Skillnet
CAGR	Compound Annual Growth Rate
CDMO	Contract development and manufacturing organization
CGT	Cell and Gene Therapies
CMC	Chemistry, Manufacturing and Control
COE	Centre of Excellence
CRA	Clinical Research Associate
CRAM	Contract Research and Manufacturing (Company)
CSI	Cyber Security Initiative
CSO	Central Statistics Office
DETE	Department of Enterprise, Trade and Employment
DFHERIS	Department of Further and Higher Education, Research, Innovation and Science
DP	Drug Product
DS	Drug Substance
DCU	Dublin City University
EDI	Equality, Diversity and Inclusion
EGFSN	Expert Group on Future Skills Needs
EHS	Environmental/Occupational Health and Safety
EI	Enterprise Ireland
ESG	Environmental, Social and Governance
ETB	Education and Training Board
FET	Further Education and Training
GBS	Global Business Services
HCI	Human Capital Initiative
HCP	Healthcare Professional
HE	Higher Education
HEA	Higher Education Authority
HEI	Higher Education Institution
HR	Human Resources
ICT	Information and Communications Technology
IDA	Industrial Development Authority
IRC	Irish Research Council
ISCED	International Standard Classification of Education
IUA	Irish Universities Association
LFS	Labour Force Survey

MTU	Munster Technological University
NAO	National Apprenticeships Office
NFQ	National Framework of Qualifications
NSV	Net Selling Value
NIBRT	National Institute of Bioprocessing Research and Training
NTF	National Training Fund
NACE	Statistical Classification of Economic Activities in the European Community *(from nomenclature statistique des activités économiques dans la Communauté européenne)*
OE	Operational Excellence
QQI	Quality and Qualifications Ireland
R&D	Research and Development
RSF	Regional Skills Fora
SETU	South East Technological University
SFI	Science Foundation Ireland
STEM	Science, technology, engineering and mathematics
TCD	Trinity College Dublin
TU Dublin	Technological University Dublin
UCC	University College Cork
UCD	University College Dublin
UX	User Experience

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