The Open University

Oxford - Cambridge
Arc Univeristies Group

LIFE SCIENCES SKILLS REPORT
2022-2030

whitecap
COMMERCIAL CLARITY™

The Oxford-Cambridge Arc Life Sciences Skills Report.

Whitecap was appointed by The Open University on behalf of the Oxford-Cambridge Arc Universities Group to research and analyse workforce skills and associated requirements for growing the Life Sciences sector in the Oxford-Cambridge Arc. This is part of the broader Oxford-Cambridge Arc Universities Project in support of the Life Sciences Vision, published in October 2021.

The Oxford-Cambridge Arc is home to the most productive Life Sciences cluster in Europe, with more than 400[1] companies contributing £2.9[1] billion to the UK economy and is currently growing faster than any region outside London. The Oxford-Cambridge Universities Project is looking to better understand and harness this wealth of economic resource for the benefit of the region. The aim of the overall project is to understand what is required for the Oxford-Cambridge Arc to be one of the world's leading clusters of innovation and economic activity in Life Sciences.

The intention of this report is to develop an understanding of what skills exist today, the areas with skills shortages, and what additional resources (i.e., critical workforce skills and associated funding options) will be needed for the Arc to compete as an international destination for Life Sciences as it grows over the next 8 years to 2030.

More specifically, this report looks to cover the following:

- **The key skills required** in the Life Sciences sector, and their relative availability currently.
- **Examine current requirements** for various types of skills and how their relative availability is expected to change in the next c8 years.
- **Broader macro factors** that are seen to be most effective at increasing the depth and strength of Life Sciences skills in the Arc (for example collaboration between businesses, universities and colleges).
- **Business level micro factors** that are seen to be most effective at increasing the depth and strength of Life Sciences skills in the Arc (for example organisational "purpose" and flexi working environments).
- **The best options for training** and developing skills for Life Sciences in the Arc – for example., internships, apprenticeships and research degrees.

> **"Our vision… is for the Oxford-Cambridge Arc to be the world's leading cluster of innovation and economic activity in the Life Sciences."**
>
> Oxford-Cambridge Arc Universities Group[1]

Whitecap Consulting & Project Team.

Established in 2012, Whitecap Consulting is a regional strategy consultancy headquartered in Leeds, with offices in Manchester, Milton Keynes, Bristol, Newcastle and Birmingham.

Whitecap typically works with boards, executives and investors of predominantly mid-sized organisations with a turnover of c£10m-£300m, helping clients analyse, develop and implement growth strategies.

The firm works with clients across a range of market sectors, with strong experience in the financial services and technology. Over recent years, Whitecap has worked with various ecosystems, accelerators and universities across the UK.

Project Team:

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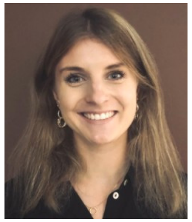

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The Open University & Project Team.

For over 50 years, the OU has been at the forefront of educational technology, providing online learning and skills development opportunities for millions of people.

The OU is one of the largest providers of Degree Apprenticeships and Higher Technical Qualifications – which makes a significant contribution to the supply of talent and skills across the UK. We are a tried and trusted partner for employers. 75% of the FTSE 100 have sponsored staff on OU programmes. In addition, our contract research consultancy service utilises our academics, scientists and engineers to help solve challenges faced by businesses.

The Open University school of life, health and chemical sciences carry out world-leading research and teaching across a range of disciplines from human biology, neurosciences and biomedicine, to chemistry, analytical sciences and the molecular basis of life. This wide range of interests offers the opportunity for exciting and vibrant collaborative projects in both teaching and research.

Project Team:

Professor Kevin Shakesheff
Pro-Vice-Chancellor of Research, Enterprise and Scholarship

Viren Patel
Director of Business Development

Chris Hogan
Director of Sector Development

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Foreword.

Professor Kevin Shakesheff,
The Open University

The Open University is pleased to have led this project on behalf of the Oxford-Cambridge Arc Universities Group, as we collectively aim to develop and significantly grow the Life Sciences sector in region and deliver a material contribution across UK to 2030 and beyond.

Having worked for over 30 years in Life Sciences, in academic and commercial roles, I am passionate about this exciting sector and ensuring that we have the right skills and capabilities to enable and sustain its anticipated growth with benefits shared across society.

The Arc's Life Sciences sector has exhibited strong growth over the past 5+ years and is critical to supporting the growth aspirations of the Arc. This growth has been generated by high growth segments, such as Advanced Therapy Medicinal Products (ATMPs) and Vaccines. If these high growth segments continue to grow at the pace evidenced over the past 5+ years, by 2030 we will have quadruple the number of people employed in Life Sciences. The magnitude of possible growth makes it ever more important that the Arc is successful in realising its full potential.

From a skills perspective, a critical objective is to enable the transition of employees into Life Sciences, even if earlier training and experience is developed in other sectors e.g., tech or advanced manufacturing. Our traditional education pathways create bottlenecks for Life Sciences relevant skills, as we ask students to decide to continue or stop studying Life Science relevant subjects at an early age. It also takes many years to create fresh talent with a Life Sciences relevant background, and the sector needs talent now. A potential option is to re-train people from other sectors. In particular, highly sought after manufacturing and digital competencies, evidenced in this report, are perfect examples of opportunities to re-train in support of growth.

Apprenticeships and short courses are promising pathways for entry into Life Sciences occupations from other sectors. These emerging pathways need coordination and possibly a new central Hub that directs people to appropriate courses. Alongside developing these courses, there is a critical requirement for SME engagement and support for offering and accepting these types of emerging training programmes.

This report outlines various significant skills challenges and funding considerations observed across the region, alongside a set of critical recommendations. These insights provide the foundations of a roadmap to join together and enhance skills development across the Arc – better supporting our Life Science ecosystem going forward.

I'd like to thank everyone who contributed to the report by participating in interviews and sharing current and future thinking. My thanks also go to the team at Whitecap Consulting for their hard work and commitment to understanding the current and future perspectives on skills developments in the Arc's Life Sciences ecosystem and for offering detailed insights and tangible actions for us to take forward.

Executive summary.

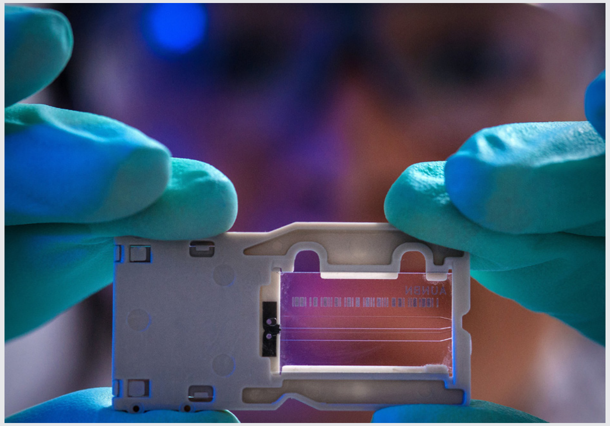
As the Arc continues to pursue its vision for growth in Life Sciences, and the associated ecosystem continues to evolve, this report has found that the Arc might expect to double the number of Life Sciences businesses and quadruple employment by 2030. This report seeks to identify what is required to ensure that this growth is achieved and is achieved from a skills delivery and subsequent funding perspective.

The Arc's Life Sciences ecosystem is at a critical stage of development and, assuming the proposed growth to 2030 is achieved, will position the Arc as an internationally leading Life Sciences cluster – standing shoulder to shoulder with other well-known clusters such as San Francisco and Boston Massachusetts.

As a consequence of the Arc's evolving and fragmented nature today, critical recommendations are focused on further coordinating and positioning the Arc as a connected entity for Life Sciences. In addition, developing and implementing a clear and structured skills strategy is recommended, as well as encouraging collaboration in pursuit of the vision – becoming the world's leading cluster of innovation and economic activity in the Life Sciences. Acting on these recommendations will better position the Arc to resolve present and anticipated challenges in a cohesive and organised manner.

As part of this project, research was conducted along the following workstreams:

- **Review of globally leading Life Sciences clusters**, San Francisco and Boston Massachusetts, to identify skills challenges and success factors relevant to the future of the Arc's Life Sciences ecosystem.
- **Review of published documentation** regarding Life Sciences skills requirements and challenges in the UK – including a review of existing skills strategies within the Arc.



- **Review of published socio-economic data** to map the Arc's regional mix, Life Sciences prevalence and historic performance.
- **Interviews with 20 Life Sciences stakeholders** from across the Arc, including senior representatives from Life Sciences businesses, universities, funders and other supporting organisations.
- **Model three growth scenarios** with varying assumptions about the trajectory and sectoral mix of the Arc's Life Sciences ecosystem and review subsequent implications on skills development going forward.
- **High-level review of the funding landscape** for Life Sciences in the Arc, including considerations about how the Arc can better attract funding to support Life Sciences skills development.

Key insights & recommendations.

The Arc holds two of the **largest Life Sciences clusters in the UK** and generated

5.3% CAGR

in employment from 2015 to 2020

- **Skills challenges that exist in mature Life Sciences ecosystems today are expected to persist into the future.** The most prominent challenges exist in technical, information / computational, technology, regulatory, business and commercialisation skills.
- Whilst there is contention around the strength of technical skills in the Arc, there is also a consensus that **employees with transferable and Life Sciences skills are highly sought after.** The full breadth of skills challenges observed across mature Life Sciences ecosystems are relevant to the Arc, as its businesses continue to scale. In addition, the Arc's existing skills challenges are expected to persist into the future.
- **The Arc is not yet as coordinated as it could be** as it continues to shape and formalise. Its Life Sciences ecosystem is also competing over talent with other sectors with similar skills requirements.
- **There is a call to invest in skills today.** Central and local government funding will remain important and attracting additional private funding will become increasingly critical.

Fast growing sectors within the Arc:

Vaccine sector growth

43% CAGR

in employment from 2015 to 2020

ATMPs growth

31% CAGR

Assisted Technology growth

38% CAGR

The Arc might expect

c.16% CAGR

Life Sciences employment to 2030

Recommendations

This report identifies four key recommendations for the Arc:

The ecosystem requires **greater collaboration** and a clear and well-structured skills strategy developed and coordinated by an appropriate body that covers higher education, further education, and professional development.

The ecosystem needs to provide **greater support** for businesses to scale-up.

The ecosystem requires a **coordinated and structured** programme focused on capturing, marketing and improving the attractiveness of its funding opportunities.

The ecosystem requires a more **collaborative approach** to skills development with other tech focused sectors.

The following page provides further detail on these recommended actions.

Recommendations.

The growth trajectory of Life Sciences in the Arc might well be driven by a continuation of existing favourable market forces.

However, there are evident headwinds facing the UK economy and the sector that will make maximising its growth opportunity more difficult; for example, present and expected skills challenges and weaker funding expectations following Brexit and of public funding following the response to the Covid-19 pandemic.

What can the Life Sciences ecosystem in the Arc do to ensure its expected growth trajectory comes true?

From a skills perspective, we recommend the following critical initiatives.

The ecosystem requires greater collaboration, a clear and well-structured skills strategy developed and coordinated by an appropriate body that covers higher education, further education, and professional development.

The role of fostering greater collaboration and alignment to the to be developed strategy should extend beyond the Arc Universities Group. There is a clear but fragmented focus on Life Sciences skills within the Arc, with the LEP-level authorities taking the lead on strategic direction. However, key Life Sciences skills considerations and actions are often generalised across other sectors in the region within a broader skills strategy. If the Arc wants to maximise the strength and growth trajectory of its Life Science ecosystem, it needs to develop an Arc Life Sciences Strategy and an Arc Life Sciences Skills Strategy.

However, there is not yet an obvious organisation or entity that might be responsible for this activity. The chosen coordinating body should take ownership of setting and managing the execution of the vision for the Life Sciences skills within the ecosystem and connecting stakeholders within and outside the ecosystem.

The skills strategy should seek to continuously ensure that there are the right skills, in the right place, at the right time from now to 2030. In addition, the strategy should cover the breadth of education and training provision from in-work training, apprenticeships, college courses, undergraduate and post graduate qualifications. Consequently, the strategy should also address skills re-training from outside the Life Sciences sector to enable the transition from other sectors and retaining talent within the sector, as well as building the overall attractiveness of Life Sciences occupations. Lastly, the strategy should also develop a deeper understanding of the equality, diversity and inclusion (ED&I) of the Arc's Life Sciences ecosystem, allowing the appropriate actions and responsibilities to then be established. A national focus on ED&I in Life Sciences is forming and, as one of the most prominent Life Sciences ecosystems within the UK, the Arc must play a leading role in driving required change. This report's review of leading Life Sciences clusters in the U.S. suggests that there is a real opportunity for the Arc to unlock a greater volume of talent to support future growth through an enhanced focus on the equality, diversity and inclusiveness of its workforce.

The ecosystem needs to provide greater support for businesses to scale-up.

Today, there is a wealth of support available for Life Sciences start-ups. However, as these businesses continue to grow, they must shift their focus to scale their business effectively. A primary concern for these businesses will be bringing in experienced leadership, in order to build commercial rigor into their business as they look toward the path to their next growth stage and toward exit. These skills and funding challenges exist today and the time to act is now. The primary actors in supporting this recommendation include educators, SMEs, corporates and funding organisations.

Recommendations.

The ecosystem requires a coordinated and structured programme focused on capturing, marketing and improving the attractiveness of its funding opportunities.

The Life Sciences ecosystem in the Arc will require additional funding to continue to grow at pace and to support the skills development and scale-up challenges identified in this report. There is a need for the ecosystem to assess and evidence the attractiveness of its funding opportunities for public and private investment. The belief today is that the business case for many of these opportunities are positive – but evidence and case studies are required to bring this to life.

The ecosystem's funding landscape today is also fragmented and uncoordinated, which makes identifying and actioning funding interests more difficult. As part of the recommended programme, there should be a focus on improving the visibility of funding opportunities and developing a consistent message – especially for interested parties that exist outside the ecosystem and especially for international parties.

The ecosystem requires a more collaborative approach to skills development with other tech focused sectors.

There are existing and fast-emerging tech skills that are becoming increasingly relevant for a variety of sectors. Challenges in recruiting for data, computational and AI skills will not be unique to Life Sciences and the competition over these skills benefits neither sector. There is an opportunity for Life Sciences to collaborate with other tech focused sectors on the identification and development of critical emerging cross-sector tech skills.

The entity responsible for this recommendation may well be the body chosen to coordinate the skills strategy. The role of this entity should include coordinating with representatives of other relevant sectors, acting as the flag-bearer of Life Sciences skills in the Arc and guiding the ecosystem on how and with who they can better collaborate on skills development.

Life Sciences in the UK and the Arc today.

The Oxford-Cambridge Arc is home to some of the UK's largest Life Sciences clusters. Greater Cambridge & Peterborough and Oxfordshire are both within the 10 largest Life Sciences clusters in the UK.

Since 2015, Life Sciences employment has grown significantly in Oxford and the South East Midlands and Cambridge and Buckinghamshire have remained relatively stable.

Greater Cambridgeshire and Peterborough has been a significant Life Sciences cluster for some time, with c16k employment in 2015, and continues to be the largest Life Sciences cluster in the Oxford Cambridge Arc today.

Oxfordshire and the South East Midlands have experienced steady growth over the 5-year period, driving Arc employment growth.

Oxfordshire sits just outside the top 5 largest Life Sciences clusters in the UK, ranked 6th in 2020. Additionally, Oxfordshire has seen strong Life Sciences employment growth since 2015 (12% CAGR) – positioning itself as a prominent growth driver within the Arc.

South East Midlands has also shown some of the strongest growth rates in Life Sciences employment across the Arc (14% CAGR since 2015).

In stark contrast, Buckinghamshire is fast becoming the smallest Life Sciences cluster in the Arc, with c7k employment. Since 2015, this cluster has recorded a marginal increase in employment (1% CAGR) – soon to be overtaken by South East Midlands.

Additionally, whilst Greater Cambridge and Peterborough remains the largest Life Sciences cluster in the Arc, it has seen a much shallower growth trajectory than Oxfordshire or South East Midlands (1% CAGR since 2015).

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LEP Rankings by Life Sciences employment:[2]

National Ranking 2020	LEP / Combined Authority	Total Life Sciences Employment 2020
1	London	32,394
2	Thames Valley Berkshire	17,498
3	Greater Cambridgeshire and Peterborough	17,123
4	Enterprise M3	14,481
5	Leeds City Region	14,148
6	Oxfordshire	14,097
15	Buckinghamshire Thames Valley	7,397
16	South East Midlands	7,262
Total: 4	Oxford-Cambridge Arc	45,878
Total: 38	**England**	**266,491**

Employment timeseries for Oxford-Cambridge Arc LEPs:[2]

Arc LEPs	2015	2016	2017	2018	2019	2020	CAGR	% Of Total Arc Growth
Greater Cambridge and Peterborough	16,384	16,051	17,382	16,398	17,526	17,123	0.9%	7.0%
Oxfordshire	7,470	9,048	8,500	10,915	12,897	14,097	13.5%	63.0%
Buckinghamshire Thames Valley	7,140	8,706	7,185	7,326	7,339	7,397	0.7%	2.4%
South East Midlands	4,366	4,996	4,927	6,192	6,988	7,262	10.7%	27.5%
Oxford-Cambridge Arc	35,359	38,801	37,993	40,831	44,750	45,878	5.3%	10,519 (100%)

The Oxford-Cambridge Arc today.

This report defines the Arc at a Local Enterprise Partnership (LEP) and Combined Authority level.

There are three LEPs and one Combined Authority in the Oxford-Cambridge Arc: Oxfordshire LEP, Buckinghamshire Thames Valley LEP, South East Midlands LEP and Greater Cambridgeshire & Peterborough Combined Authority.

The South East Midlands (SEM) is the Arc's largest LEP by population, GVA and business volume (c1.7m, c£48.9bn and c77k, respectively). SEM also has the smallest proportion of employees with a national vocational qualification level 4 (NVQ4) and above (39.2%) – despite having the highest volume (c415k).

Greater Cambridgeshire and Peterborough, and Oxfordshire both possess the strongest concentration in Life Sciences, with the largest proportion of their total employment within the industry (c4%) and the largest overall volume of Life Sciences employment (c17k and c14k, respectively) and Life Sciences GVA (£1.1bn and £1.0bn, respectively) in the Arc.

Greater Cambridgeshire and Peterborough is the largest Life Sciences employer in the Arc, and third largest in the UK (c17k employed). It is followed by Oxfordshire (c13k employed, 6th nationally), Buckinghamshire Thames Valley (c7k, 15th) and South East Midlands (c7k employed, 16th).

Buckinghamshire is by far the smallest region in the Arc, by GVA, population and employment. However, Buckinghamshire's Life Sciences sector is well developed given its relative size and is as large as SEM's – a region with over three times the volume of businesses.

Oxford-Cambridge Arc LEPs / Combined Authorities – Macro Economic Comparative Table - 2020 Data:[3]

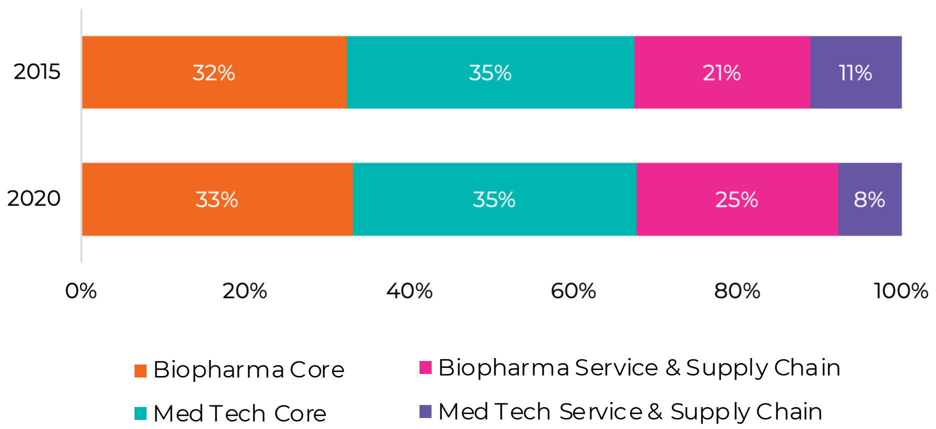
	Oxfordshire	Buckinghamshire Thames Valley	South East Midlands	Greater Cambridge and Peterborough	England
GVA £million	23,453	15,513	48,949	26,723	1,682,752
Population	696,900	547,100	1,709,700	859,800	56,550,100
Total Employment 16-64	338,500	253,500	838,600	405,600	34,869,000
Unemployment Rate	3.3%	3.8%	4.0%	4.2%	4.9%
% With NVQ4+	224,300 (52.8%)	146,500 (44.9%)	414,600 (39.2%)	230,900 (43.6%)	14,886,100 (42.8%)
% With no qualifications	20,000 (4.7%)	17,900 (5.5%)	59,200 (5.6%)	25,100 (4.7%)	2,153,900 (6.2%)
Number of Businesses	32,250	31,280	76,935	37,000	2,390,970
Micro	28,635 (88.79%)	28,635 (91.54%)	69,745 (90.65%)	33,010 (89.22%)	2,144,180 (89.68%)
Small	2,930 (9.09%)	2,135 (6.83%)	5,790 (7.53%)	3,165 (8.55%)	200,445 (8.38%)
Medium	530 (1.64%)	415 (1.33%)	1,110 (1.44%)	650 (1.76%)	36,885 (1.54%)
Large	155 (0.48%)	95 (0.30%)	295 (0.38%)	175 (0.47%)	9,460 (0.40%)
*Life Sciences Employment	14,097	7,397	7,261	17,123	265,819
*Life Sciences GVA £m (% of total GVA)	977 (4.16%)	453 (2.92%)	424 (0.87%)	1,128 (4.22%)	12,828 (0.76%)

The Arc's Life Sciences employment growth has been driven across Biopharmaceutical (Biopharma) Core, Biopharma Service & Supply and MedTech Core sectors – generating 36%, 35% and 33% of the Arc's growth, respectively.

The Arc's largest sectors in employment are Med Tech Core (c15.8k) and Biopharma Core (c15.2k), followed by Biopharma Service & Supply (c10.6k) and Med Tech Service & Supply (c3.6k).

Between 2015 and 2020 the Biopharma Service & Supply sector has grown its share of employment from 21% to 25%, alongside Biopharma Core from 32% to 33% whilst the MedTech Service & Supply sector has decreased and MedTech Core has remained the same.

Oxford-Cambridge Arc employment by sector:[2]



Employment growth in Life Sciences has been driven predominantly by a mix of Biopharma Core, Biopharma Service & Supply and MedTech Core sectors – growing at CAGRs of 5.8%, 8.3% and 5.0%, respectively.

Employment in Med Tech Service & Supply sectors have decreased in the Arc between 2015 and 2020 – decreasing by a 2.5% CAGR.

Life Sciences sector employment breakdown and growth:[2]

Sector	Employment 2020	Employment 2015	CAGR	% Of Total Arc Growth
Biopharma Core	15,195	11,445	5.83%	36%
Med Tech Core	15,841	12,389	5.04%	33%
Biopharma Service & Supply Chain	11,274	7,574	8.28%	35%
Med Tech Service & Supply Chain	3,568	3,952	-2.02%	-4%
Total	**45,878**	**35,359**	**5.35%**	**10,519 (100%)**

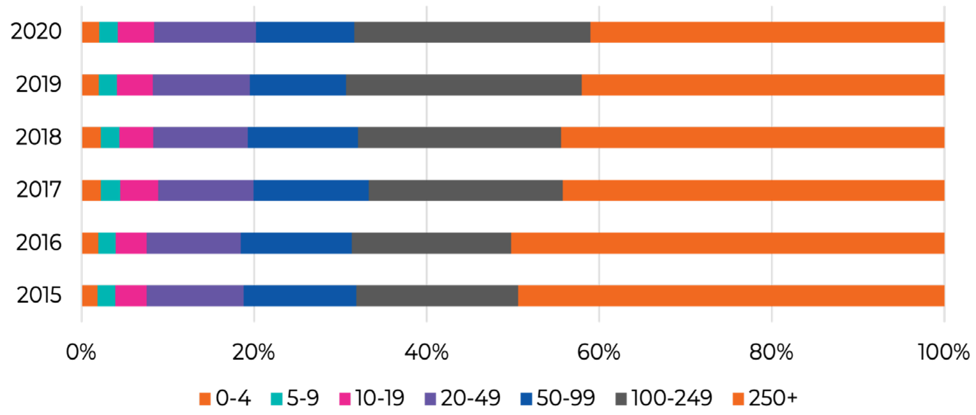
The Arc has experienced a notable shift in the mix of business sizes between 2015 and 2020.

The volume and proportion of total employment in businesses with 100-249 employees has grown, whilst the proportion employed by large firms (250+ employees) has decreased.

The volume and share of Life Sciences employees working in firms with 100-249 employees has grown significantly between 2015 and 2020 (56% of the Arc's employment growth) – Increasing its proportion of total Arc employment from 19% to 27%. A similar, but less pronounced trend is observed in businesses with 20-49 employees.

The proportion and share of Life Sciences employees working in large firms with 250+ employees has decreased quite significantly, which appears to be a gradual trend – although, material decreases were observed in 2017 and 2020. This decrease reduced this business range's share of Arc employment falling from 49% to 41%.

Oxford-Cambridge employment share by firm size: employment band:[2]



Life Sciences sector employment breakdown and growth by firm size: employment band:[2]

Employment Band	2020: Total Employed	2020 Share of Employment	2015: Total Em-ployed	2015 Share of Employment	% Of Total Arc Growth
0-4	936	2%	658	2%	3%
5-9	987	2%	721	2%	3%
10-19	1,943	4%	1,291	4%	6%
20-49	5,417	12%	3,968	11%	14%
50-99	5,215	11%	4,619	13%	6%
100-249	12,564	27%	6,631	19%	56%
250+	18,816	41%	17,472	49%	13%
Total	45,878	100%	35,359	100% (R.E.C)	10,519 (100%)

Biopharma Core (BP), Service & Supply (BX) and Med Tech Core (MT) share the largest segments in Life Sciences employment.

Growth segments are most concentrated by those in Biopharma Service & Supply, making up 4 of the top 10.

Segments in decline are predominantly Med Tech – 8 out of the 10 poorest performing segments are in Med Tech.

Arc top 10 Life Sciences segments by employment (2020):[2]

Ranking 2020 (Change 2015)	*Sector	Segment	Employment	% Of Employment
1 (-)	BP	Small Molecules	8,866	20%
2 (+1)	BX	Contract Manufacturing/Research Organisation	3,878	8%
3 (+2)	MT	Medical Imaging/Ultrasound Equipment and Materials	2,734	6%
4 (-2)	MT	Drug Delivery	2,310	5%
5 (-1)	MT	In vitro diagnostic technology	2,232	5%
6 (-)	BP	Antibodies	2,079	5%
7 (+1)	BP	Therapeutic Proteins	1,995	4%
8 (-1)	MT	Re-usable diagnostic or analytic equipment n.e.c.	1,881	4%
9 (+1)	BX	Reagent, Equipment and consumables supplier	1,721	4%
10 (+4)	BX	Logistics and Packaging	1,712	4%

**BP: Biopharma Core, BX: Biopharma Service and Supply, MT: Med Tech Core, MX: Med Tech Service and Supply*

***Some segments differ only in that they serve either the core or service & supply side of the industry.*

Arc top 10 Life Sciences segments by growth (2015 – 2020):[2]

*Sector	Segment	2020	Employment Growth	% Of Total Arc Growth
BX	Contract Manufacturing/Research Organisation	3,878	1,373	13%
BP	Advanced Therapy Medicinal Products (ATMPs)	1,303	962	9%
BP	Small Molecules	8,866	893	8%
BX	Logistics and Packaging	1,712	858	8%
MT	Medical Imaging/Ultrasound Equipment and Materials	2,734	846	8%
MT	In vitro diagnostic technology	2,232	780	7%
BP	Therapeutic Proteins	1,995	762	7%
BP	Vaccines	870	761	7%
MT	Assistive Technology	921	736	7%
MX	Analytical Services	711	676	6%

Arc bottom 10 Life Sciences segments by growth (2015 – 2020):[2]

*Sector	Segment	2020	Employment Growth	% Of Total Arc Growth
MX	Healthcare service provider	0	-15	0%
BX	Assay developer	16	-33	0%
MT	Mobility Access	92	-34	0%
MT	Implantable devices n.e.c.	51	-40	0%
MX	Market Analysis/Information Consultants/Communications/Specialist consultants	1,010	-146	-1%
MX	Investment Companies	69	-228	-2%
MT	Wound Care and Management	70	-525	-5%
MT	Drug Delivery	2,310	-627	-6%
BX	Analytical Services	602	-804	-8%
MX	Contract Manufacturing/Research Organisation	747	-836	-8%

Leading US Life Science clusters:

What can we learn from them?

What learnings can be observed for the Oxford-Cambridge Arc?

Technical skills are a priority, due to rapidly increasing demand for core science skills. Additional courses in biotechnology, biomanufacturing, medical laboratory tech, chemical tech, and laboratory science tech were introduced to help stimulate supply.

Tech skills are a priority, due to the increasingly digitised Life Sciences sector and increasing competition with Big Tech. 'Mission-focused' employee messaging was recommended for Life Sciences businesses to better attract talent to the sector.

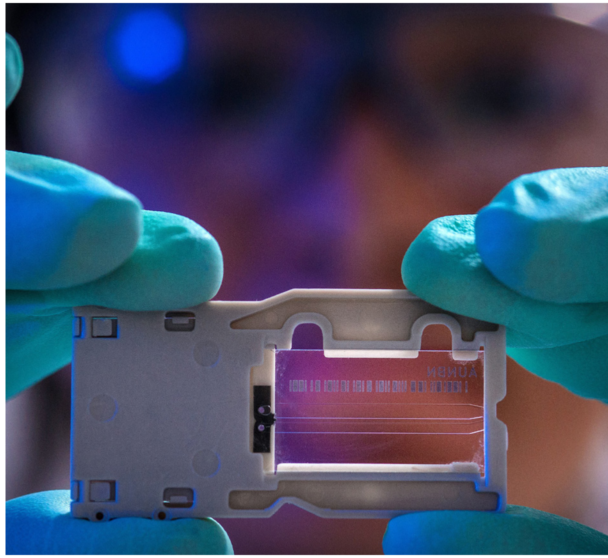
Regulatory skills are a priority, especially in Boston. Regulation skills are struggling to keep pace with strong growth in the sector.

Soft skills and Business skills should be prioritised, especially in San Francisco, a concern shared across all tiers of Life Sciences businesses.

San Francisco and Boston are both building a reputation as internationally leading Life Sciences clusters, with businesses focusing on a range of disciplines.

These firms are typically supported and enabled by a broad range of organisations and capabilities including investors, higher education, technology, digital, manufacturing and logistics – operating in growing and effective regional Life Sciences ecosystems.

As a result, San Francisco and Boston can provide potential benchmarks and comparisons for the development and growth of Life Sciences skills in the Oxford-Cambridge Arc.

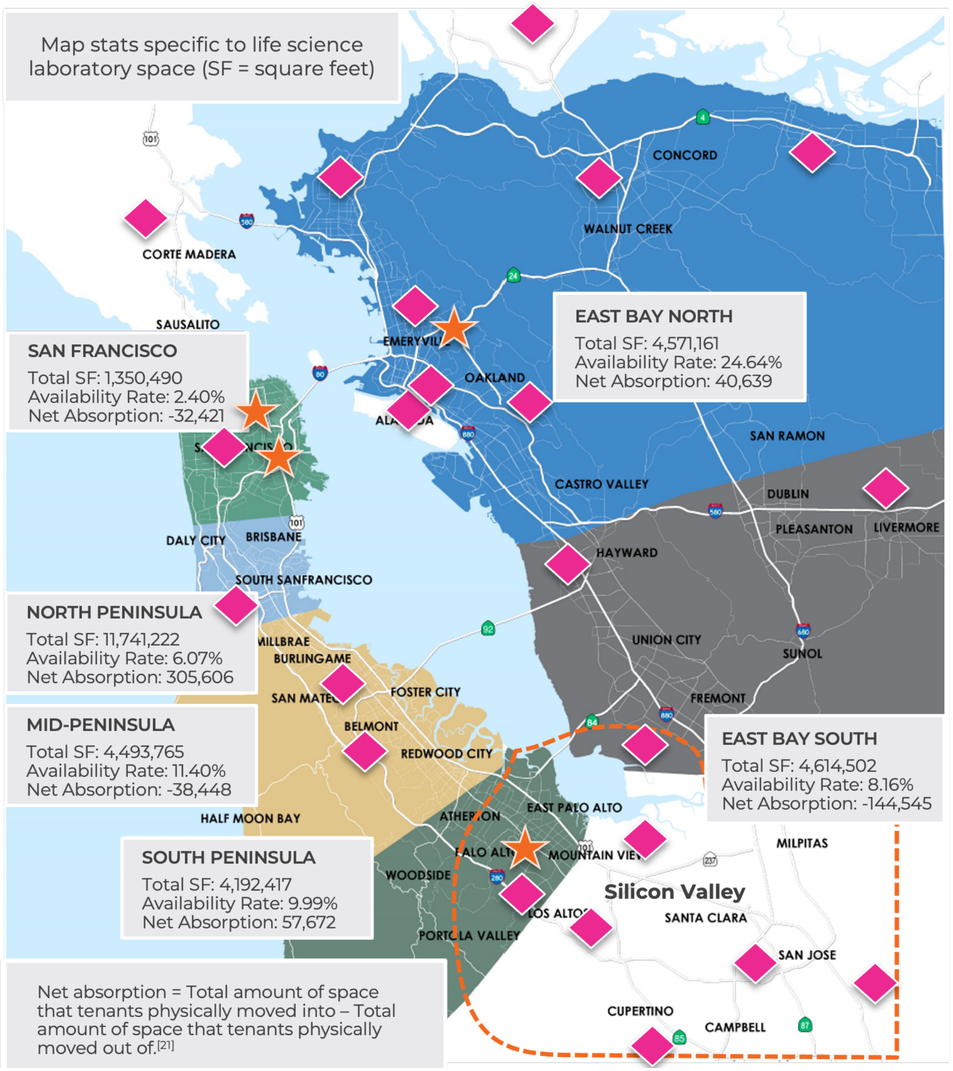


San Francisco - California.

Supply of technical skills are struggling to meet rapidly increasing demand, both in raw volume and in diversity. Broadening recruitment channels, including community colleges and apprenticeships, has helped to unlock additional volume and diversity – aided by increasingly tailored Life Sciences curriculums in community colleges.[4],[5]

Identified college programme categories include biotechnology, biomanufacturing, medical laboratory tech, chemical tech, and laboratory science tech. Also, companies highlight the benefits of locating near these institutions to better enable open discussions – spurring academic partnerships.

Like San Francisco, the Arc benefits from world leading education institutions. To better unlock talent in the Arc, the many other universities can play a pivotal role in negating this pain point in the future – especially if they effectively tailor their curriculum to the ongoing and emerging needs of the industry.



Key Stats:

Population:[1]	c7.8m
Businesses:[2]	c318k
Workforce:[3]	c3.9m
Universities:[4]	14
Community Colleges:[4]	30+
Life Sciences:	
Businesses:[5]	c4k
Workforce:[5]	c179k
Universities:[6]	4
Community Colleges:[7]	34

Leading Life Science Universities[18] ★

Community Colleges w/ Life Science Related Courses[17] ◆

San Francisco - California.

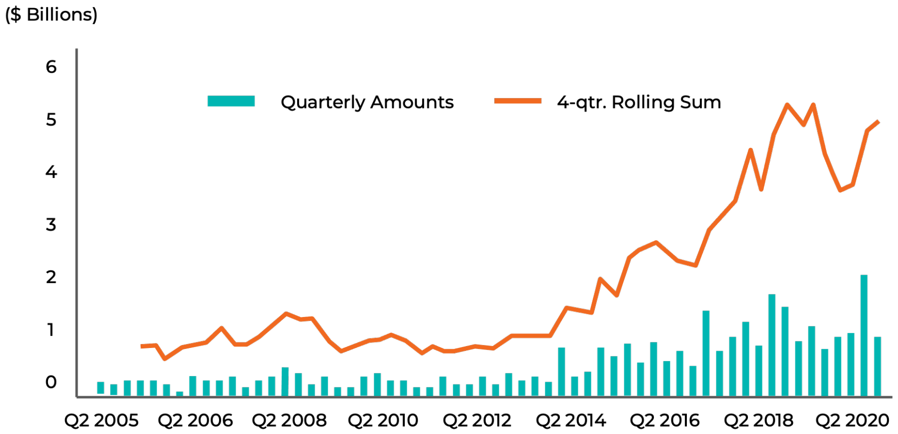
Increasing competition over tech skills by Life Sciences companies and big tech – a common trend emphasised by the neighbouring cluster of tech companies in Silicon Valley. Life Sciences companies have benefitted from developing more 'mission focused' employee propositions and engaging students earlier in life.[5] The Arc might also benefit from a strong mission focused Life Sciences employee proposition to better compete with other sectors, such as big tech, for these skills and engaging students with these propositions earlier in life.

Soft and business readiness skills are becoming increasingly sought after and remain a prominent pain point for recruiters. This trend is apparent across all tiers of Life Sciences companies. Targeted actions are required across the ecosystem to identify and develop these skills both in an education and work setting.[5],[6] The Arc might negate this in the future, with a more targeted focus in education and within businesses – perhaps through focus on professional development programmes.

Whilst not specifically skills focused, the significant laboratory space required to support the growth of the cluster is a material pain point worth noting. Increasing competition over limited space is inflating rent prices for businesses – amplified in key locations, often around leading universities but also in central metropolitan areas. The Arc may look to further examine areas of available green and brown space for construction in line with forecasted increases in demand to negate these issues going forward.

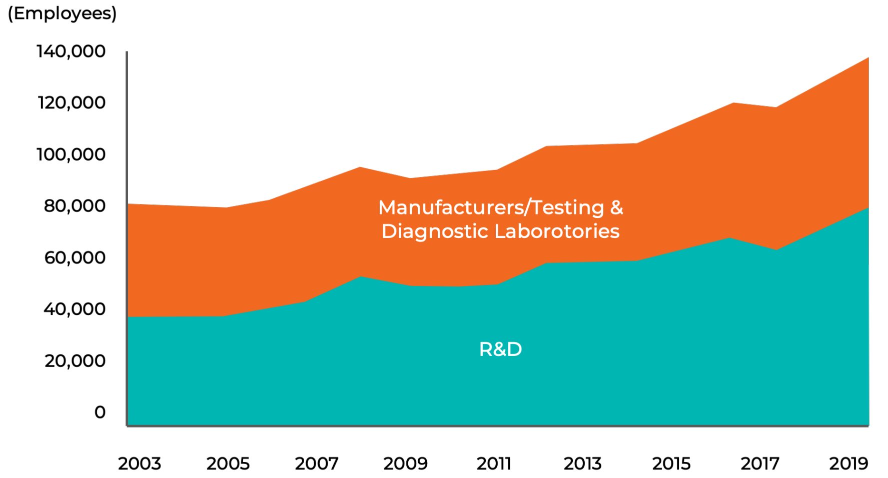
Venture Capital Funding

(San Jose-San Fransisco-Oakland, CA CSA)



Source: PwC Money Tree (BioTech, Drug Development & Discovery, Pharma/Drugs, Disease Diagnosis), CBRE Research, Q2 2020.

Employment



Source: US bureau of Labor Statistics, CBRE Research, Q3 2020.

Boston - Massachusetts.

Employers in Massachusetts are struggling to fill roles across the Life Sciences industry, with acute shortages in highly educated scientists, and managers in secondary occupations. Demand for data scientists, process engineers and regulatory affairs professionals is also outstripping supply; an imbalance that will worsen as the sector converges further with technology and as the advanced therapeutics industry matures.[18]

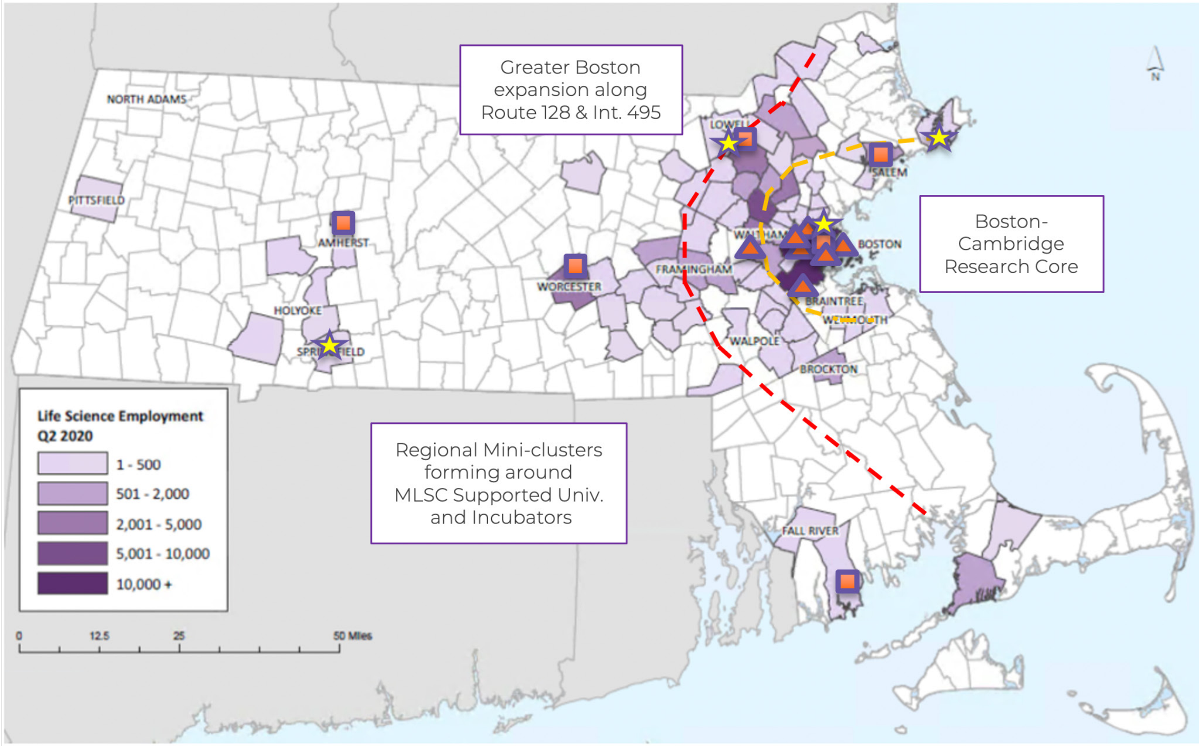
Massachusetts is targeting growth in inter-disciplinary specialisms, its manufacturing capacities, and a broader ecosystem of micro-clusters outside the Boston-Cambridge hub. These targets aim to help keep pace with the speed of Life Sciences innovation and to develop the Massachusetts cluster into new geographies, specialisms, and skill sets.

To ease labour shortages and rising rental costs, the ecosystem is investing in Life Sciences infrastructure at state universities and growing into less expensive regional areas. This is creating greater capacity for training, a more diverse talent pool and the opportunity to establish new specialisms within the state cluster.[19],[20],[21],[22]

The Arc should consider aligning present and future skills needs with academic and commercial assets across the region. Universities and towns without traditional specialisms in Life Sciences may offer an opportunity to reach previously under-represented groups, and to leverage less expensive real estate. Public and private funding should also align with the industries strategic priorities, and the spatial / workforce opportunity, to ensure best value and the full utilisation of regional assets.

Key Stats:
Population:[8] 6.98m
Businesses:[9] 252k
Workforce:[10] c3.3m
Universities:[11] 73
Comm. Colleges:[11] 41

Life Sciences:
Businesses:[12] c600
Workforce:[13] 89k
Universities:[14] 15+
Comm. Colleges:[14] 10+



Route 128
Interstate 495
Public Universities[19]
Private Universities[19]
Major MLSC Incubator[20]

Boston - Massachusetts.

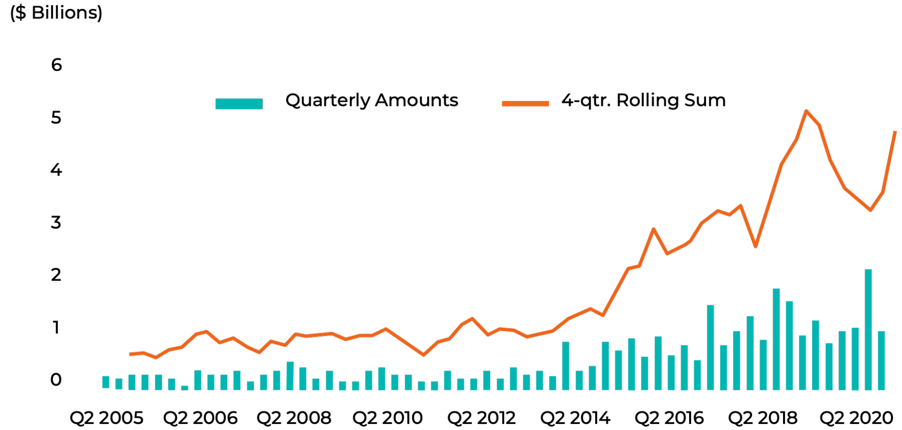
Universites without established Life Sciences curriculums may be flexible to deliver education in new converging areas of technology, computation and Life Sciences. Furthermore, LEPs with a surplus of real-estate capacity may offer opportunities to establish specialised mini clusters in emerging areas of Life Sciences.

A successful policy utilised in Massachusetts has been to establish incubators, equipped with cutting edge Life Sciences facilities, in regional centres to attract start-ups and to better attract private equity investment. Massachusetts has also funded research centres outside of the Boston-Cambridge core to grow research and training capacity and form the foundation for future Life Sciences hubs.

To deliver on skills requirements, ecosystem stakeholders should be aware and confident of the publicly funded initiatives available to receive interns, win infrastructure grants, and to support research spinouts. All of these provide a platform for training and skills growth; whilst also allowing some degree of ecosystem steering at a strategic level.

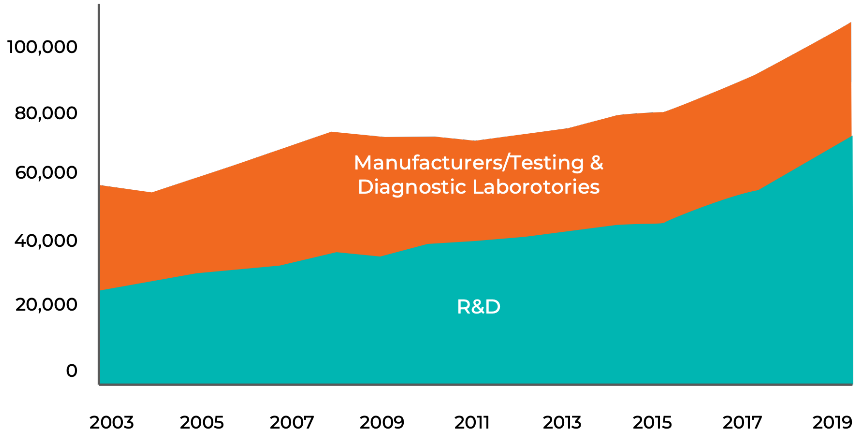
Venture Capital Funding

(Boston CSA)



Source: PwC MoneyTree (BioTech, Drug Development & Discovery, Pharma/Drugs, Disease Diagnosis), CBRE Research, Q2 2020.

Employment



Source: US bureau of Labor Statistics, CBRE Research, Q3 2020.

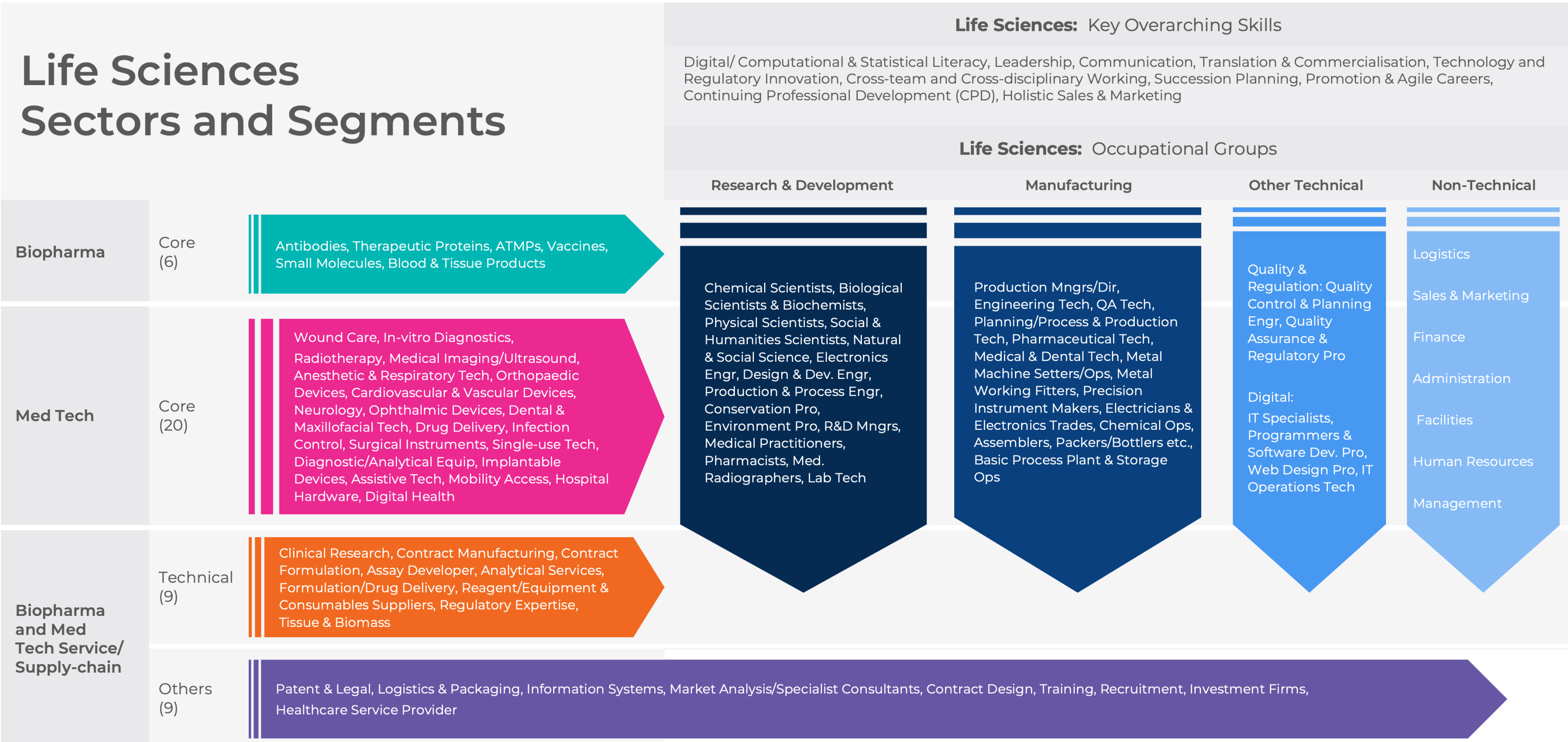
Critical Life Sciences:
Skills and occupational groups.

Critical Life Sciences skills and occupational groups.

This report's Life Sciences industry and skills framework was established at the on-set of the project to enable a holistic approach for assessing the current and future workforce skills requirements within the Arc.

The framework (see below) is based on the UK-wide database structure established by the Office of Life Sciences[32], to ensure consistency with definitions and segmentations used across several publicly available UK Life Sciences industry reports such as the Life Sciences 2030 Skills Strategy Report.[33]

Although complex, the framework provided a context to capture and assess skills profiles within the Arc over the past five years and then build scenarios about plausible skills gaps/requirements going forward. Likewise, it was used as a frame of reference for discussions with stakeholders to gather perspectives about priorities for developing the Arc's Life Sciences ecosystem.



What range of skills are required by a successful / mature Life Sciences eosystem?

As skills challenges are discussed at various levels within publicly available material, and in this report, we have developed a Life Sciences skills guide to aid connecting skills categories to specific skills.

As part of the review of Life Sciences skills in the Arc, we have developed a broad 'menu' of relevant skills within a typical Life Sciences ecosystem (see right). The primary source of this list is the ABPI's biopharmaceutical skills report[34], supplemented with a Med Tech focused skills report in Ireland.[35]

For the Arc, all these skills may not be necessary and there may well be higher demand for specific skills depending on the profile of businesses within the ecosystem.

This menu looks to add depth to common categories of skills that have been noted in market reports and in interviews with stakeholders across the Arc – discussed later in this report.

Biological Sciences & Technology

- Animal technology
- Biochemistry
- Biopharmaceuticals / biologics
- Biotechnology
- Drug metabolism and ADME
- Genomics
- Histology
- Immunology
- Lab technician
- Metabonomics
- Microbiology
- Molecular biology
- Molecular / translational toxicology
- Pharmacology
- Physiology
- Proteomics
- Regenerative medicine / Stem cell biology
- Structural biology
- Toxicology

Med Tech

- System Architecture
- Interoperability engineering
- Cyber security
- Software validation
- Orthopaedic product design
- Material science
- Forging manufacturing
- Additive manufacturing
- Automation engineering
- Microbiology
- Medical imaging engineering
- Moulding skills
- Human factor skills
- Biomedical engineering
- Mechatronic engineering
- Software developers
- Pharmacology
- Neural engineering
- Medical robotics
- Computational neuroscience
- Nanotechnology
- Balloon engineering
- Microbiology
- Technical sales
- Robotic engineering

Clinical (including Trials)

- Clinical pathology
- Clinical trial design (incl. novel trial design)
- Clinical pharmacology / translational medicine
- Clinical research operations

Chemical Science

- Analytical chemistry / biochemistry
- Chemical biology
- Materials science
- Medicinal and synthetic organic chemistry
- Nanotechnology
- Physical chemistry
- Process chemistry
- Protein & peptide chemistry

What range of skills are required by a successful / mature Life Sciences eosystem?

Informatics, Computation, Mathematics & Statistics

- Automation
- Biomedical imaging
- Bioinformatics / Computational systems biology
- Chemoinformatics
- Chemometrics
- Computational chemistry
- Computational science
- Computer science
- Data management
- Data science
- Epidemiology and pharmacoepidemiology
- Engineering
- Health economics and outcomes (includes market access)
- Health informatics
- Pharmacokinetic / Pharmacodynamic modelling
- Physiological modelling
- Statistics
- Cyber security
- 3D printing

Regulation & Quality

- Pharmacovigilance
- Medical device safety monitoring
- Quality assurance
- Quality control
- Cleanroom
- Regulatory affairs
- Government Affairs
- Data management
- Data science
- Epidemiology and pharmacoepidemiology
- Engineering

Business

- Clarity of vision for the business
- Project planning and management
- Budget development and financial analysis
- Corporate governance understanding
- Fund raising capability
- Communication and presentation (of both science and business) to key stakeholders – oral and written
- Negotiation and persuasion ability
- Marketing
- Leadership and decision making
- Risk assessment & mitigation
- Global experience

Commercialisation

- Investor communication
- Commercial judgment
- Opportunity / Unmet need identification
- Intellectual property strategy and management
- Business development plan
- Stakeholder management
- Project planning and management
- Budget development and management
- Market analysis – local and global
- Regulatory requirements – local and global
- Funding track record – local and international
- Sales
- Strategic partnerships and networking
- Translational understanding
- Training (individuals and groups)

What are the present and future skills challenges for a successful / mature Life Sciences ecosystem?

Prominent skills challenges today, at a skills category level (e.g., technical, information/computation and business and commercialisation) and are expected to persist into the future.

More recent innovations are expected to drive future skills challenges in technical skills, such as nanotechnology, translational medicine, and process chemistry.

As Life Sciences and technology converge further, more generalist tech skills are expected to become increasingly important, such as computational science, cyber security, data science and statistics.

Specialist regulatory and quality control skills challenges observed are expected to persist into the future.

From a current vs future perspective (see following page), this report assumes that skills challenges being experienced by more mature international clusters including San Francisco and Boston Massachusetts will remain as future challenges for the Arc as it continues to scale and mature.

Also, this report assumes that future skills challenges identified at a national / international level (including the UK[33],[34] and Australia[35]) that are considered future skills challenge are also relevant for the Arc's future trajectory. Additionally, current skills challenges are not guaranteed to dissipate into the future, as they depend on actions not yet taken; thus, all current skills challenges may well be relevant in the future.

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What are the present and future skills challenges for a successful / mature Life Sciences ecosystem?

Additionally, current skills challenges are not guaranteed to dissipate into the future, as they depend on actions not yet taken; thus, all current skills challenges may well be relevant in the future.

This report indicates that Life Sciences skills challenges, today and in the future, for successful / mature Life Sciences ecosystems (internationally and in the UK) exist across a range of skills categories including technical (such as chemical science and biological sciences & technology) and supporting skills (such as regulation, information / computational, business and commercialisation).

Skills challenges are particularly evident in technical and information / computational skill categories.

Critically, whilst these skills challenges are often identified across these categories – likely for simplicity – concerns also exist in specific skills. This is particularly evident for technical and information / computational skills.

Current Skills Challenges	Future Skills Challenges
Technical Skills: Epidemiology and pharmacoepidemiology; Engineering in manufacturing; Chemical Biology;	**Technical skills:** Process chemistry; Pharmacology and Biopharmaceuticals / biologics; Nanotechnology; Clinical pharmacology / translational medicine; Physician pharmacologists
Information/Computation Skills: STEM more broadly; Chemometrics, formulation science, Physiological modelling, Computational chemistry; Pharmacokinetic / pharmacodynamics modelling	**Information/Computation Skills:** Computational science; Cyber security; Pharmacometricians (modellers) Bioinformatics / computational systems biology; pharmacokinetic / pharmacodynamics modelling; Data science; and Statistics
Support skills: Manufacturing skills Regulatory skills incl. regulatory affairs Quality skills Logistics skills	**Support skills:** Regulatory skills Quality skills Soft skills
Business and commercialisation skills	**Business and commercialisation skills**

Source: Summary of key insights through all lenses (International, UK & Arc-specific), covered in this document, split where possible by current vs future.

What challenges exist across the different routes to attaining key Life Sciences skills for a successful / mature Life Sciences ecosystem?

Significant variation exists in skills challenges across different qualifications and seniority levels.

The qualification and experience levels that currently hold the highest volume of skills challenges include Experienced Staff and Graduates / MScs

Looking specifically at different levels of qualification and seniority, the ABPI report[34] identifies a much broader range of high priority skills – requiring immediate action.

Examining skills challenges across different levels of qualifications and seniority presents significant variation in the challenges faced by the sector and particularly evident need in experienced staff and Graduates / MScs.

Non-graduate	Graduate / MSc		Apprenticeships	PhD	Post-doc	Experienced Staff		
Animal Technology	Biotechnology	Microbiology	Cell and gene therapy	Metabonomics	Structural Biology	Animal Technology	Histology	Process Chemistry
Histology	Analytical chemistry / biochemistry	Pharmacy		Cell and gene therapy	Cell and gene therapy	Alliance management	Human Genetics	Programming
Microbiology	Cell and gene therapy	Programming		Chemoinformatics	Epidemiology and pharmacoepidemiology	Analytical chemistry / biochemistry	Immunology	Project management
	Data Science	Proteomics		Epidemiology and pharmacoepidemiology	Materials Science	Bioinformatics / computational systems biology	In Vitro Pharmacology	Proteomics
	Formulation	Quality assurance and quality control		Formulation	Medicinal and synthetic organic chemistry	Biotechnology	Materials Science	Proteomics
	In Vitro Pharmacology	Statistics		Materials Science	Physical Chemistry	Cell and gene therapy	Medical information scientists	Qualified person (QA)
	Materials Science	Toxicology		Medicinal and synthetic organic chemistry	Process Chemistry	Chemoinformatics	Medically qualified clinicians	Qualified person (QPPV)
	Medicinal and synthetic organic chemistry	Veterinary and toxilogical pathology		Pharmacokinetic / pharmacodynamics	Toxicology	Clinical pharmacology / translational medicine	Medicinal and synthetic organic chemistry	Quality assurance and quality control
	Metabonomics			Pharmacy	Veterinary and toxilogical pathology	Clinical research operations	Metabonomics	Regulatory affairs
				Physiological modelling		Computational chemistry	Microbiology	Responsible person (RP)
				Process Chemistry		Data Science	Neuroscience	Statistics
				Proteomics		Drug metabolism and ADME	Pharmacokinetic / pharmacodynamics	Structual Biology
				Toxicology		Engineering in manufacturing	Pharmacoviglance	Toxicology
						Epidemiology and pharmacoepidemiology	Physical Chemistry	Veterinary and toxilogical pathology
						Genomics	Precision medicine	Veterinary medicine
						Health economics, outcomes, informatics and real-world evidence		

What challenges exist in developing key Life Sciences skills in the Arc?

Identified challenges in developing relevant Life Sciences skills exist in:

- The overreliance on degrees over vocational qualifications (e.g., apprenticeships)
- Poor perception of certain industries and apprenticeships
- Declining volume of apprenticeships
- Lack of engagement with STEM related courses
- The need to retain talent in the region
- Calls for greater alignment between education and industry.

Oxfordshire

Oxfordshire LEP's Skills Strategy Report[36], published in 2021, outlines the successes, challenges, and skills shortages in Oxfordshire. There is limited specific focus on Life Sciences which is classified and commented on as a 'Breakthrough' sector – alongside 9 other sectors.

However, the report identifies several 'cross-cutting' skills challenges and barriers including: the value of technical qualifications may not be seen as equal to a degree by employers; graduate retention in the region; SME capacity to support work and industrial placements is tight, such as those required by new T-Level qualifications; and one third of employers provided no on/off job training.

The LEP's two universities' qualifications are reportedly well aligned to the needs of the breakthrough sectors – which often demand specialist skills that the universities are well placed to supply.

Oxfordshire identifies the following challenges relevant to Breakthrough sectors: higher concentration of students in other subjects than STEM; employers' demand for degrees over vocational qualifications; growing demand for flexible courses; and declining number of apprenticeships.

Moreover, for Breakthrough sectors, the focus in the region in the future is aimed towards driving greater volume of STEM and business support student uptake; focusing and linking the local talent pipeline; and supporting and driving vocational and technical qualification reform.

Greater Cambridgeshire & Peterborough

Greater Cambridgeshire & Peterborough highlight several critical skills challenges in the region and are considered a potential inhibitor to growth.[37]

Partnership working is recognised as being essential to harness the benefits of academia, industry and the NHS working collaboratively together. This has been aided by a county wide Life Science Strategy[38], led by Anglia Ruskin University in collaboration with the Business Board of the Combined Authority and Cambridge University Health Partners, to develop proposals to address identified skills gaps.

The specific skills gaps being targeted include:

- **Entry level positions** – with the opportunity to provide further education and apprenticeship opportunities from these targeted at those in the broader region who may feel disconnected from the workforce and require support to enter or re-enter.
- **Cross-over skills** between disciplines and also fostering understanding of needs of different environments; NHS, Academia, Industry and Start-up.
- **Entrepreneurial skills** as well as later stage commercial skills to be able to support innovation and growth of companies.
- **Specific skills** such as data engineering, green technologies and sustainability that are likely to be increasing demand.

The region is also putting an increasing emphasis on careers education, specifically around STEM and green skills, including through a programme of work through the Greater Cambridge Partnership (GCP)[39] and Careers and Enterprise Company support across the Combined Authority area . There is also a priority around increasing work-based learning, particularly apprenticeships where it is recognised that there is more work to be done.

South East Midlands & Buckinghamshire

Specific Life Sciences skills coverage is much less pronounced in these LEPs' skills strategies than in Oxfordshire and Cambridgeshire & Peterborough.

In the South East Midlands[40], whilst Life Sciences is mentioned as a strong sector, there is much greater focus on the skills challenges in logistics, manufacturing, health and social care and business administration – which are all relevant support sectors for Life Sciences. Logistics skills appear as a material challenge in this region.

In Buckinghamshire[41], there is an observed mismatch between skills being developed and the supply of jobs with skills demand and jobs local residents wish to work in. Also, there is a call to establish stronger local pipelines for emerging sectors in the region – where Life Sciences is referenced specifically.

Given these regions' less developed Life Sciences industries, the more limited focus on Life Sciences is somewhat unsurprising. However, there appears to be clear appreciation that this sector is a growth opportunity and that these locations are looking to further scale their own skills base relevant to Life Sciences core and service sectors.

Growth scenarios

to 2030.

Growth scenario to 2030.

As part of this report's review of Life Sciences datapoints within the Arc, three possible scenarios for Life Sciences employment growth to 2030 have been developed. The Office for Life Sciences (OLS) business register 2015-2020 was used as the primary dataset to build these scenarios, by examining growth rates from three separate time periods: 2015-2020, 2017-2020 and 2019-2020, to forecast through to 2030. See Appendix 1 for further details.

Key observations from each of the scenarios include:

Low Growth: 3.41x employment growth multiple

- Two features characterise the Low Growth scenario – a MedTech Core boom, consistent to varying degrees across all three scenarios, and the decline of Biopharma Core, attributable to poor ATMP and Vaccines segment growth 2019-2020.
- Whilst MedTech Core growth is resilient across the three scenarios because of its diverse segment portfolio (and ongoing growth since 2017), Biopharma Core suffers in the Low growth scenario from a lack of segment growth diversity.

Medium Growth: 4.48x employment growth multiple

- The medium growth scenario is the least volatile of the three. Growth is spread more evenly across all four sectors, and Biopharma Service and Supply has its strongest growth forecast.

High Growth: 5.87x employment growth multiple

- High growth is realised by strong employment CAGRs in the Arc's two leading sectors: Biopharma Core and MedTech Core.
- Biopharma Core has its strongest 2030 employment forecast owing to large Advanced Therapy Medicinal Products (ATMPs) and Vaccines segment increases.

This scenario analysis would suggest that Biopharma Core is a sector in transition, and that skills policies should focus on enabling growth segments whilst facilitating skills transfers from segments that are in stasis. The three scenarios make clear that Biopharma Core growth will come predominantly from ATMPs and Vaccines. The Small Molecules, Antibodies and Therapeutic Proteins segments did not contribute significantly to sector growth 2015-2020 and were left behind in the forecasts to 2030. As such, skills initiatives looking to enable transformational growth should focus on servicing the needs of ATMPs and Vaccines, whilst also supporting skills transfers from other areas which are not growing as rapidly.

In addition, MedTech Core is a growing sector with diverse skills requirements, which may benefit from a more targeted skills focus. For MedTech Core the appropriate conclusion appears to be the opposite as in Biopharma Core; as there is a mix of growth segments supporting employment growth, it would be sensible to take a general sector-level approach to skills helping to service the sector as a whole.

Biopharma Service and Supply has a contingent of growing segments, such as Research Organisations and Regulatory Expertise, but is a volatile sector with many segments experiencing growth and decline over the period. It also incorporates a broad range of firms and services making targeted skills policy at the sector level more difficult. The growth of Regulatory Expertise, Market Analysis and Research Consultants, Research Organisations and Logistics & Supply segments is encouraging and represents a broad mix of skills requirements.

Scenario 1: Low Growth.

The Low Growth scenario is the most volatile as only two years of data, 2019-2020, was used to forecast to 2030. Despite its 2030 inaccuracy, the Low growth scenario helps to underline two key trends. MedTech Core's consistent growth, and Biopharma Core's reliance on ATMPs and Vaccines.

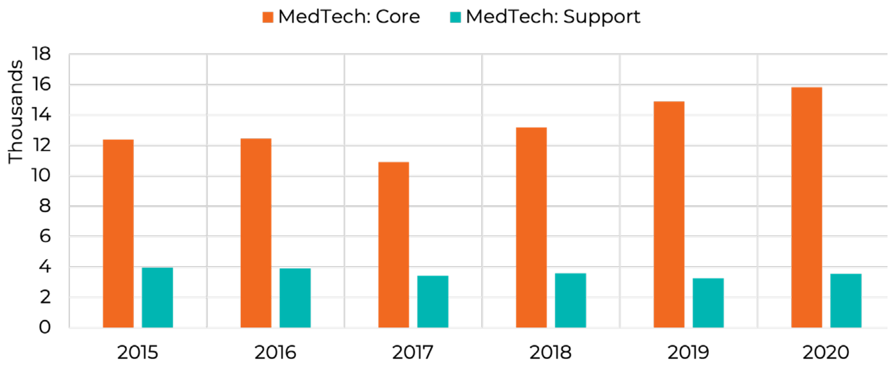
Low Growth scenario primary segment drivers: (10%+ CAGR)

- **Biopharma Core:** No segments above 10% CAGR.
- **MedTech Core:** Assistive Technology (CAGR: 43%), Single Use Technology n.e.c (36%), Medical Imaging / Ultrasound Equipment & Materials (21%).
- **Biopharma service & supply:** Clinical Research Organisation (CAGR: 35%), Regulatory Expertise (13%).

The MedTech service & supply sector is driven entirely by Analytical Services (CAGR: 43%). However, this is an anomaly. Despite MedTech supply's seemingly consistent growth across all three scenarios, it can be attributed to the entry of a single firm into the Oxford-Cambridge Arc. The Analytical Services segment saw its employment increase by 641 (from 69) from 2019 to 2020, which meant consistently high CAGRs across all three scenarios. This type of anomaly was largely mitigated by only including segments employing less than 1% of the arc total (see methodology in Appendix 1) but was not avoided in this case.

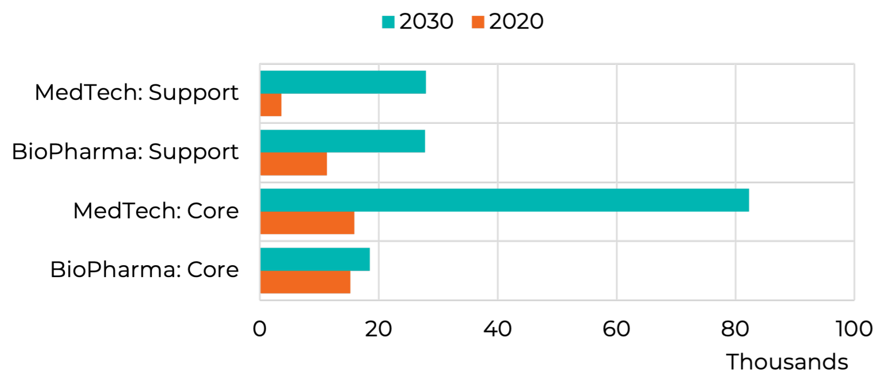
The Biopharma Core sector has only 5 segments with an employment share above 1% of the Arc total. Of these ATMPs and Vaccines are two, the other three include Small Molecules (the largest Arc segment by employment), Antibodies and Therapeutic Proteins. Of those three, none had a CAGR above 10% in any of the three scenarios. As a result, Biopharma Core's growth in the High and Medium growth scenarios was largely attributable to ATMP and Vaccines growth. When ATMPs (declined) and Vaccines remained static in 2019-2020, Biopharma Core saw its total employment fall 2019-2020, and remained static in the Low growth scenario forecasts to 2030 – highlighting their importance to the growth opportunity for the Arc.

Med Tech Core and Service & Supply: Employment: 2015-2020



Arc Sector Totals: Employment 2020 / 2030

Arc Employment Growth Multiple: 3.41x			
Employment:	**2020**	**2030**	**CAGR**
BioPharma: Core	15,195	18,436	1.95%
MedTech: Core	15,841	82,225	17.90%
BioPharma: Support	11,274	27,770	9.43%
MedTech: Support	3,568	27,926	22.85%
Arc Total	**45,878**	**156,357**	**13.05%**



Scenario 2: Medium Growth.

The medium growth scenario is the least volatile of the three. Growth is spread across all four sectors, and Biopharma Service & Supply has its strongest growth forecast. This produces a more sensible scenario result in terms of sector proportionality. Arc employment growth 2015-2020 is attributed (36%) to Biopharma Core, (35%) to Biopharma service & supply, and (33%) to Med Tech Core.

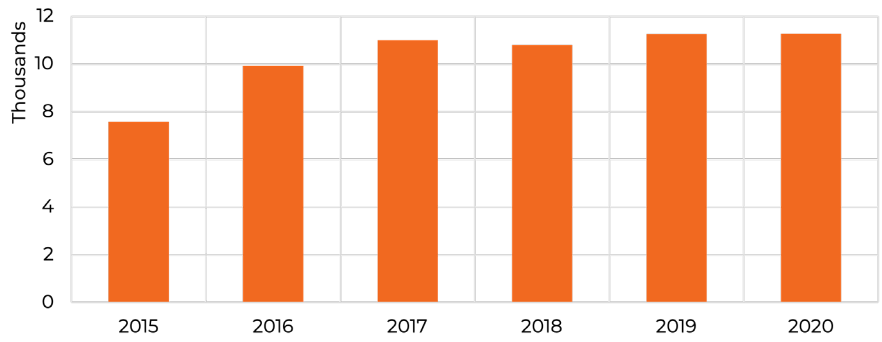
Medium Growth scenario primary segment drivers: (10%+ CAGR)

- **Biopharma Core:** growth is driven by Vaccines and ATMPs, with respective segment CAGRs of 43% and 31%.
- **MedTech Core:** growth is driven by Assistive technology (CAGR: 38%), Orthopaedic devices (27%), Infection control (11%) and Surgical Instruments (reusable) n.e.c (10%).
- **Biopharma Service & Supply:** growth is driven by Regulatory Expertise (CAGR: 41%), Clinical Research Organisations (25%), Market Analysis & Information Consultants (20%) and Logistics and Packaging (15%).
- **MedTech Service & Supply:** driven entirely by Analytical Services (CAGR: 43%). However, this is an anomaly that is consistent in each scenario.

Despite its strong trajectory in the Medium Growth scenario, the Biopharma Supply segment struggles in the other two scenarios. The sector's strong growth from 2015-2017 does not continue to 2020, but this is not because its segment primary growth drivers stopped performing – rather, it appears to be driven by other segments in decline.

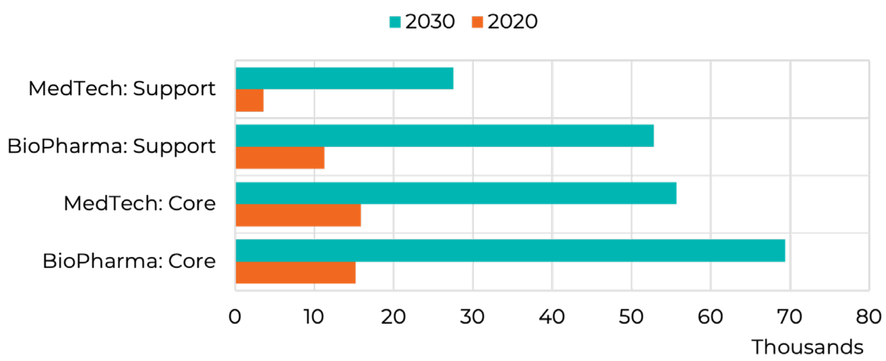
Biopharma Service & Supply segments that decline in the Arc in the High and Low growth scenarios (2017-2020) include: Contract Manufacturing / Research Organisations, Reagent Equipment and Consumables Suppliers, Analytical Services and Information Systems Specialists – highlighting its volatility.

Biopharma Service & Supply: Employment: 2015-2020



Arc Sector Totals: Employment 2020 / 2030

Arc Employment Growth Multiple: 4.48x			
Employment:	**2020**	**2030**	**CAGR**
BioPharma: Core	15,195	69,383	16.40%
MedTech: Core	15,841	55,668	13.39%
BioPharma: Support	11,274	52,791	16.69%
MedTech: Support	3,568	27,535	22.67%
Arc Total	**45,878**	**205,377**	**16.17%**



Scenario 3: High Growth.

The high growth scenario shows the transformative outcome enabled by strong sector growth in both Biopharma Core and MedTech Core.

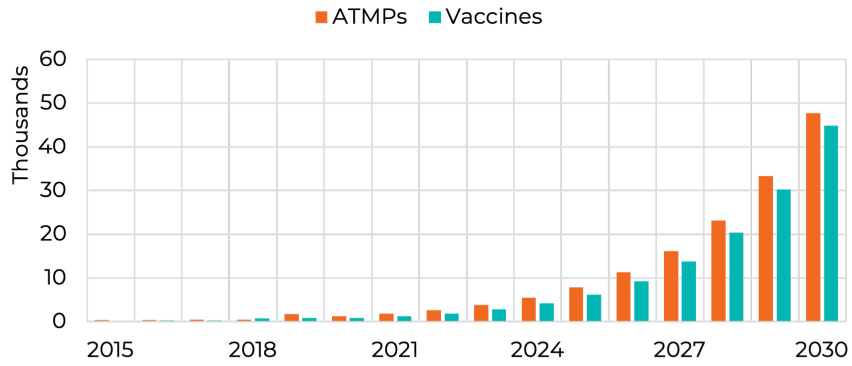
High growth scenario segment drivers: (10%+ CAGR)

- **Biopharma Core:** Vaccines (CAGR: 48%) and ATMPs (43%).
- **MedTech Core:** Assistive technology (CAGR: 43%), Drug Delivery (29%), Medical Imaging / Ultrasound Instruments & Materials (26%), Surgical Instruments (reusable) n.e.c (13%), Digital Health (12%), In vitro Diagnostics (10%).
- **Biopharma Service & Supply:** Market Analysis and Information Consultants (CAGR: 22%), Regulatory Expertise (18%), Clinical Research Organisation (12%), Reagent, Equipment & Consumables Supplier (12%).
- **MedTech Service & Supply:** driven entirely by Analytical Services (CAGR: 43%). However, this is an anomaly that is consistent in each scenario due to rapid growth in 2020 alone.

The Biopharma Core sector is defined by two features in this scenario analysis. The first is that as a sector it has only 5 segments employing at least 1% of the Arc total, compared with MedTech Core (14) and Biopharma supply (8). This is despite being the second largest sector employer, which means its growth is not as well diversified as other sectors.

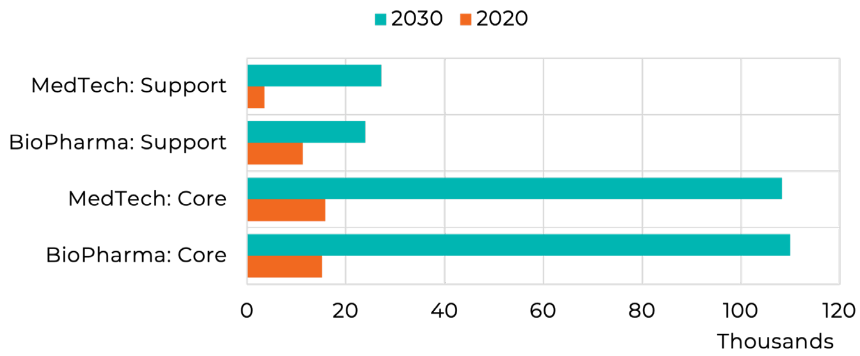
The second feature is somewhat a consequence of the first, that the sector is entirely reliant on ATMPs and Vaccines for significant growth. In the high growth scenario both segments hit the CAGR cap (see Appendix 1 for further details), which results in Biopharma Core having its strongest employment growth of the three scenarios.

Biopharma Service & Supply: Employment: 2015-2020



Arc Sector Totals: Employment 2020 / 2030

Arc Employment Growth Multiple: 5.87x			
Employment:	**2020**	**2030**	**CAGR**
BioPharma: Core	15,195	109,921	21.88%
MedTech: Core	15,841	108,278	21.19%
BioPharma: Support	11,274	23,953	7.83%
MedTech: Support	3,568	27,168	22.51%
Arc Total	**45,878**	**269,321**	**19.36%**



Medium Growth:
Scenario Skills Consideration.

The R&D & Manufacturing occupational groups present the largest increase in employment through the forecasts. They are also relevant to a vast breadth of critical Life Sciences skills areas – core and supporting.

The range of supporting occupational groups are heavily reliant on business and commercialisation skills, with a few supplementary technical skills from the core science areas and informatics and computation skills.

The required skills to effectively facilitate the Arc's desired growth trajectory are broad and can't be solved by focusing solely on one or two skills challenges that are present today

The Medium Growth scenario is considered the most accurate growth trajectory for the Arc of all the scenarios, given the forecasted sector mix in 2030. This section further assesses the underlying occupational groups that are driving this growth in employment and highlighted any areas of significant growth – in volume of employees.

The primary drivers of employment growth within this scenario include:

R&D: the largest occupational group today (c62% of total employment in 2020), which is expected to continue to 2030 (c49% of total employment in 2030). R&D is expecting the largest increase in employment volume of any occupational group assessed.

Manufacturing: the second largest occupational group today (c11% of total employment in 2020), which is expected to continue to 2030 (c12% of employment in 2030).

Sales & Marketing: the third largest occupational group today (c8% of total employment in 2020), which is expected to continue to 2030 (c10% of total employment in 2030).

Digital: a supporting occupational group today (c3% of total employment in 2020), which is expected to see significant growth during the scenario's forecasts – c28% CAGR, increasing to the third largest occupational group in 2030 (c9% of total employment in 2030). It is worth noting that this significant growth in Digital is erroneous and is generated by a significant YoY increase in the Analytical Services segment, from 2019 to 2020 – as mentioned earlier in this report. Due to this, the Digital occupation has been excluded from further analysis.

Administration: a moderate supporting occupational group today (c4% of total employment in 2020), which is expecting strong growth (c23% CAGR).

Management: a strong supporting occupational group today (c7% of total employment in 2020), which is expected to scale with the sector retaining a consistent share of employment in 2030.

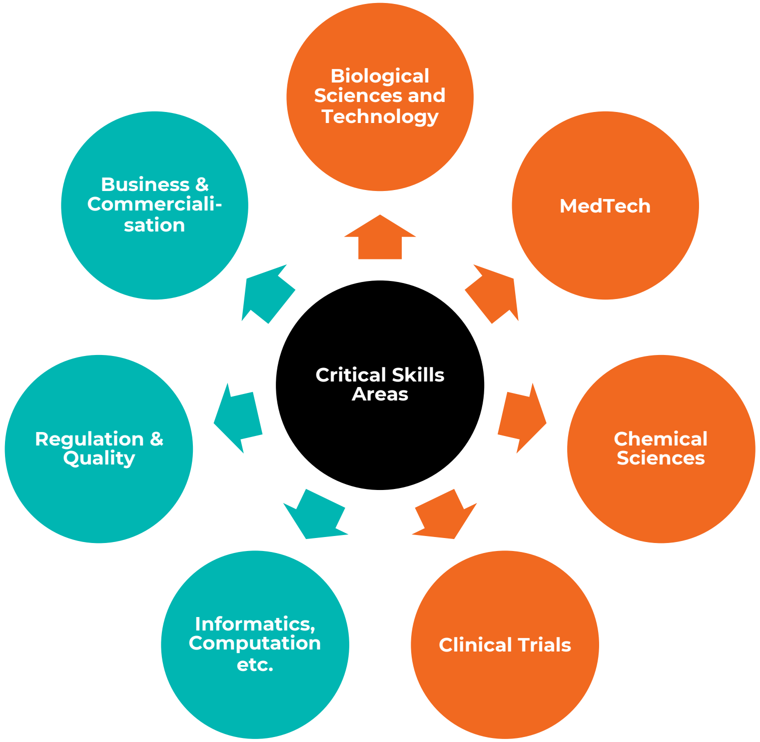
Occupation Group:	2020	2030	Change	Segment Drivers:	% Change Per Annum
R&D	28,214	99,716	**71,501**	Vaccines; ATMPs	13%
Manufacturing	5,264	24,758	**19,494**	Assistive Technology; Orthopaedic Devices	17%
Quality & Regulation	509	3,018	2,509	Regulatory Expertise	19%
Digital	1,510	17,899	**16,389**	Analytical Services	28%
Logistics	844	3,526	2,682	Logistics & Packing	15%
Sales & Marketing	3,466	20,636	**17,170**	Assistive Technology; Orthopaedic Devices;	20%
Finance	395	2,989	2,594	Mixed	22%
Administration	1,932	15,726	**13,794**	Regulatory Expertise	23%
Facilities	281	1,853	1,572	Mixed	21%
Human Resources	106	1,027	922	Mixed	26%
Management	3,356	14,229	**10,873**	Vaccines; ATMPs; Consultants; Regulatory Expertise	16%
Total	**45,878**	**205,377**	**159,499**	**N/A**	**16%**

R&D and Manufacturing occupations require a significant breadth of skills that are relevant across the set of critical skills areas e.g., science and medical skills, clinical trials knowledge, informatics and computational skills, regulation and quality and business and commercialisation skills. Although, we might expect there to be a slight skew towards core skill areas. It is therefore critical that the Arc's response to skills development in the future is not hyper-focused in one skills area. All skills will remain relevant into the future and the core functions of the sector continue to scale.

In Sales & Marketing and Administration occupational groups, skill sets most relevant are business and commercialisations skills. The breadth of relevant business skills ranges from leadership to good commercial judgement to businesses development to training. In addition, there are some core skills that are relevant including Technical Sales, Statistics and Government Affairs.

In the Management occupational group, skill sets most relevant are business and commercialisations skills. The relevant skills span the full breadth of identified business and commercialisation skills – from vision to project planning to investor communication to strategic partnerships and networking.

The assessment of the Medium Growth scenario suggests that the required skills to effectively facilitate the Arc's desired growth trajectory are broad and can't be solved by focusing solely on one or two skills challenges that are present today. In addition, the greatest volume of critical life sciences skill requirements to support increased employment in the sector is seemingly split between the core skill areas in science and medicine (e.g., biological sciences and technology, MedTech, clinical trials and chemical sciences) and skills within the business and commercialisation skill area.



Life Sciences:

Skills, strengths, and weaknesses in the Arc.

Current Life Sciences skills strengths and weaknesses in the Arc.

Contention exists across the Arc about the relative strength of core / technical Life Sciences skills.

Many stakeholders across the Arc suggest that science and medical skills are one of the biggest strengths that the Arc possesses today. In addition, some suggest that these skills are readily accessible – especially in the more established clusters like Oxford and Cambridge.

However, whilst there is an appreciation that these skills are available in the more established hubs in Oxford and Cambridge, other stakeholders suggest that it is difficult to attract technical skills out into other areas of the Arc. Similarly, attracting talent away from academia can be difficult and is a bottleneck for developing available talent for businesses.

Additionally, some suggest that specific specialisms of technical skills are difficult to acquire e.g., animal testing / technology given the specific qualifications and experience required and the public's stigmatised perceptions about some of its practices.

Stakeholders also observe that technical skills are yet to hit critical mass – especially at the more junior levels, such as lab technicians. This trend has been made more difficult to resolve in the more established hubs due to inflated living costs and poor transport infrastructure.

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One of our biggest strengths is in science and medical skills. We will need more in the future, but we're really good at developing these.

Professor Matthew Wood, University of Oxford

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Observing firms at the Campus, businesses still seem to be able to access high quality scientists and senior scientists, as they come through and attracted by Cambridge University and other academic locations and institutions, and confident that it is the same in Oxford too. They seem happy to life and work in these locations – we should be able to attract world class talent in this sector.

Derek Jones, Babraham Research Campus

"

In Cambridge you'll find an abundance of technical skills, and at CIC we are nurturing these talents to create future global leaders in the life sciences sector.

Dr Michael Anstey, Cambridge Innovation Capital (CIC)

"

People who need to be based onsite are the issue – you can't work remotely in a lab. We struggle to get people here, rather than these skills don't exist.

Gareth Williams, TCS Biosciences

"

Research and development – you have to invest plenty of effort to motivate certain people to move into industry as opposed to staying in academia. It is obviously a big conversion bottleneck to make the talent available.

Marcel Gehrung PhD, Cyted

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Lack of technical skills / technicians are a common present challenge... More specifically, lab animal technicians are a specific skills gap. These technicians need particular qualifications / experience... also, in wider society, some perceive a stigma around animal-related testing, even though it is a necessary part of approved drug development processes.

Dr Claire Pike, Anglia Ruskin University

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At the junior end, technical roles (such as Lab Technicians) are critical and we've yet to hit that critical mass. This, in part, has been made more difficult as Cambridge continues to have growth barriers – the high cost of housing in particular for lower paid workers and the need for more affordable homes.

Harriet Fear MBE, Cambridge& and Cambridge Ahead

There is a clear appreciation that the intersection of transferable skills with Life Sciences knowledge and experience are some of the most difficult skills to recruit for.

It is considered relatively easy to find talent in broader supporting disciplines such as business, sales and marketing and IT. There is also an appreciation that not everyone who possesses these skills will have a background in Life Sciences. However, those who do possess these transferable skills – who have relevant Life Sciences knowledge and experience are not only highly sought after, but very difficult to find.

“

The marriage between business and technical skills is key. More can be done to develop business skills among technical graduates / employees. You do see more universities supporting the business side of the equation for spinouts.

James Preston, TCS Biosciences

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In Sales and Marketing for life sciences companies, not everyone will have a technical background. However, those who do would be heavily sought after.

Gareth Williams, TCS Biosciencesy

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For IT roles it is easier to find someone who is ‘tech only’ in their mind but it’s significantly more difficult to find someone who is able to live at the intersection of life sciences and software.

Marcel Gehrung PhD, Cyted

Data, digital and emerging technological innovations (such as AI and automation) are considered skills shortages in the Arc today.

There is a clear appreciation that prominent skills shortages exist across the realm of informatics, computation, mathematics and statistics. Data science, AI and big data are often cited as a challenge to recruit for – both in terms of generalist skills (e.g., data science) and Life Sciences specific skill sets (e.g., computational chemistry). Cyber security, coding and statistical literacy are also cited as challenges across the ecosystem.

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Data science, AI and big data and coding are often mentioned: both life sciences-specific skills like bioinformatics or handling large volumes of patient data (which is definitely a skills gap in delivery), but also more general skills like data science and computation.

Dr Claire Pike, Anglia Ruskin University

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Cyber security is challenge and will likely continue to be – it’s a visible challenge and supply with be driven by demand.

Professor Alistair Fitt, Oxford Brookes University

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There is a move away from the lab to bioinformatics. This area is getting increasingly important in the curriculum, and being able to code in Python, and the Big Data, hence the need for the statistical literacy.

Nacho Romero, Open University

“

New graduates come with low statistical literacy and maths, we should focus on this. Better at basic digital – i.e., basic computation, Excel, PowerPoint. Better to have computing skills based on maths and stats.

Nacho Romero, Open University

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There are several skills that are underserved in the region including digital and IT skills such as software engineers and dev ops – which seems to also be an issue across Europe and accessing skills in the USA may help.

Dr Ala Alenazi, Ascension Life Fund

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There’s a big gap today for computational / informatics skills – could we bring these in from elsewhere in the country? This is true across most of the value chain and is certainly true in science / core sectors.

Professor Matthew Wood, University of Oxford

Regulation and quality are a commonly observed and material challenge in the Arc, often requiring skills to be bought in from outside the region at significant cost.

Regulation and quality control are often referenced as very difficult to recruit for across the Arc. More often than not, due to the significance of this shortage and the importance of the skill set, these skills are brought in from outside the ecosystem – if the business pays enough to attract them.

Moreover, references are also made to the relative difficulty in developing a clear and attractive pathway for graduates into this space – especially in regulation. Common pathways that are observed today are more experienced research and development staff choosing to specialise in these disciplines, rather than directly from a degree.

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Good QARA candidates are very difficult to find. When we hired previously, we had to hire from outside the ecosystem and then bring them over here.

Marcel Gehrung PhD, Cytedy

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People who can manage and engage with the clinical trials, from a regulatory perspective, are a gap.

Dr Claire Pike, Anglia Ruskin University

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We have a need for more people to specialise in regulation – however, it's not usually the first job you'd take after graduating from a degree. These people are more often experienced staff in R&D who chose to specialise in regulation.

Professor Kevin Shakesheff, The Open University

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Skills shortages include technical roles such as quality control, quality and regulation and manufacturing. Post Brexit, the regulatory landscape is changing – with a shift from Europe to the USA and increasing alignment to the FDA, which also supports USA investors in the market.

Dr Ala Alenazi, Ascension Life Fund

Management, leadership, commercialisation, and global experience are a pronounced challenge – especially at the senior level.

The shortage of experienced talent with management, leadership, commercialisation, and global experience is hard felt across the Arc. Challenges in filling C-suite roles is often cited, where the common alternative is to try and attract these skills from outside the ecosystem – often from overseas.

There is a clear appreciation across the Arc that these skills play a vital role in scaling-up the sector and, critically, the fast-growing start-ups within it. This observed shortage is, at times, referenced to be tempting SMEs to sell their businesses into big corporates, as the skills required to effectively scale the business does not yet exist internally and are very difficult to find externally.

Many start-ups within the region are often created under the leadership of scientists and academics, sometimes without the previous experience of building and scaling a business. However, there is some consensus that the significance of these types of skills is more pronounced at the scale-up stage and that the business / commercial support for new start-ups has improved over time.

> **“Non-technical is related to this point of not fully being able to get heavy hitters which have more global experience which is just the nature of the companies that usually reside in the ecosystem. This would be a problem which can’t be easily overcome.**
>
> Marcel Gehrung Phd, Cyted

> **There’s also a huge need for management / leadership skills. We often look overseas for C-suite level roles. This is more important for scale-up companies than early-stage start-ups. We need to become better at attracting and developing people with these skills / experiences.**
>
> Professor Matthew Wood, University of Oxford

> **There are gaps in commercialisation, marketing, business management – which might also be tempting SMEs to sell to big businesses. It’s hard to find people with these skills. Additionally, those people who have these skills – not just generically, but specific to life sciences – are very rare. Global experience is also spoken of in the same breath as some the of the skills challenges above.**
>
> Dr Claire Pike, Anglia Ruskin University

> **Also, there is a shortage of commercial leadership skills and talent – many of the start-ups are formed by scientists and academics, but they may not have the skills and/or experience to build and scale-up firms.**
>
> Dr Ala Alenazi, Ascension Life Fund

> **There’s also a material need for scale-up experience and global experience too at the senior level. Increasing connectivity has helped for job mobility, but location and some physical presence are both very important – especially for those leading teams – to be connected in all ways to their colleagues.**
>
> Harriet Fear MBE, Cambridge& and Cambridge Ahead

> **We’re building a track record of attracting experienced leaders into the region, but there is still a gap that must be filled in order for the industry to achieve its full potential. There’s clear evidence that businesses in the region have the potential to become global category leaders, but we must focus on securing and developing talent to enable this.**
>
> Dr Michael Anstey, Cambridge Innovation Capital (CIC)

Future Life Sciences skills and occupational needs in the Arc to 2030.

Photo credit: Milner Therapeutics Institute

Identified skills challenges are expected to persist into the future, as skills supply continues to struggle to keep pace with the ongoing growth of the sector.

There is a clear consensus across stakeholders in the Arc that skills challenges that exist today will remain into the future. More specifically, technical, regulatory, quality control, data, digital, emerging technological innovations, and commercial skills challenges are all likely to persist. The reasoning behind this is that all skills will remain relevant, and the industry will continue to grow at pace – thus, supply of talent will continue to struggle to keep pace with strong skills demand growth across the Life Sciences ecosystem.

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Skills challenges will likely remain the same. There's a Brexit question: are we still able to attract leading European scientists? Perhaps the quality of scientific staff might need to increase, the sector will continue to demand more and more highly qualified, highly trained staff.

Professor Matthew Wood, University of Oxford

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The main challenges are likely to be in quality control and regulatory approval / management.

Dr Ala Alenazi, Ascension Life Fund

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There will likely be a greater focus in technology, digital and commercial business skills.

Derek Jones, Babraham Research Campus

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The beauty of our sector is that all skills remain relevant, providing many opportunities for future generations. However, we must continue to attract and develop the talent needed to support the growth of our industry.

Dr Michael Anstey, Cambridge Innovation Capital (CIC)

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Where are the future skills challenges? Across key research and development skills absolutely.

Professor Jan Domin, University of Bedfordshire

The Life Sciences sector must invest now to support future growth, reach and inspire students earlier and better integrate identified skills challenges into established education pathways e.g., degrees and PhDs.

Some stakeholders suggest that the Arc's Life Sciences sector has reached a point of no return. Given significant historic growth supported by regional, national, and international interest – there is opportunity for further advancement of the sector, but execution is critical.

There are calls for reaching out to students earlier in life (e.g., primary school level) to inspire their interest in Life Sciences, further integration of critical skills challenges (such as data and digital skills) into established life science pathways e.g., degrees and PhDs. However, these changes need to happen now to effectively support the sector's future growth.

> "
> **We're at an inflexion point today, if we don't get this right now there will be a significant reduction in future sector growth.**
>
> Dr Nick Johnson, Cell & Gene Therapy (CGT) Catapult

> "
> **We need to start talking to primary school children. GCSEs are too late to inspire young people into life sciences. This does also speak to geographical differences in access to good education, and polarisation of available opportunities across the Arc – i.e. links to industry. It is key for us to make use of all the skills potential across the region.**
>
> Dr Claire Pike, Anglia Ruskin University

> "
> **Given the current skills shortage, if we act now to build a stronger skills and talent base then we should be in a better position by 2030 to meet increased demand. It is likely, for example, that more degree courses and PhD's will include topics such as data science, machine learning and artificial intelligence which will help develop skills.**
>
> Dr Kathryn Chapman, Milner Therapeutics Institute

Scaling-up the sector will involve developing greater manufacturing, management, leadership, and commercialisation skills – with experience at the global level as the sector becomes increasingly internationally recognised.

There is a clear appreciation across many stakeholders in the Arc that one of the critical skills challenges for the future is skills specific to scaling up businesses. This relates to manufacturing, management and leadership skills and commercialisation skills. There is expected to be a growing need for global experience across many of these skills as the Arc scales and develops an increasingly strong international presence. Some stakeholders also suggest that there is a growing need to attract a greater volume of large businesses to the Arc – due to the strong impact they have in bringing skilled talent to the area.

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To achieve the desired future state by 2030, the main skills challenge over the next few years relates to the maturing of the sector and having successful scale-ups. Central to this is developing commercial leadership – business leaders who have the skills and experience to build, secure funding and exit attractive and successful firms.

Dr Ala Alenazi, Ascension Life Fund

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More people are going to come into the ecosystem, if there is more demand for skilled people, so getting more large businesses to come to the UK and set up shop here. A great example today is AstraZeneca. Fifty start-ups are not going to do even remotely as much as one big corporate player - so attracting larger companies to fuel the system and tap into the into the Arc is important.

Marcel Gehrung PhD, Cyted

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Developing scale-up skills and capability will be critical for the successful development of the Arc and its ambition in Life Sciences. But there is fundamental difference between managing and leading a firm of 10 FTE compared to a firm of 120 FTE. There is a management challenge, a cultural challenge and an investment challenge.

Derek Jones, Babraham Research Campus

Transformation from 2022 to 2030.

Photo credit: Milner Therapeutics Institute

Central and Local Government funding will remain critical to the future development of Life Sciences skills in the Arc. However, public money can only go so far.

There is a clear sense that public funding will be critical to the future growth of Life Sciences skills in the Arc. These funding streams play a vital role of minimising intrinsic risk perceived by other funding providers – making Life Sciences a more attractive investment opportunity for private equity and venture capital. A call for ring-fenced central government funding to support Life Sciences skills has been made by some stakeholders – referencing Innovate UK as an exemplar in this practice.

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The market will look after skills of the future through apprenticeships and blended learning. We are 5 years off knowing what future need will be, but it will emerge from the market – businesses that move here will need certain sets of skills.

Alistair Lomax, Arc Universities Group

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You'd have thought that the business schools have already got strong industry links but it's not as mature as you might think. It's an important ongoing discussion for us. For many top business students today, local innovation / biotech / manufacturing isn't a considered pathway.

Professor Matthew Wood, University of Oxford

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I'm totally convinced that the public sector should allocate funds from grant schemes and general financial injections into economic development. As the intrinsic capital in the private equity markets in the UK is usually lower than in some other jurisdictions as well it is even more important that the public sector does more to de-risk and give as many resources as possible to develop opportunities for skills development and job creation.

Marcel Gehrung PhD, Cyted

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Government, central and local, it has to be. Both in terms of organisation but also for funding – potentially supported by the educators in the region.

James Preston – TCS Biosciences

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This should be supported by more central (and local) government ring-fenced funding to support Life Sciences, especially to help transition from start-ups to scale-ups – Innovate UK does this very well.”

Dr Ala Alenazi, Ascension Life Fund

There is a call for a more coordinated approach to Life Sciences skills development across the Arc in ownership, intended action and, critically, funding.

Clear consensus exists that the responsibility for Life Sciences skills lies with a broad range of stakeholders e.g., central government, local government, research and innovation councils, educators, and industry players to name a few.

Whilst positive attention has been referenced across the LEPs and Combined Authority in the Arc in the support for skills development – there is also room for greater collaboration. There is a clear appreciation across many stakeholders that much of the work conducted is good work – yet there is room for develop a more coordinated approach to systematise skills development across the Arc. This trend is also observed in the more established hubs in Oxford and Cambridge from an industry perspective.

Developing a coherent and coordinated skills approach across the Arc is referenced by some stakeholders as being relatively simple and mutually beneficial to its participants – however, it has yet to take shape today. This will be a critical development for the Arc, not just in setting skills strategy across the Arc, but also the delivery of these initiatives in an organised and methodical manner.

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We need to build upon the foundation of the work done the LEPs and others who have been doing a good job. What is needed for the future is a shift in gear towards something that is more collaborative and systemic. We should all prepare for a very different future.

Alistair Lomax, Arc Universities Group

"

We currently exist more in pockets than as a connected ecosystem and this is not being perused in a coherent way – but this isn't difficult and its mutually beneficial.

Professor Matthew Wood, University of Oxford

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Skills funding should be a mix of central government funding, private investment in start-ups and scales-ups, and established corporates investing in skill and talent development.

Dr Ala Alenazi, Ascension Life Fund

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Funding for skills is likely to be from multiple sources: public through central and local government; higher education; and private sector from investors in start-ups and scale-ups through to the larger corporate organisations. There is growing recognition that the skills shortage and future agenda needs to be addressed on a collective and co-ordinated basis; however, this is still forming and there is no current overarching strategy and plan to deliver this approach.

Dr Kathryn Chapman, Milner Therapeutics Institute

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An umbrella initiative across the Arc is a real opportunity. We need to be sensible about the strategic approach. We can do better in this, as progress appears to have stalled – perhaps due to the impact of Covid?

Professor Jan Domin, University of Bedfordshire

Sector competition over skills has led to salary inflation, which is not in the interest of any sector within the Arc. There is a call to action for greater collaboration for skills development across competing sectors.

Competition over skills between Life Sciences and other sectors with similar skills requirements is not a novel concern. A particularly prominent focal point today is the convergence between Life Sciences and technology – which is inflating salaries and make it much more difficult to bring these skills into the sector.

However, whilst this is an observed trend in Life Sciences ecosystems across the world there is an opportunity for greater collaboration in skills development between competing sectors and improvements to ease of transfer from one sector to another where possible.

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Competition between sectors largely depend on the sectors that emerge in the Arc over time. There's certainly lots of transferable skills in the Arc – so competition is likely.

Professor Alistair Fitt, Arc Universities Group

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Digital, data scientists, AI may be competitive with other sectors.

Professor Kevin Shakesheff, The Open University

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There is high and increasing competition for digital and tech skills in the Life Sciences sectors, which is likely to continue. Many tech and digital roles come with a range of qualifications, and often not to degree level.

Dr Ala Alenazi, Ascension Life Fund

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The growing convergence between life sciences and technology offers great potential, as we continue to tackle skill shortages within both sectors. Greater collaboration means there will be less competition for talent where skills may overlap and consequently a faster rate of growth in both industries.

Dr Michael Anstey, Cambridge Innovation Capital (CIC)

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We will see more tech and IT collaboration across sectors, given the demand for and transferability of these roles, and we may also see increased outsourcing of tech and IT skills as the sector develops and grows.

Dr Ala Alenazi, Ascension Life Fund

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There is going to be increasing competition for the tech / computational / digital / data type roles as the life sciences sector and other tech-based sectors develop and overlap. However, there is also an opportunity for increasing collaboration and cross-over in these types of roles across sectors.

Derek Jones, Babraham Research Campus

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There will definitely be increasing demand and competition for skills and talent across sectors where tech and data skills are required. However, we may also see more collaboration in these areas too where skills can be transferred across industry sectors, where they are not unique to a specific industry – such as AI, Machine learning, data science, etc.

Dr Kathryn Chapman, Milner Therapeutics Institute

Attracting and retaining talent is considered a material concern for the future of the Arc. Stakeholders suggest skills is a people issue and living costs and transport are the most material challenges to day – which are expected to persist.

Talent retention is a critical part of many of the Arc's constituent skills strategies and an identified challenge observed when talking to stakeholders across the Arc. There is a clear appreciation that just because someone trains in Oxford or Cambridge, there is no guarantee that they will settle there for good.

Stakeholders are also cognisant that expensive housing and poor transport infrastructure is exacerbating these issues – especially in Oxford and Cambridge and in more junior positions. In addition, these factors make it much more difficult to attract talent into the Arc e.g., from the North or from overseas. There is clear concern that the issues around whether someone would want to live in the Arc is one of the biggest challenges to skills for the future.

"

Just because people study at Oxford or Cambridge university doesn't mean they'll stay / settle there. How can we retain more of this talent in the Arc?

Gareth Williams, TCS Biosciences

"

A big issue will be retention. If you train in Oxford, why would you stay there? It's expensive to live there and transport is poor. Sustainable transport might well be key.

Professor Alistair Fitt, Oxford Brookes University

"

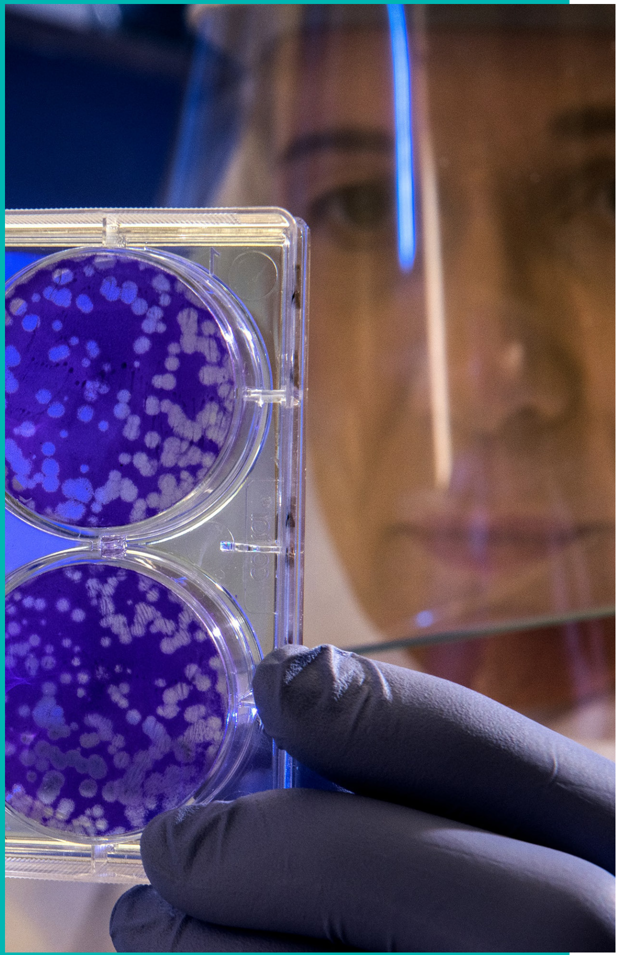
You'll struggle to attract people from the north to places like Cambridge – as standard of living drops significantly.

Dr Nick Johnson, Cell & Gene Therapy (CGT) Catapult

"

It's worth noting that Oxford and Cambridge are very expensive to live in. Transport and housing are required to remedy this and retain skills. It doesn't matter if we build the skills here if we don't invest in this issue – talent be pushed out because of it.

Professor Roderick Watkins, Anglia Ruskin University



Funding considerations.

Funding Considerations.

To effectively compete for public funding the Arc must work together to articulate how further funding will achieve transformational growth for the region – to the benefit of UK Life Sciences as a whole.

Three key challenges have been identified towards Skills 2030: supporting the private sector to train effectively, proactively creating the future workforce, and effectively leveraging the Arcs regional assets.

The Oxford-Cambridge Arc would benefit from a collaborative regional body. Inspiration can be drawn from industry catapults and from the Massachusetts Life Science Center (MLSC) in the USA

The Oxford-Cambridge Arc is targeting transformational growth that will position it on par with world-class Life Sciences ecosystems such as San Francisco and Boston Massachusetts. This report's (medium) growth scenario provided a possible 2030 future with 4.48x employment compared with 2020. To achieve this vision and deliver the skills necessary for 2030 the Arc will require effective ecosystem leadership and coordination.

To support delivery of the UK Research and Innovation (UKRI) 5-year strategy (2022-27), a multi-year budget split across UKRI councils and new cross-UKRI strategic programmes has been confirmed.[42] This represents an overall 14% increase from £7.79bn in 2021-22 to £8.87bn in 2024-25.

Opportunities for additional public funding into skills development are emerging, with the UKRI introducing a new collective talent scheme worth £2bn up to 2024-25. The new collective talent scheme involves a transition towards working across research council remits to deliver talent initiatives, including studentships and fellowships.

However, levelling up has increased the level of competition for public funds, with areas outside of the South-East receiving priority to address regional imbalances. To compete for public funding the Arc must work together to articulate how further funding will achieve transformational growth for the region – to the benefit of UK Life Sciences as a whole. This might well be realised by matching private sector investment to additional public funding commitments.

There is a significant opportunity for the Ox-Cam Arc to influence and champion the Life Sciences workforce skills and training development funding as a 'super cluster' – setting out how funding it receives will contribute to overall value creation (such as GVA), strengthen its position as a magnet for talent, and attracting potential co-funded private sector investment that could be leveraged by the Arc.

A formal cluster development organisation may be helpful for coordinating and driving the effort within the Arc – acting as the bridge to the UK national strategies within the context of delivering the Life Sciences Vision.

UKRI Strategy – Core R&D Budgets and Collective Talent Funding

Moving towards 2030, private sector funding represents a significant opportunity towards a step-change in financing. Venture capital and IPO funding has increased considerably in recent years as novel research areas approach commercial applications.

The UK Life Sciences and biotech sector is estimated to have secured circa £4.5bn in both public and private sector investment in 2021 – a substantial increase from prior years and a circa £1.7bn increase on 2020. Venture capital funding was estimated at circa £2.5bn, IPOs at circa £1.3bn and public financing at circa £0.7bn.[43]

In 2021, seven of the top 10 biotech companies that secured funding rounds above £100m were in the Arc (i.e., Oxford Nanopore, Exscientia, Vaccitech, Artios Pharma, Apollo Therapeutics, bit.bio, and Cambridge Epigentix). The remaining three firms (Quell Therapeutics, Gyroscope Therapeutics and Pulmocide) were in London. This highlights the dominance of the "London, Oxford and Cambridge Triangle" in receiving private funding either through venture capital or IPOs.[44]

Council	2021/22	2022/23	2023/24	2024/25
Arts and Humanities Research Council	61	71	65	70
Biotechnology and Biological Sciences Research Council	306	300	318	326
Engineering and Physical Sciences Research Council	617	621	647	661
Economic and Social Research Council	114	121	119	122
Medical Research Council	563	548	587	615
Natural Environment Research Council	289	288	311	325
Science and Technology Facilities Council	485	531	544	575
Research England	1,772	1,730	2,163	2,333
Innovate UK	631	669	799	970
Core R&I Budgets Total	**4,839**	**4,881**	**5,553**	**5,999**
Existing time-limites commitments (including COVID interventions)	355	140	135	151
Collective Talent Funding	571	599	670	726
Total	**5,765**	**5,619**	**6,358**	**6,876**

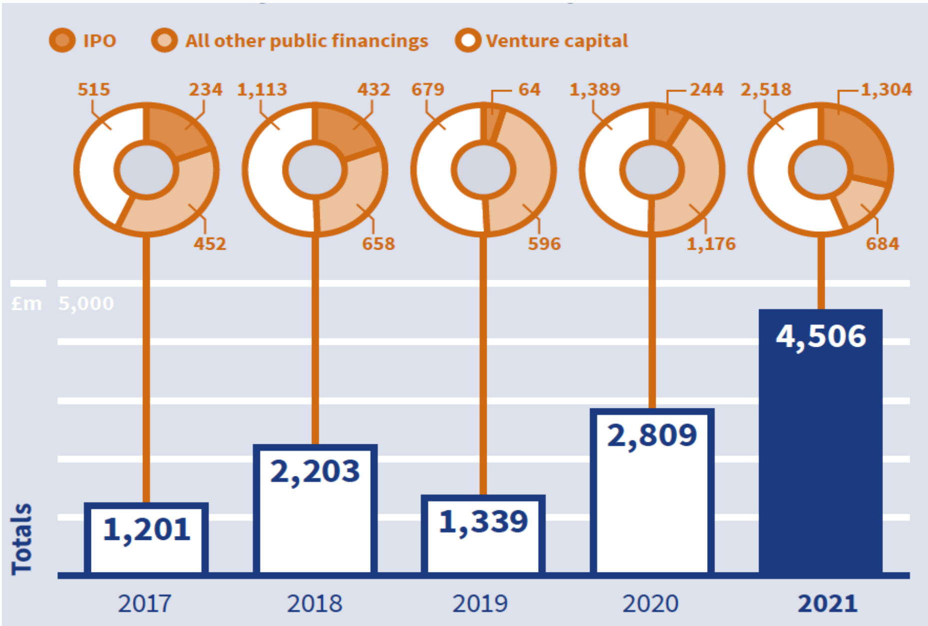
The Arc and London also have a high proportion of Life Sciences educational and research institutes. The Association of the British Pharmaceutical Industry (ABPI) Life Sciences industry and academia links survey (2019)[42] highlights a diversity of opportunities across different career stages, including undergraduate industrial placements, graduate placements & recruitment, PhD studentships, postdoctoral researchers working across academia and industry, and apprenticeships in the pharmaceutical industry.

Many established links between academia and industry, however, are tailored towards large companies. Although the Arc's universities, predominantly Oxford and Cambridge, are leaders in industry engagement with the Life Sciences industry (nationally) through these channels, there may be room for further engagement with other universities within the arc, and with SMEs.

However, because SMEs do not have the resources to engage and coordinate with the Arc's numerous universities and research facilities, a coordinating body that can act as a single point of contact would be an effective facilitator. This would help to leverage private funding and equip emerging talent with skills in growing areas of Life Sciences.

Crucially, for the Arc to capitalise on private funding growth it must support the private sector, particularly SMEs, to translate business growth into effective skills development.

Finance raised by UK-based biotech companies[41]



Three key challenges have been identified towards Skills 2030 relating primarily to co-ordination failures not unusual to market ecosystems. These include:

Supporting the private sector to train effectively.

SMEs must have access to shared workspaces which will otherwise act as a barrier to entry and jobs growth. The Savills report (2022)[45] on Cambridge Life Sciences capital raising flagged laboratory supply as a limiting factor for companies looking to scale.

Equally, SMEs must be supported with centrally coordinated human resource functions to match growing start-ups with apprenticeship talent. The ABPI report on Life Science apprenticeships highlighted SME difficulties in onboarding trainees without established finance and HR functions.

Large corporates must be supported in developing apprenticeship standards that work for them, and then educated on maximising their use of the apprenticeship levy. ABPI (2021)[46] raises the concerning statistic that Life Sciences companies are only claiming 24% of their levy contributions which represents gross inefficiency and lost training hours

Proactively creating the future workforce.

Creating the future workforce before skills gaps limit growth, and in advance of major private investment decision making, is a core theme behind catapult and emerging skills initiatives.

If the Arc does not establish and work proactively towards a strategic future, it risks being left behind as future industry gravitates towards ecosystems with ready-skilled talent pools and effective shared infrastructure.

Catapult high value manufacturing's 'Manufacturing the future workforce' and 'Aerospace Industrial Digitisation' reports are effective examples of strategic workforce planning.[47],[48]

Effectively leveraging the Arc's regional assets.

Without an organising body, the Arc's overall growth risks being hampered by market inefficiencies. An ecosystem approach to space, talent, funding applications, scale-up support and big corporate incentivisation must be engineered if the Arc is to maximise its potential.

Ecosystem engineering and strategic direction is even more important in the current context of Brexit, levelling up and industry change. The UK's exit from the European Union is creating opportunities for increased collaboration with the USA, levelling up means that government focus will no longer prioritise the golden triangle, and new Life Sciences industries in therapeutics and data science must be supported and scaled within the Arc. Each of these create opportunities for path-changing action that can trigger transformational growth.

The Oxford-Cambridge Arc would benefit greatly from a collaborative regional body directing skills initiatives and connecting national funding bodies, academia and industry. Inspiration can be drawn from industry catapults which are effectively co-ordinating strategic industries at a national level, and from the Massachusetts Life Sciences Center (MLSC) in the USA which constitutes the gold standard for Life Sciences ecosystem coordination at a regional level. Case studies on both the Cell and Gene Therapy Catapult and MLSC have been included on the following pages.

Case studies.

Photo credit: Milner Therapeutics Institute

Cell and Gene Therapy Catapult.

Industry catapults are turning market failures into strengths and coordinating industry development on a national scale. They represent an accessible model for the arc to emulate at a regional level.

The Arc must work with national catapults to learn best practice and address existing ecosystem challenges that require localised action.

Industry Catapults were conceived in order to resolve specific market failures:

The valley of death:

Catapults help to bridge the funding gap between research developments and the first rounds of venture capital, which require a demonstrable business case. Without funding in this 'valley of death' many promising start-ups can go bust before their product reaches the market.

Collaborative infrastructure:

In industries which require expensive infrastructure many start-ups may not come to fruition from high entry costs. By investing in collaborative infrastructure catapults remove barriers to entry and create thriving start-up ecosystems.

Ecosystem skills provision:

SMEs lack the human resource infrastructure to train and integrate new talent. Without an effective ecosystem partner helping to train local talent many SMEs will struggle to recruit the necessary skills needed for growth.

Investment inefficiencies:

In novel industries involving long-term risk, many firms are unwilling to invest large sums. Industry catapults can remove some risk by committing public funds, encouraging the private sector to make investments with their risk reduced.

Coordination failure:

In cluster formation, and in strategic action at the sector level, Catapults can support industry by providing signals and investing in market research that helps to plan industry action. Catapults also act as network curators by connecting SMEs, big corporates, government and talent for effective industry cooperation.

Stevenage Manufacturing Innovation Centre:

The CGT Catapult exists to develop and scale a world leading therapeutics industry in the UK. The Stevenage manufacturing centre solves many of the market failures described: providing advanced collaborative research space for SMEs to establish the commercial viability of their products, a dynamic environment for skills training, a market signal for effective cluster creation and the public financing capable of incentivising matched-corporate investments.

Advanced Therapies Apprenticeship Community:

The CGT catapult is also attempting to solve many of the issues surrounding UK apprenticeships. It is doing so by establishing effective apprenticeship standards that are tailored to industry, creating onboarding infrastructure to engage prospective talent, and engaging a corporate network where talent can be placed and nurtured in a commercial setting. An apprenticeship ecosystem that is fully integrated within the Arc would provide SMEs and Corporates with the skilled talent they need for effective growth and future training.

Sources: [49], [50], [51], [52], [53]

Massachusetts Life Scienes Centre (MLSC).

The Massachusetts Life Sciences Center (MLSC) is an effective example of regional ecosystem leadership. If the Arc is to become a world-class Life Sciences ecosystem in its own right, it will require similar leadership and direction.

The CGT catapult operates in much the same way, except at a national level. One could argue that if the Arc is to become a world-class cluster comparable to Massachusetts, it will require effective coordination at a regional level.

In Massachusetts, the MLSC addresses the same market failures targeted by the Cell and Gene Therapy Catapult in the UK.

The two organisations differ, however, in their scale. Whilst the Massachusetts Life Sciences Center serves a state with a population of 6.98m, the CGT catapult serves the whole of the UK. The Arc, with its population of c3.7m is more comparable to the size market served by the MLSC.

With considerable state-funding, and a smaller regional ecosystem to coordinate, the MLSC has integrated its skills initiatives alongside other investment activities creating highly joined up ecosystem policies. It also commissions state-wide strategic reports which help to coordinate public funds more effectively.

MLSC funded facilities provide the infrastructure for non-traditional Life Sciences universities to train future graduates. The same infrastructure creates anchor points for new regional sub-clusters outside of the Boston-Cambridge core, and a cooperative space where SMEs can incubate their research.

SMEs in MLSC funded laboratories are hot beds for MLSC apprenticeship programmes which are coordinated from the centre, thereby relieving start-ups of the HR administrative costs that restrict apprenticeship uptake in the United Kingdom.

The MLSC also has powers to provide tax incentives for employment growth and training provision, and to attract firm relocations from other states.

State-wide devolution of this kind is not possible in the UK as it is in the USA. However, the Oxford-Cambridge Arc could benefit from an organisation co-ordinating regional asset, targeting regional strategic priorities, and effectively managing Arc wide relationships with SMEs, big corporates, the CGT Catapult and government.

Such an organisation could solve the coordination failures that exist at a regional skills level such as:

- **Clarifying Life Sciences apprenticeship routes** specifically into Arc businesses and supporting local SMEs with the administrative costs of training.
- **Effectively coordinating Life Sciences infrastructure** across the Arc to encourage the entry of new firms and to facilitate the formation of new regional sub-clusters which will support the talent development pipeline in novel areas.
- **Supporting universities** within the arc to access public funding and attract talent from overseas.
- **Facilitating university-industry interactions** for all of the Arc universities group.
- **Effectively leveraging public funding** to deliver regional skills policy and crowd in private investment.

Appendices.

Appendix 1: Methodology.

Arc Life Sciences Dataset

The Life Sciences business datasets for each individual year are available at: https://www.gov.uk/government/collections/bioscience-and-health-technology-database-annual-reports

These datasets were compiled into a timeseries for the four LEP-level authorities within the Arc, aggregated to give an Arc figure for each year from 2015 to 2020.

Individual business employment in the dataset is provided at employment bands:

- E1: 0-4
- E2: 5-9
- E3: 10-19
- E4: 20-49
- E5: 50-99
- E6: 100-249
- E7: 250+

To estimate employment figures, each business' employment bracket has been allocated an employment value, equal to the median of their employment bracket. For example:

- E1: 2
- E2: 7
- E3: 14.5
- E4: 34.5
- Etc.

For the 250+ category this report used the Dun & Bradsheet Database (in keeping with the OLS methodology) to identify an employment figure for every 250+ company with an address within the Arc. For those with multiple locations across the UK, where location employment distribution was unclear, employment was spread equally across locations. For companies where employment was ambiguous, this report assigns the average 250+ employment figure (672). This average figure was also allocated to all 250+ businesses 2015-2019, and in 2020 as well, in order to maintain consistency.

Thus:

- E7: 672

Business employment was then aggregated by year, segment and sector.

Life Sciences GVA is calculated as:

- (Life Science Employment/Total LEP Employment) x (Total LEP GVA)

Growth Scenario Modelling

Our growth scenarios are based on the standard CAGR formula:

CAGR= ((Vfinal/Vinitial)^1/t) -1

Growth is capped at 43%, which is the growth rate achieved by Advanced Therapeutics 2017-2020. This segment was chosen as a growth cap because of the well-documented high growth rate and potential in this segment.

2021 Cell and Gene Therapy Skills Demand Survey Report https://ct.catapult.org.uk/sites/default/files/publication/2021%20Skills%20Demand%20Survey%20Report%20-FINAL_TO%20PUBLISH.pdf

Only segments that accounted for 1%< of Arc employment in 2020 were included in growth forecasts. This was done to prevent segments with tiny employment counts from growing disproportionately to 2030.

The scenarios were constructed using CAGRs derived from the following periods,

High: 2017-2020 CAGR

Medium: 2015-2020

Low: 2019-2020

All scenarios are constructed from segment forecasts to 2030, aggregated at a sector and industry level for analysis.

Occupational Group Employment Mix

Occupational group employment mix for core Life Sciences SIC codes have been sourced from and are consistent with the UK national analysis cited in the SIP Life Sciences Skills Report 2030. In SIPs analysis, six SIC codes accounted for circa 90% of core Life Sciences businesses in the UK.

- Available at: https://www.scienceindustrypartnership.com/skills-issues/sip-2030-skills-strategy/

SIC codes used:

- 21100: Manufacture of basic pharmaceutical products
- 21200: Manufacture of pharmaceutical preparations
- 26600: Manufacture of irradiation, electromedical and electrotherapeutic equipment
- 32500: Manufacture of medical and dental instruments and supplies
- 72110: Research and experimental development on biotechnology
- 72190: Other research and experimental development on natural sciences and engineering

However, the Life Sciences ecosystem in the Arc is home to a range of supporting segments such as Analytical Services, Regulatory Expertise, Investment Companies and various Consultants and Advisors. For these supporting segments, occupation group employment mix has been assumed to be consistent with similar organisations in other sectors and geographies in the UK. Thus, a SIC code to SOC code mapping has been extracted from NOMIS data, from the 2011 census dataset.

- Available at: https://www.nomisweb.co.uk/sources/census_2011

SIC Codes examined and mapped to the Arc's Life Sciences ecosystem include:

- 69.1: Legal activities
- 62: Computer programming, consultancy and related activities
- 49.3 & 49.4: 49.3 Other passenger land transport; 49.4 Freight transport by road and removal services
- 64: Financial service activities, except insurance and pension funding
- 74909: Other professional, scientific and technical activities n.e.c.

The SIC Code / Occupational Group mix used in this analysis is included below:

SIC Code	Description	R&D	Manufacturing	Quality & Regulation	Digital	Logistics	Sales & Marketing	Finance	Administration	Facilities	Human Resources	Management
21100	Manufacture of basic pharmaceutical products	28.50%	34.97%	12.69%	0.00%	0.00%	13.78%	3.32%	2.95%	0.00%	0.00%	3.79%
21200	Manufacture of pharmaceutical preparations	30.21%	21.82%	5.03%	2.07%	3.28%	21.67%	1.24%	2.00%	2.13%	2.21%	8.33%
26600	Manufacture of irradiation, electromedical and electrotherapeutic equipment	0.00%	78.78%	0.00%	0.00%	0.00%	21.22%	0.00%	0.00%	0.00%	0.00%	0.00%
32500	Manufacture of medical and dental instruments and supplies	9.37%	50.37%	4.20%	0.00%	1.54%	24.63%	0.00%	7.04%	1.70%	0.00%	1.15%
72110	Research and experimental development on biotechnology	92.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.85%
72190	Other research and experimental development on natural sciences and engineering	54.06%	4.78%	1.31%	8.91%	0.00%	4.57%	6.91%	6.08%	0.00%	2.70%	10.67%
69.1	Legal activities	2.41%	2.32%	4.54%	7.15%	0.48%	17.35%	5.09%	45.21%	4.01%	2.48%	8.95%
62	Computer programming, consultancy and related activities	2.71%	3.35%	0.66%	58.55%	0.43%	17.44%	3.20%	7.01%	0.47%	0.89%	5.30%
49.3 & 49.4	49.3 Other passenger land transport; 49.4 Freight transport by road and removal services	1.10%	21.91%	0.35%	1.51%	37.74%	13.58%	2.17%	13.43%	3.32%	0.55%	4.34%
64	Financial service activities, except insurance and pension funding	1.11%	3.18%	1.56%	14.77%	0.49%	22.80%	19.19%	19.20%	1.60%	2.07%	14.04%
74909	Other professional, scientific and technical activities n.e.c.	17.35%	6.36%	1.54%	4.21%	0.82%	17.62%	5.85%	17.33%	0.83%	0.75%	27.32%

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