

# MATRIX

NORTHERN  
IRELAND  
SCIENCE  
INDUSTRY  
PANEL

February 2015

## LIFE & HEALTH SCIENCES NORTHERN IRELAND

Capability Assessment & Foresight Report





# FOREWORD

The life and health sciences sector in Northern Ireland has burgeoning potential. It contains the largest single employer in the region in the form of the HSC; it includes some of the UK's most successful indigenous companies including Almac, Randox and Norbrook, in addition to being the focus of world-class research at our two academic institutions. The sector is complex, heterogeneous, heavily regulated and requires a spectrum of support to service its manifold needs. If Northern Ireland is to provide world-leading standards of healthcare to its citizens whilst creating strong, sustainable economic outputs the sector must be understood and delineated accurately and in detail. This report seeks to lay the foundations of this understanding so that a clear and concerted strategy may be developed to serve the needs of patients dovetailed to Northern Ireland's future economic growth.

In the spring of 2014 a panel was drawn from across Northern Ireland's life and health science sector. Led by industry but including representatives from government, academia, and the HSC, the panel sought to not only reach a consensus on the region's strengths and capabilities but also to identify areas where barriers could be broken down to pave the way for further success in areas of future need. The panel also sought to understand how other regions with committed life and health science strategies have achieved success so that we might best take advantage of the unique circumstances in Northern Ireland.

It is this uniqueness that has revealed itself as the panel has gone about its task. Northern Ireland has a commercial sector that provides a fertile base for further entrepreneurial activity, a world-class academic sector with particular strengths that can provide areas of focus and an integrated HSC system that facilitates a test-bed for innovation and a generator of information that charts patient treatment and care.

Specifically, Northern Ireland has the opportunity to build on its present capability to continue to excel in the areas of precision medicine, that is the understanding of disease and tailoring its management to maximise treatment efficacy, diagnostics and medical devices, analysis of large data-sets, and the provision of tools and technologies to achieve a connected-health environment. The future offers the paradox of challenge and opportunity in the form of an increasing ageing population with its attendant healthcare demands and an increasing onus on personal-healthcare management thus providing the demand for new and innovative solutions.

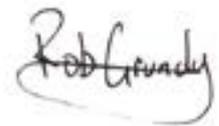
By building on our current strengths and accepting the challenges of future needs, the life and health sciences sector in Northern Ireland has the opportunity to improve the health of its citizens whilst providing strong economic growth for the future. The report's recommendations provide a foundation that can be built upon to achieve these goals via a new, dynamic strategy.

Grateful thanks go to all members of the MATRIX Life and Health Sciences Panel whose patience, persistence and determination have been instrumental to the production of this report. Thanks also go to OCO Global and PA Consulting who facilitated the panel process and report production.

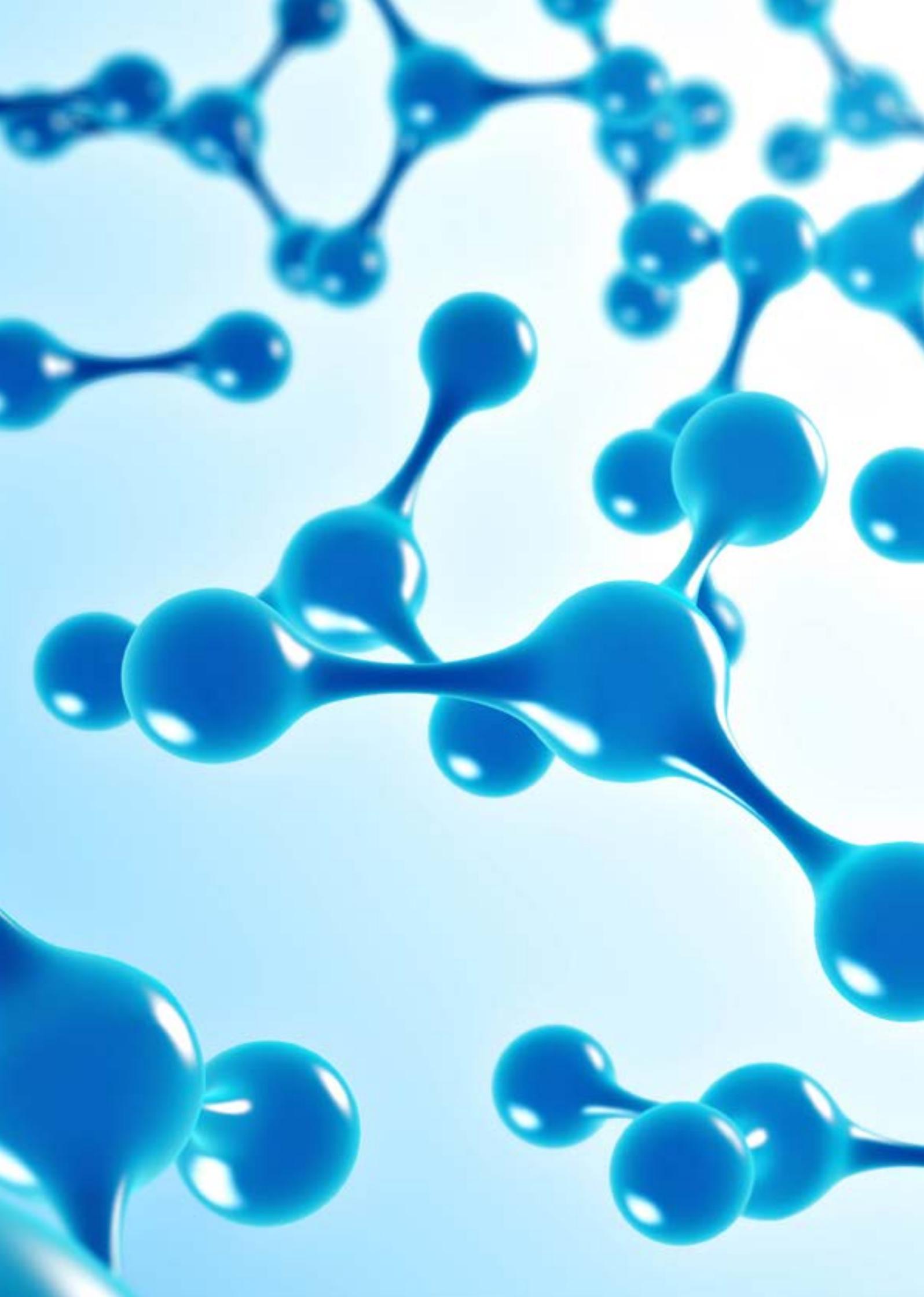
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# EXECUTIVE SUMMARY

Today, the global life and health sciences (LHS) sector is in the midst of significant and rapid change, which presents both opportunities and challenges for Northern Ireland. Driving this change are supply and demand side pressures, lifestyle choices, longevity and a rise in chronic conditions such as diabetes, obesity and dementia.

The upward trend in spending means healthcare is becoming a more significant part of national GDP and along with this the long-term sustainability of current models of provision is being increasingly questioned.

Across the sectors healthcare is going to have to become more about prevention, self-management of conditions and earlier diagnosis and treatment of conditions in order to reduce this cost burden. There will need to be fundamental changes in the way that the LHS sector is developed in order to address the challenges and opportunities this presents for Northern Ireland.

One significant way of enabling and assessing this change will be the development of health economics and predictive analysis.

## **Building upon pre-existing strategic work to support a fundamental shift in healthcare**

The shift towards self-managed local care and more cost effective, targeted healthcare approaches will build upon a pre-existing body of strategic work. The 2008 Matrix Life & Health Sciences Foresight Report suggested home based care and personalised medicine were key areas of focus going forward. Transforming Your Care also supported this shift towards a more home based or local care based approach. Key enablers like connected health, targeted R&D initiatives and key required infrastructural elements like the HILS Hub (which is to act as a central hub for sustainable and effective interaction between the various spokes (research and innovation centres) in the HSC, the private sector, academia and the various economic development agencies) have been the subject of the Memorandum of Understanding (MoU) between the DHSSPS and DETI.

The focus of the previous body of strategic work has been on developing upon key areas of sectoral capability in Northern Ireland. This work similarly identified areas of capability across academia, public sector and the private sector.

Building upon the previous strategic work this work outlined the healthcare market opportunities for Northern Ireland going forward and the range of enabling technologies and processes required to be developed in order to meet demand across global market sub-sectors in the future.

## **Areas of capability across academia, public sector and private sector**

The approach to delivering this capability assessment allowed for significant iteration across key components of work, e.g. between capability and foresight. This was entirely natural and enabled the development of a strong consensus and executable outcomes from the overall process.

Initially a prioritisation framework was developed in conjunction with stakeholders to provide a picture of different areas capability and future growth for Northern Ireland. This framework (illustrated in Figure 1) included a list of sub-sectors and therapeutic areas and enablers along the vertical axis and the horizontal access were a number of supply, demand and competitive context factors.

In spite of the broad nature of the framework it was used in conjunction with deliberations by the panel to identify a number key focus areas going into the future including oncology and cardiology. There was then a foresight exercise which identified a number of key health sub-sectoral markets as key areas of future global demand. The Market Opportunity Foresight was produced through 8 meetings of the panel that took place between the 4th April 2014 and 15th October 2014.

These areas of global demand were mapped alongside areas of strength identified using the framework and the deliberations of the panels (discussed in more detail below) to identify five areas of overlap as between the capability and foresight exercises.

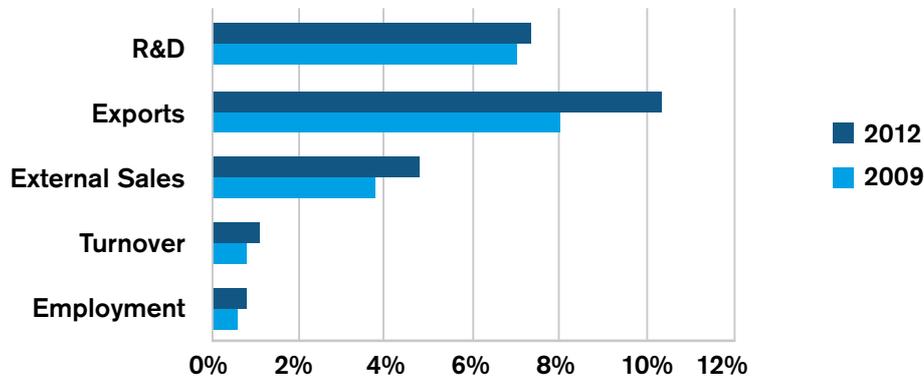
These areas were:

- oncology
- respiratory
- cardiology
- vision
- diabetes

**FIGURE 1 – PRIORITISATION OF FOCUS AREAS FOR FUTURE GROWTH**

SUB SECTORS/ THERAPEUTIC AREAS	DEMAND			SUPPLY			COMPETITIVE CONTEXT		
	EVIDENCE OF GLOBAL FDI	SIZE OF SECTOR GLOBALLY	MEGA TREND/ GLOBAL GROWTH POTENTIAL	NI RESEARCH CAPABILITY	NI SECTOR SIZE	SKILLS & LABOUR POOL	SOCIETAL PRIORITY	UK/NI RANKING	SCALE OF RESEARCH FUNDING AVAILABILITY
<b>THERAPEUTIC AREA</b>									
ONCOLOGY	HIGH	HIGH	PERSONALISATION	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
CARDIO	HIGH	HIGH	DIAGNOSIS AND THERAPY/CONNECTED HOME	HIGH	HIGH	HIGH	HIGH	MEDIUM	HIGH
VISION	MEDIUM	MEDIUM	DIAGNOSIS AND THERAPY/AGEING POPULATION	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
RESPIRATORY	MEDIUM	HIGH	DIAGNOSIS AND THERAPY/CONNECTED HOME	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
NEUROLOGY	LOW	LOW	DIAGNOSIS AND THERAPY/AGEING POPULATION	MEDIUM	HIGH	MEDIUM	HIGH	HIGH	HIGH
DIABETES	MEDIUM	HIGH	DIAGNOSIS AND THERAPY/CONNECTED HOME	MEDIUM	HIGH	MEDIUM	HIGH	LOW	MEDIUM
DIAGNOSTICS	HIGH	HIGH	MOBILE/CHRONIC DISEASE	MEDIUM	HIGH	HIGH	HIGH	HIGH	HIGH
DERMATOLOGY/COSMETICS	LOW	MEDIUM	WELLNESS	LOW	LOW	MEDIUM	LOW	LOW	MEDIUM
MENTAL HEALTH	HIGH	HIGH	DEPRESSION/TRAUMA	MEDIUM	MEDIUM	HIGH	HIGH	HIGH	MEDIUM
ANIMAL HEALTH	LOW	MEDIUM	FOOD SECURITY	HIGH	MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM
<b>ENABLER</b>									
CLINICAL TRIALS	HIGH	HIGH	BIG DATA/REAL WORLD HEALTH ECONOMIC STUDIES	MEDIUM	MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM
HEALTH ANALYTICS	HIGH	HIGH	BIG DATA/REAL WORLD HEALTH ECONOMIC STUDIES	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH
CONNECTED HEALTH	HIGH	MEDIUM	SENSORISATION/CONNECTED HOME	MEDIUM	HIGH	MEDIUM	HIGH	HIGH	HIGH

**FIGURE 2 – LIFE & HEALTH SCIENCES GROWING CONTRIBUTION TO NORTHERN IRELAND ECONOMY**





## LHS PERFORMANCE ACROSS ACADEMIA AND THE PUBLIC AND PRIVATE SECTORS

The contribution of life and health sciences to the Northern Ireland economy has increased over the past five years as set out in Figure 2.

### Academia:

- 2014 Research Excellence Framework - QUB and UU achieved impressive life sciences results.
- Over 1,000 people in centres of excellence attracting over £50m in funding.

### Public Sector

- Every £1 of HSC R&D funding leverages an additional £4.14.
- One in five funded studies impacting positively on increased length or quality of life.
- Unique integrated health and social care is a positive that has yet to realise a benefit for the sector as a whole.

### Private Sector

- Approximately 130 mostly indigenous companies employing around 7,500 people – averaging 10% growth per annum in last 3 years.
- Highly export focussed sector – around 10% of Northern Ireland exports, growing by average 12% per annum.
- Internationally recognized R&D capability in sensors, diagnostics, oncology, diabetes and vision science, respiratory medicine and clinical research aligned with its highly rated REF universities, QUB and UU.
- Largely indigenous business base with 3 global leaders in diagnostics, generics, veterinary pharmaceuticals and drug discovery who have developed their own unique supply chains.
- Close to £1bn value to local economy and is 90% export orientated.
- Accounts for approximately 12.5% of all Northern Ireland R&D expenditure.
- Northern Ireland has already created the ideal climate for the life sciences sector with unique integrated health and social care infrastructure.

## LEVERAGING NORTHERN IRELAND'S SECTORAL CAPABILITIES<sup>1</sup>

This work further identifies key areas of strength across sectors in academia, the public sector and in the private sector. The report additionally examines:

- the innovation capability within these areas
- further specialisations within these areas of sectoral capability

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<sup>1</sup>The area of animal health and agri-food could not be addressed in enough detail as part of this capability assessment and foresight exercise. This particular scope could be addressed in a separate exercise. AFBI's emerging capabilities constitute an opportunity. There is also a significant opportunity around the AgriFood Quest Conference Centre to which AFBI and Norbrook have contributed.

# INNOVATION CAPABILITY OF NORTHERN IRELAND LIFE & HEALTH SCIENCES

The table below identifies areas of sectoral capability and further specialisations within these areas.

## KEY NORTHERN IRELAND SECTORAL STRENGTHS/CAPABILITIES OF LIFE & HEALTH SCIENCES DEVELOPMENT

<b>Drugs, devices and diagnostic development</b>	Northern Ireland's particular strengths lie in oncology and cardiology. Northern Ireland has a strong reputation in oncology and two of the UK's largest diagnostics companies. Northern Ireland has also developed new diagnostics for accurate diagnosis (multiplex testing), prevention and risk assessment.
<b>Clinical trials</b>	<p>Northern Ireland's strengths lie mainly within oncology, vision science, cardiology, ophthalmology and respiratory conditions. The Northern Ireland Cancer Trials Centre (NICTC) is a key infrastructural strength in this area.</p> <p>The Northern Ireland Cancer Trials Network (NICTN) and the Northern Ireland Clinical Research Network (NICRN) are also important infrastructural strengths in this area.</p> <p>Northern Ireland has also developed strong relationships with key bodies such as the Wellcome Trust-Woolfson Foundation Clinical Research Facility and CROs such as Celerion, Biokinetic Europe, Venn Life Sciences and O4 Research.</p>
<b>Connected health</b>	Northern Ireland's strength in connected health is in the management of long term and chronic conditions. One of the responses highlighted that the largest volume of jobs was driven by 'hands-on' care. The TF3 telemonitoring service, for the remote monitoring of chronic conditions and the elderly, was also specifically mentioned and long standing strengths at both Universities were recognised. The area has seen encouraging spin-outs from NIBEC, smart homes within SERG and the development of successful ECO systems and Industry led alliances.
<b>Health analytics</b>	Again, Northern Ireland is particularly strong in the field of oncology. More generally there is key infrastructural capability through bodies like the Administrative Data Research Centre, the HSC Safe Haven, iHAC and companies such as Exploristics and Kainos.
<b>Precision medicine</b>	<p>Once again, oncology is our key strength in precision medicine. There are particular strengths around the development of diagnostics to determine the response of colorectal cancer patients to anti-EGFR therapy and in the treatment of breast cancer.</p> <p>There are important infrastructural elements in the Northern Ireland Biobank and the Centre for Stratified Medicine.</p> <p>Biomarker discovery and development are pillars of research at QUB across many disease areas (mainly oncology and respiratory disease) and the basis for the two main companies in this field - Almac Diagnostics and Randox Laboratories Ltd.</p> <p>The Northern Ireland Biobank is able to access NHS tissue archives and enhance the biobank resources through the selective creation of unique tissue microarrays (TMAs) and DNA libraries for particular cancer types. All of these samples are linked anonymously with robust clinical outcome data which have been gathered through partnerships with clinical care teams in the trust.</p> <p>The Northern Ireland Centre for Stratified Medicine at CTRIC aims to translate advances in personalised medicine into enhancements in the delivery of care for key degenerative diseases of ageing, through research and the connection of key stakeholders. Areas of research focus include head and neck and prostate cancer.</p>

## HSC – Integrated Social & Healthcare Record

Northern Ireland is also unique within the UK in that its health and social services are integrated, so providing a unified approach to patient engagement. The five HSC trusts form a 'manageable' region where the main actors form a closed loop healthcare system.

This closed loop healthcare systems create unique advantages for Northern Ireland in the UK and EU regional context around patient data analytics and forecasting, which leverages established IT and data mining capabilities.

Northern Ireland has a unique position on structural integration of health and social care. Health and care integration is now a key policy driver for health & wellbeing improvement globally, and in particular in the US, UK and by the European Commission.

This presents opportunities for Northern Ireland to take a leadership position and thus create economic opportunity by the development of products and skills for international markets.

A key task of any future strategy group will be to examine areas of overlap between Northern Ireland's areas of capability and the key trends or areas of market opportunity going forward. These areas of overlap will aid in the process of formulating a life sciences strategy and a series of strategic recommendations going forward.

In addition to these capabilities and future market opportunities there is also a need to look at the way in which Northern Ireland leverages its capabilities. The international comparison of the life sciences in Northern Ireland highlights the region's shortcomings in attracting FDI and leveraging its sectoral capabilities to build up areas of critical mass.

### UK & international comparison - identification of key learnings for NI

The international comparison points out key learnings on how other countries effectively leverage their capabilities. An example of this would be the way Scotland has used its global reputation, including that of its universities, to attract investment.

The international comparison, however, sounds a cautionary note and invites Northern Ireland to realise that other countries are also extensively pursuing opportunities in areas such as cancer research and biomedical devices.

Additionally a national benchmarking exercise comparing the cost to quality ratios across a number of LHS sub-sectors was conducted.

### Foresight for the future of the life & health sciences - megatrends

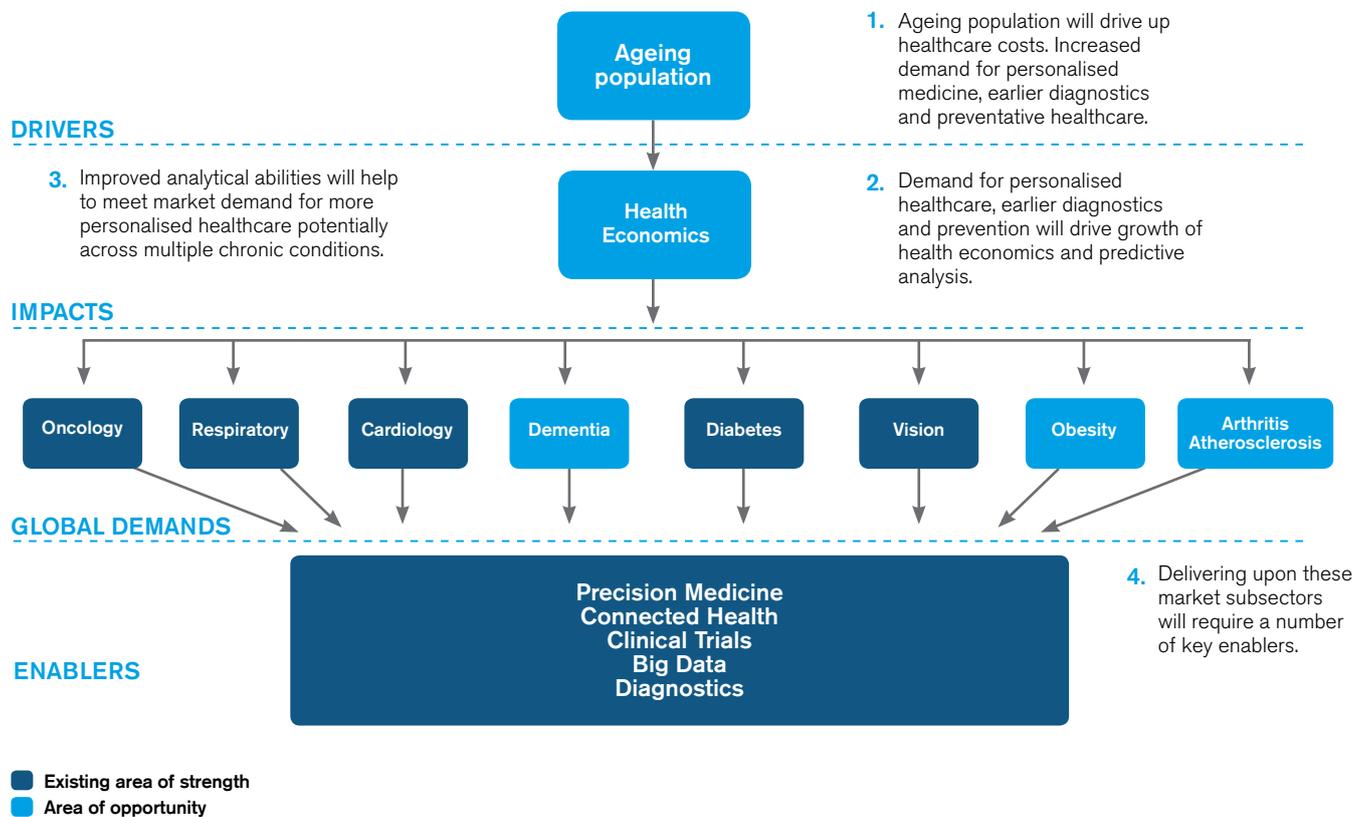
Figure 3 illustrates the relationship between the drivers, impacts, demands and enablers involved in the future development of the life & health sciences sector.

This report examines how the key driver of a growing ageing population and the resulting impact of the development of health economics will help meet the demands for increasingly personalised healthcare across several sectors.

The report summarises the future global market demands across health sub-sectors and then outlines the key technological and infrastructural enablers that will be required in order to meet those demands across those sectors.

This was developed by examining global megatrends as well as technology trends in the sector.

**FIGURE 3 – ILLUSTRATION OF THE FUTURE LIFE & HEALTH SCIENCE DRIVERS, IMPACTS, DEMANDS AND ENABLERS**



The development of health economics will enable Northern Ireland to better take advantage of demands across key health markets. There will be an increase in demand for more effective and personalised care across a number of health sectors including:

- **Oncology** - Targeted therapies, driven by improved analytical capabilities, will be a key driver in the global oncology market in the future.
- **Respiratory illnesses (autoimmune/infection)** - Improvements in accurate patient diagnosis by identifying the infectious agents through multiplexing technology and also patient management techniques including faster, readily available diagnostic tests, telehealth and advancing inhaler technologies will benefit this industry as it moves increasingly towards personalised health.
- **Cardiology/cardiovascular** - The global cardiovascular market recorded sales of \$170bn in 2010 and is set to grow to \$187bn in 2016 at a CAGR of 1.6%. Within that the cardiovascular devices market will feature prominently driven by the increasing incidence of cardiovascular diseases (CVDs) with an increasing elderly population.
- **Dementia** - In the medium term (2012-2019) there will be market opportunities around improved and validated methods for early diagnosis and care, as well as methods for measuring responses to treatment more rapidly and objectively.
- **Diabetes** - In the medium term (2012-2019) there will be a focus on earlier diagnosis and intervention which will drive market opportunities. Self-monitoring blood glucose devices will also continue to be a growth market.
- **Ophthalmology** - Key opportunities within vision will be around conditions brought on by the driver of the ageing population. A key focus for the market will be the long-term self-management of ophthalmic conditions like glaucoma (35% of global ophthalmic market in 2010) and therapies for diabetic retinopathy and age-related macular degeneration (AMD).
- **Obesity** - Due to the launches of several novel drugs during the next decade, the obesity market will increase from \$407m in 2012 to \$8.4 billion by 2022.
- **Rheumatoid arthritis** - By 2018, analysts forecast the immunology market will be worth over US\$38.5bn as leading players focus on growing their rheumatoid arthritis franchises in the emerging markets.



Finally there are a range of key enabling technologies and processes required to capitalise on the opportunities arising from these demands across sectoral markets. These include:

- **The use of big data** - In Scotland, big data has already transformed the way in which diabetes is managed and treated culminating in the production of an information rich database containing a large number of patients that have agreed to take part in clinical research on diabetes, streamlining the process of patient recruitment into clinical trials. The HSC, via their “Safe Haven”, is a potential source of a vast amount of data which could be subjected to a range of analyses leading to better diagnosis, management and treatment of disease.
- **Precision medicine & clinical trials** - Precision medicine will be required in the short term, medium to long term and long term to develop a number of health areas and select groups for more effective clinical trials which will produce more targeted therapies.
- **Diagnostics** - Point of care diagnostics will facilitate a shift towards more personalised care which will help to capture the opportunities across health sectors. Additionally, the evolution of companion diagnostics will represent a shift from single to multiplex analyses to guide treatment decisions, monitor treatment effectiveness and occurrence of acquired drug resistance.
- **Connected health** –Connected health and sensory technologies will allow Northern Ireland to meet demands across health sectors going forward. Dementia provides a good example. The economic and social burden of dementia is primarily on the patient and the immediate caregiver. Technology will be crucial in with the care of the patient and to support the caregiver's needs.

# BRIDGING THE GAP: CREATING THE RIGHT FRAMEWORK CONDITIONS

In order to build the right conditions for the life and health sciences in Northern Ireland, five priority areas need to be progressed:

1. Demonstrate visible, dynamic and committed leadership for the sector.
2. Be committed to a focused development of the sector, particularly in the areas of precision medicine, big data, data analytics, clinical trials, diagnostics and connected health.
3. Establish health and social care (HSC) as a major driver of innovation.
4. Build new Foreign Direct Investment (FDI) presence in Northern Ireland.
5. Build a supporting ecosystem.

## 1. Demonstrate visible and committed leadership and committed leadership for the sector

Two of the key recommendations of the Economy and Jobs Initiative Task and Finish Group (2013) were:

- Department for Enterprise, Trade and Investment (DETI) and the Department for Health, Social Services and Public Safety (DHSSPS) to create a new overarching Health and Life Sciences Strategy for Northern Ireland
- To establish a Health Innovation and Life Sciences Hub (HILS Hub) to co-ordinate and drive individual projects and programmes coming out of the overall agreed Life & Health Sciences strategy.

DETI and DHSSPS are about to embark on the development of a Life & Health Sciences Strategy for Northern Ireland and, reflecting the UK Strategy for Life Sciences, a Life Sciences Champion for Northern Ireland should be appointed in order to support its delivery.

The Task & Finish Group report described the HILS Hub as a “central hub for sustainable and effective interaction between the various spokes (research and innovation centres) in HSC, LHS, private sector, academia and the various economic development agencies”.

There is a need for such a facility built on existing areas of excellence to act as a hub for the many distributed spokes of excellence throughout Northern Ireland. This facility would also allow for the development and implementation of a more coherent LHS strategy, ultimately leading to the attraction of more and higher quality FDI. The success the Northern Ireland Science Park has been successful at attracting FDI into the IT sector is a great example of how this model could work.

The life and health science (LHS) sector of Northern Ireland therefore requires a visible, dynamic and committed leadership structure that will:

- constitute a single point of contact for all stakeholders involved in the sector;
- lead the execution of Northern Ireland LHS strategy;
- act as the catalyst for further collaboration between academia, industry and the HSC;
- represent Northern Ireland internationally from a marketing perspective and where funding and grant opportunities are available; and
- review the overall market trends to ensure Northern Ireland remains in line with key market opportunities.

## RECOMMENDED ACTIONS

- **Establish a Life & Health Sciences hub that will act as the single point of contact for all stakeholders in the LHS sector and will have the attributes listed above.**
- **Appoint a Life & Health Sciences Champion for Northern Ireland.**

## SUGGESTED OWNER

**Connected Health and Prosperity Project (CHAP) Board**

## 2. Be committed to a focused development of the sector, particularly in the areas of precision medicine, big data, data analytics, clinical trials, diagnostics and connected health.

The development of Northern Ireland's LHS sector requires a focused approach that leverages existing strengths while also remaining open to opportunities emerging from outside of Northern Ireland. That approach will take into consideration long term societal trends that demonstrate a significant long term shift for healthcare including:

- an increasing focus on the need for personalised care and prevention
- the shift towards a partnership model of care where patients will play an active part in determining their own care and support needs
- greater focus on prevention, earlier diagnosis and better treatments
- building the capability to help people manage multiple chronic conditions at once.



Northern Ireland will continue to build on established strengths in oncology, respiratory, cardiology, diabetes and vision/ ophthalmology whilst addressing emerging challenges by employing key enabling capabilities in:

- big data
- data analytics
- clinical trials
- precision medicine and stratified medicine
- diagnostics
- connected health.

### RECOMMENDED ACTIONS

- **Establish teams to advance each of the six focus areas. These teams will involve a range of partners whose role will be to outline the necessary actions and activities, which they and the central facility will see implemented.**

### SUGGESTED OWNER

**Life & Health Sciences Hub (once established)**

## 3. Establish the HSC as a major driver of innovation

Northern Ireland benefits from an integrated HSC sector supported by a developed Electronic Patient Record, the Northern Ireland Electronic Care Record (NIECR). The close proximity of academia, industry, Government and HSC constitutes a solid foundation for collaboration.

There is a significant opportunity to support the HSC in becoming an innovation leader in order to:

- improve quality of care and efficiency of service
- improve care professional decision-making for individuals
- improve planning for health and wellbeing
- improve support to individuals to manage their health and wellbeing
- help support the growth of indigenous companies and attract FDI.

This can be realised by:

- utilising the HSC's datasets in order to help improve health and wellbeing
- facilitating access, including private sector companies, to HSC customers and users in the context of product and service development and procurement activities
- securing time that care professionals can spend on Research & Development and Innovation in collaboration with the rest of the sector
- adopting a leadership position in the development and use of innovative technologies
- establishing a biomedical research facility which will conduct translational research to transform scientific breakthroughs into life-saving treatments for patients (reflecting Objective 3 of the HSC R&D strategy).

### RECOMMENDED ACTIONS

- **Create an environment for effective R&D within the HSC and ensure that this R&D is linked not only to specific patient outcome objectives but also to economic development objectives.**
- **Facilitate meaningful, legal and intelligent access to the datasets that reside within the HSC.**
- **Develop stronger collaboration between the HSC and companies (indigenous and FDI) in order to deliver better patient outcomes and drive local economic growth.**

### SUGGESTED OWNER

**HSC (with assistance from Invest NI on company collaboration)**



## 4. Build new Foreign Direct Investment presence in Northern Ireland

The LHS sector in Northern Ireland requires a more unified approach that will:

- focus on building up areas of critical mass in the Life & Health Sciences
- provide clearer leadership within FDI policy
- leverage existing Northern Ireland sectoral strengths and Northern Ireland global stars
- ensure phased development of existing FDI (the recent growth of the IT sector in Northern Ireland illustrates how high value FDI can grow out of low value FDI)
- incorporate the retention, attraction and growth of skills as a key part of attracting FDI (research has indicated that the availability of graduates drives high quality FDI)
- place FDI by acquisition on the agenda as an acceptable development option.

### RECOMMENDED ACTIONS

- **Develop and implement an FDI strategy for providing leadership and building up areas of critical mass for LHS.**
- **Build a sustainable sectoral marketing capability.**
- **Leverage the opportunity of bidding for the Precision Medicine Catapult to demonstrate the level of collaboration and integration across academia, industry, HSC and government.**

### SUGGESTED OWNER

Invest NI

## 5. Build a supporting ecosystem

From a policy perspective, NI will need to address the key framework conditions will be addressed to support the growth of the sector across the following components:

1. Human capital
2. Funding
3. Entrepreneurship
4. Legal framework
5. Regulatory framework
6. Infrastructure

The table on page 14 lists the categories that need developed, the actions that we recommend and the organisation best suited to take it forward.

Category	Recommended Actions	Suggested Owner
<b>Human capital – skills (quantity and quality)</b>	<p>Develop health economics and predictive analysis as well as a range of attendant skill sets including:</p> <ul style="list-style-type: none"> <li>» statistical, analytic and bioinformatics skills (including specialisations within these skillsets)</li> <li>» software development, data analysis, programming, computational thinking and electronics &amp; embedded systems (incorporated into degree courses)</li> <li>» chemistry, analytical and medicinal analytical skillsets, especially at the undergraduate level</li> <li>» LHS specific legal and regulatory skills (especially those grown in-house)</li> <li>» business and strategic skills for clinicians and scientists</li> <li>» research skills (especially the development of a mixture of clinical and research skills).</li> </ul> <p>Continue the emphasis on STEM at all levels and reinforce the STEM message at every opportunity.</p> <p>Incorporate an approach to build in cross-disciplinary capabilities at all educational levels which could include:</p> <ul style="list-style-type: none"> <li>» examples of good practise CPD and short courses</li> <li>» adequate interfaces between disciplines (e.g. chemistry, biology, physics and analytics).</li> </ul> <p>Promote the LHS more effectively by developing a co-ordinated voice of skills needs from a commercial perspective.</p>	DEL
<b>Funding</b>	<p>Ensure that there is an easily accessible, single repository explaining sources of local, national and European funding available to LHS companies.</p> <p>Develop more opportunities for specialised funding and a more structured funding approach, including:</p> <ul style="list-style-type: none"> <li>» more coherent and phased LHS funding</li> <li>» sufficient funding focus on specific areas to achieve critical mass</li> <li>» recognising the need for more private equity involvement</li> <li>» examining the need for ring-fenced LHS funding</li> </ul>	Invest NI / DFP
<b>Entrepreneurship</b>	<p>Provide specific support to LHS start-ups to facilitate the development of a vibrant start-up/spin-off base. For instance:</p> <ul style="list-style-type: none"> <li>» make LHS more attractive, along the lines of other sectors such as IT</li> <li>» examine the high cost of startup in the traditional LHS space compared to other sectors (regulatory costs etc.).</li> </ul>	Invest NI
<b>Legal framework</b>	<p>Review the current IP arrangements to leverage internationally proven IP models, allowing companies to operate more freely and bringing better balance on IP issues between industry, academia and HSC.</p>	HSC
<b>Regulatory Framework</b>	<p>Streamline access to data and patient data in order to better support innovation and emerging big data, data analytics and health economics capabilities.</p> <p>Provide better support for indigenous companies through regulatory approval process (CE, FDA etc.)</p> <p>Create a more joined up process for clinical trials to include:</p> <ul style="list-style-type: none"> <li>» points of accountability</li> <li>» reduced time for approval process.</li> </ul>	HSC
<b>Infrastructure</b>	<p>Develop a physical infrastructure within Northern Ireland which will include:</p> <ul style="list-style-type: none"> <li>» bio incubator that will provide clean labs, wet labs, administrative space and funding advisors</li> <li>» lab space that is Good Manufacturing Practice (GMP) ready</li> <li>» infrastructure supporting the need for more spin outs.</li> </ul>	InvestNI



## SUPPORTING PHYSICAL INFRASTRUCTURE

A co-ordinated approach addressing the following issues should be considered in scoping the Health Innovation Life Sciences Hub (HILS Hub) for Northern Ireland:

One of the key recommendations of the Economy and Jobs Initiative Task and Finish Group (2013) was to establish a HILS Hub to co-ordinate and drive individual projects and programmes coming out of the overall agreed strategy.

The HILS Hub will act as a central hub for sustainable and effective interaction between the various spokes (research and innovation centres) in HSC, LHS, private sector, academia and the various economic development agencies.

There are a number of key considerations raised in this report concerning the development of supporting physical infrastructure within the Northern Ireland LHS ecosystem. This includes the importance of building a committed visible leadership and co-ordination capability for the sector.

There is a need for a facility built on existing areas of excellence to act as a hub for the many distributed spokes of excellence throughout Northern Ireland. This would allow decision makers within industry, academia and Government to meet and make decisions for the Northern Ireland LHS sector. This facility would also allow for the development and implementation of a more coherent LHS strategy, ultimately leading to the attraction of more and higher quality FDI. The success the Northern Ireland Science Park has been successful at attracting FDI into the IT sector is a great example of how this model could work.

HSC R&D recognises the importance of cohesion between the MATRIX Foresight Report for Life & Health Sciences and the HSC R&D Strategy. The biggest commitment laid out in the strategy is the establishment of a Biomedical Research Facility.

Most of the UK LHS sector benefits from a Biomedical Research Facility – in England in particular the Department of Health has recognised the importance of a joined up approach and shared priorities with regard to research and innovation between healthcare trusts and academia. Thus translational research - harnessing academic insight, leveraging commercial collaborators, and focussing on patient need - has become the norm rather than the exception.

Significant funding has been placed into Biomedical Research Units, Biomedical Research Centres and more recently Academic Health Science Centres. These have aligned research and innovation activities between academia and health trusts, created integrated governance frameworks with greater efficiency and driven significant Government and private investment in infrastructure and research programmes.

These centres, modelled on similar structures in the US and Scandinavia, have created world-leading facilities with a huge critical mass of research expertise which is globally competitive. Recent Innovate UK (formerly TSB), European

Commission and Research Council funding through LHS related programmes (including catapults) has added to the investment as these large, integrated centres facilitate more and more success. Areas without such forward thinking infrastructure (physical, governance, expertise etc.) will lag behind. Whilst patient need and patient outcomes are at the heart of these models, the attractiveness to industry cannot be underestimated. Those companies involved in precision medicine, drug discovery etc. are keen to access clinical research facilities, to draw on academic insight into clinical research and accelerate the time to market through smooth, integrated structures.

## CONCLUSION

Northern Ireland is emerging as an internationally recognised location for innovation in LHS.

The LHS sector has been identified as a priority growth area in Northern Ireland's overall Economic Strategy and is one of our best performing sectors due to its continued growth throughout the global recession, averaging 10% growth per annum.

Northern Ireland already offers investors many of the core assets that are driving the global LHS market: major investments in LHS research infrastructure, a strong track record of growing indigenous LHS companies, strong international collaboration, a talented and affordable skills base and an internationally recognised academic research base.

Adding to these key assets, our unique 'closed loop' HSC system, our world class research and telecoms infrastructure and our small but complete demographic size, it becomes clear that Northern Ireland is perfectly placed to establish a fully integrated LHS ecosystem.

We believe that the realization of the recommendations contained within this report, coupled with investment at a local and national level in this region, can help to catalyse this integration, deliver better patient outcomes and drive economic growth with the potential to double the size of the sector in terms of employment and by generating revenues of £1.6b per annum by 2020.

The Department of Enterprise, Trade and Investment (DETI) and the Department of Health, Social Services and Public Safety (DHSSPS) are about to embark on the development of a Life & Health Sciences Strategy for Northern Ireland. This strategy can create the right conditions for the future growth of our indigenous LHS companies, the attraction of foreign investment, the improvement of efficiencies in the healthcare system and of patient outcomes. We trust that our ambitions for the future of the LHS sector in Northern Ireland, as set out in this report, will be realised through this new and ambitious strategy.



INTRODUCTION

# 1

## Overview and structure of the report

Chapter	Chapter Overview
Chapter 1: Introduction	Outline of Northern Ireland strategic context and document structure
Chapter 2: Northern Ireland capability assessment	Northern Ireland capability assessment (includes cluster profiles)
Chapter 3: UK and international perspective	Overview of wider UK and international perspective
Chapter 4: Foresight for the future of the LHS	Overview of the trends and growth areas in pharmaceuticals
Chapter 5: Bridging the gap – creating the right framework conditions	Overview of the interventions required to capitalise on future LHS trends

# 1. INTRODUCTION

This chapter provides an introductory definition of the life & health sciences sector in Northern Ireland and gives a brief overview of the following policy initiatives and papers:

- **MATRIX Life and Health Sciences Foresight Report** - suggested that Northern Ireland should focus on two areas: home based care and personalised medicine.
- **Transforming Your Care** – related to the redevelopment of Health and Social Care (HSC) which focused on increasing stay at home or local care.
- **Memorandum of Understanding (MoU) between DHSSPS and DETI** - led to the publication of the Connected Health and Prosperity Strategic Action Plan, setting targets for connected health R&D and other initiatives.
- **Economy and Jobs Initiative Task and Finish Group** – examined how to exploit the economic opportunities from connected health for the health and social care (HSC) sector. Recommended the establishment of a HILS Hub (Health Innovation & Life Sciences Hub) to co-ordinate and drive individual projects and programmes.

- **Innovation Strategy for Northern Ireland 2013-2025** – demonstrated the value of knowledge exchange, knowledge exploitation and the importance of international partnerships which are relevant in the LHS context.
- **HSC Research & Development Strategy ‘Research for Better Health and Social Care’** – published for consultation in September 2014.

The chapter then goes on to outline briefly the methodology used to assess the Northern Ireland life & health sciences capability (Including OCO's FDI tool Velociti and key benchmark data). Finally it provides an overview of the scope and structure of this report.

# 1.1 DEFINING THE NORTHERN IRELAND LIFE & HEALTH SCIENCES SECTOR

Life & health sciences are not defined in a traditional ‘Standard Industrial Classification’ (SIC Code) sense which makes it difficult to draw upon published statistics such as the Annual Business Inquiry or R&D surveys, which typically report on SIC codes. As such, our researchers have had to draw upon

sources provided by Invest NI as well as subscription services such as Bureau van Dijk and Duedil. For the purposes of this report, the working definition of life and health sciences is presented in the table below.

## WORKING DEFINITION OF LIFE AND HEALTH SCIENCES

Sub group	Definition
<b>Agri health</b>	The various chemical products used in agriculture. Companies include Norbrook and Provita.
<b>Bio technology</b>	Refers to recombinant DNA based and/or tissue culture based processes. Biotechnology combines disciplines like genetics, molecular biology, biochemistry, embryology and cell biology, which are in turn linked to practical disciplines like chemical engineering, information technology, and robotics. Companies include Fusion Antibodies and Randox.
<b>Clinical trials</b>	Refers to companies that conduct clinical trials. Companies include Bio-Kinetic Europe and Celerion.
<b>E-health (Software)</b>	Refers to various forms of software applications that are typically developed to service the telemonitoring and process management sphere. Companies include Kainos and IoT Tech.
<b>Medical devices and diagnostics</b>	The creation, design or manufacture of an instrument, apparatus, implement, machine, implant, in vitro reagent or other items. Diagnostics refers to anything that is used to aid the diagnosis of an ailment. Companies include Randox Laboratories Ltd, Almac and Heartsine.
<b>Medical disposals</b>	Disposable instruments, devices and materials that are used within medical and surgical procedures. Companies include TG Eakin and Clonallon.
<b>Packaging</b>	Packaging of health items. Companies include Sepha and Perfecseal.
<b>Pharmaceuticals</b>	The research, discovery, development, manufacture and marketing of drugs and biologicals for human and veterinary use. This encompasses drug composition and properties, interactions, toxicology, therapy and medical applications. Companies include Almac and Actavis.
<b>Services</b>	Refers to connected health services which use technology to provide healthcare remotely. These include services such as care home providers or nursing agencies. Companies include Carecall and Domestic Care Ltd.
<b>Connected health</b>	Connected health is a model for healthcare delivery that uses technology to provide healthcare remotely. Connected health aims to maximize healthcare resources and provide increased, flexible opportunities for consumers to engage with clinicians and better self-manage their care. It uses technology – often leveraging readily available consumer technologies – to deliver patient care outside of the hospital or doctor’s office. Connected health encompasses programs in telehealth, remote care (such as home care) and disease and lifestyle management, often leverages existing technologies such as connected devices using existing cellular networks and is associated with efforts to improve chronic care.

## 1.2 BACKGROUND TO THE WORK & STRATEGIC CONTEXT

Today, the global life sciences sector is in the midst of significant and rapid change, which presents both opportunities and challenges. Driving this change are supply and demand side pressures, lifestyle choices, longevity and a rise in chronic conditions such as diabetes, obesity and dementia. In confronting these realities, traditional ways of working will become outdated. The drive for cost-effective solutions in the health service, combined with the regulatory approvals process, can mean that uptake is slow.

New and emerging medical technologies, advances in pharmaceuticals and biological sciences, ageing populations and the rising costs of healthcare delivery are driving major change in regions across the world, including Northern Ireland. As a result of this, new global markets are opening and new opportunities are emerging for product-based and service-based Northern Ireland companies to grow even more significantly than in recent years, for clinicians to provide improved healthcare for patients and for researchers to produce findings of value to life & health sciences companies globally.

There is huge potential to better support the adoption and diffusion of innovation, to access patient data in order to inform the development phase, and to involve patients in trials and early access schemes for the treatment of chronic diseases, such as cancer. The industry is changing and many countries are driving forward innovative new practices to adapt. Northern Ireland must do likewise so that we can compete in this challenging environment. At the core of this will be innovation, commercialisation and government support. This chapter highlights the Government context, Northern Ireland's innovation context and presents a snapshot of Northern Ireland's current capacity in life & health sciences.

### UK sector overview

The UK has one of the strongest and most productive life sciences industries in the world, contributing to patient well-being as well as supporting growth. The UK life science industry generates turnover of over £50b and employs an estimated 176,000 people in around 5,000 companies.

As such, it forms a central strand of the UK Government's growth plans.

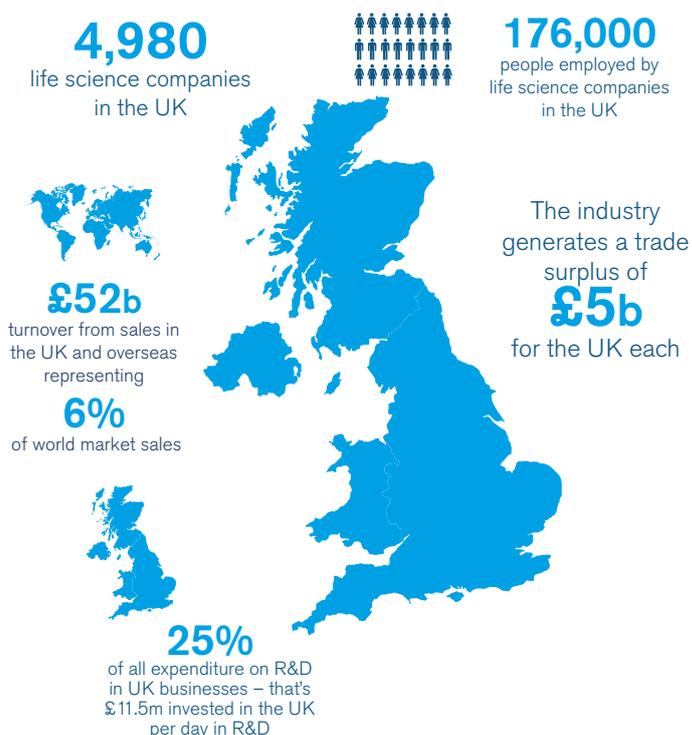
Government's desires for the sector were articulated in December 2011 when the Prime Minister launched the Strategy for UK Life Sciences. This strategy is built around three key pillars - building a UK ecosystem, attracting talent and overcoming barriers. The strategy commits to a broad range of initiatives and improvements including the biomedical

catalyst fund, formation of the Cell Therapy Catapult, improving NHS management of clinical trials and aligning financial, operational and performance incentives within the NHS.

"The UK will become the global hub for life sciences in the future, providing an unrivalled ecosystem that brings together business, researchers, clinicians and patients to translate discovery into clinical use for medical innovation within the NHS."

"The UK will provide an environment and infrastructure that supports pioneering researchers and clinicians to bring innovation to market earlier and more easily, making the UK the location of choice for investment. Life sciences will continue to be vibrant in the UK and will be a key contributor to sustained economic growth."<sup>2</sup>

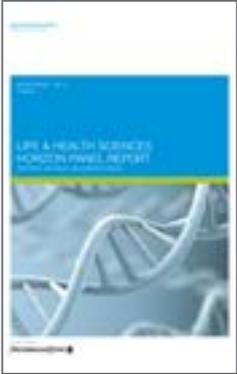
Life & health sciences attract significant attention from the Northern Ireland Executive, from both a health outcomes and economy perspective. In its Programme for Government 2011-2015, the Northern Ireland Executive committed to growing the economy and to reforming and modernising the delivery of health and social care (HSC). The Programme for Government also sets specific references and targets around cancer, diabetes and mental health. Other key strategy documents set the context for government's interest in this sector:



<sup>2</sup> Department for Business Innovation & Skills (2011), Strategy for UK Life Sciences: The Vision for Life Sciences in the UK.

## 1.2.1 NORTHERN IRELAND STRATEGIC DRIVERS

### MATRIX Life & Health Sciences Foresight Report



The MATRIX Life & Health Sciences Foresight Report (2008), which received the support of the Northern Ireland Executive, recommended that Northern Ireland should pursue objectives in two areas - home-based care (connected health) and personalised medicine. To develop in these sectors, a number of pre-requisites were noted, including skills development, a supportive policy environment and the ability to provide an integrated service and

product portfolio. This means a joined-up approach among the private sector companies, but also the use of academic and clinical capability as a catalyst to innovation and science. Collaboration with international partners was also noted as being key to help address some of the gaps that may exist in the local capability.

### Transforming Your Care



The way health and social care services are provided is changing. This is part of a process called Transforming Your Care (TYC) (2011) to make HSC more modern and improve health and social care services for everyone.

Changes proposed through TYC include investing in new technology and local services to enable patients to stay at home or be cared for locally. The strategic direction of TYC towards more efficient delivery of health services lends itself to significant opportunities in personalised medicine and, more acutely, connected health.

### Memorandum of Understanding (MoU) between DHSSPS & DETI



The Ministers of Enterprise, Trade and Investment and Health, Social Services and Public Safety agreed, through this MoU, that greater cooperation between DHSSPS and DETI in taking forward connected health solutions would contribute to improved health and wellbeing and wider economic development.

Following on from this, in September 2012, the Ministers for Health and the Economy published a Connected Health and Prosperity Strategic Action Plan to take forward the following priorities:

Targeted, connected health Research & Development & Innovation (R&D&I) funding, including optimising assets across the various organisations;

- The development of the Northern Ireland Connected Health Eco-System, along with international linkages;
- Collaboration with international regions, particularly within Europe and North America, for mutual gain; and
- Promoting the connected health agenda internationally, particularly within Europe and North America.

Building on these initiatives, in September 2012 the Northern Ireland Connected Health Ecosystem was established. Its objectives were to:

- Foster a positive attitude to innovation and the possible benefits to the delivery of HSC services;
- Share HSC innovation in practice;
- Consider ways of addressing key TYC priorities through implementation of connected health solutions;
- Improve communication across HSC, academia and business on health priorities; and
- Identify opportunities where sectors can engage to develop connected health solutions.

## The Economy and Jobs Initiative Task and Finish Group



In November 2012 the Northern Ireland Executive launched its Economy and Jobs Initiative which committed to, among other economic growth measures, the establishment of a Task & Finish (T&F) Group, under the remit of the Connected Health and Prosperity Project Board, to exploit the economic opportunities from connected health for the HSC sector.

The T&F Group was appointed to provide an assessment of the potential opportunities for employment and business development from HSC through greater innovation and export-led growth. The group published its report in May 2013.

Key recommendations included:

- DHSSPS and DETI to create a new overarching Life & Health Sciences Strategy for Northern Ireland which will complement existing strategies and be a future proofed catalyst for the development of the life & health sciences;
- Establish a HILS Hub (Health Innovation Life Sciences Hub) to co-ordinate and drive individual projects and programmes coming out of the overall agreed strategy (this is the subject of a separate study);
- Establish a new health innovation infrastructure with six key economic attractors<sup>3</sup> in Northern Ireland for indigenous and FDI companies which would complement the new HILS Hub;
- Review the existing Northern Ireland Executive Procurement Policy and apply changes to public sector procurement process to support new, innovative solutions, key initiatives and the proposed HILS Hub and health innovation infrastructure;
- Establish a resource dedicated to international collaboration. Its primary function will be to build key relationships and also to identify new funding streams throughout the EU and alternative public and private investment funding; and
- DHSSPS and HSC to create strategic partnerships with the Department for Employment and Learning (DEL) to align future skill-sets of the HSC Health and Social Care sector and the current provision through Universities and Further & Higher Education Colleges in Northern Ireland.

## Innovation Strategy for Northern Ireland 2013-2025



R&D&I has been identified as one key theme for rebalancing the economy and the draft innovation strategy proposes to deliver a vision for Northern Ireland to be recognised as one of the UK's leading high-growth, knowledge-based regions.

In tangible terms this sort of transformation will mean that by 2025:

- many more of our companies will be engaging in innovation, collaboration and exporting;
- the number of knowledge economy businesses would double and the sector would increase employment by 15,000;
- £1b would be invested in R&D every year; and
- greater numbers of young people would be achieving graduate and post-graduate qualifications in STEM.

The strategy notes that a world-class research base is a key driver in promoting economic growth. Investment in R&D&I creates new businesses and improves existing ones; it brings highly skilled people into the job market and it attracts international investment.

The strategy focuses on the development of knowledge generation, knowledge exchange and knowledge exploitation which are key areas for the life & health sciences. The focus on 'knowledge exchange' in the development of new international partnerships, such as Clinical Translational Research and Innovation Centre (C-TRIC), is important from a life & health sciences perspective.

## HSC Research & Development Strategy

The HSC Research & Development Strategy: 'Research for Better Health and Social Care' was published for consultation in September 2014. The strategy focuses on the use of evidence to improve health and social care, ensuring that Northern Ireland health and social care researchers compete successfully for research funding, and investing further in Northern Ireland's research infrastructure to support the health economy. The 13-week consultation period closed on 2 January 2015 and will be followed by an HSC R&D division implementation plan.

<sup>3</sup> Dynamic Action Register Online; International Health Analytics Centre; Smart Connected Residential Community; Connected Health Integration Platform; Clinical and Device Trials; Continued development and exploitation of hard IP such as new drugs and medical devices.



## 1.3 METHODOLOGY

This overall approach and methodology was supplemented by the use of OCO's Velociti tool, which is a specialised FDI tool which is described below.

### **OCO's Velociti FDI tool**

Velociti is a tool which helps economic developers to understand a company's propensity for innovation, trade and investment. The relationship between these behaviours is often sequential and the Velociti tool enables economic development organisations to identify, screen and qualify target companies, sectors and markets in an efficient, reliable and systematic way.

The platform integrates a number of sources to ensure comprehensive company data points are gathered through industry and proprietary sources. Companies are then scored using an algorithm which determines their trade, investment and innovation propensity.

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NORTHERN IRELAND'S  
CAPABILITY ASSESSMENT





## 2. NORTHERN IRELAND'S CAPABILITY ASSESSMENT

The first chapter of this report outlined the strategic and innovation context of the life & health sciences within Northern Ireland. Chapter 2 starts off with a closer look at the indicators around Northern Ireland's innovation context (Section 2.1), placing it within its broader UK and European context.

This overview is used to highlight the significant differences between Northern Ireland and other regions and to set out the size of the challenge in developing the sector. The chapter then goes on to cover Northern Ireland's life & health sciences capability across the private, academic and public sectors.

The section on the private sector focuses on the local business landscape which includes three large companies (Almac, Norbrook and Randox) and examines Northern Ireland's private sector innovation capability in a wider UK regional context.

The chapter concludes with an overview of the key learnings from the international comparison which should inform the future development of the life and health sciences in Northern Ireland.

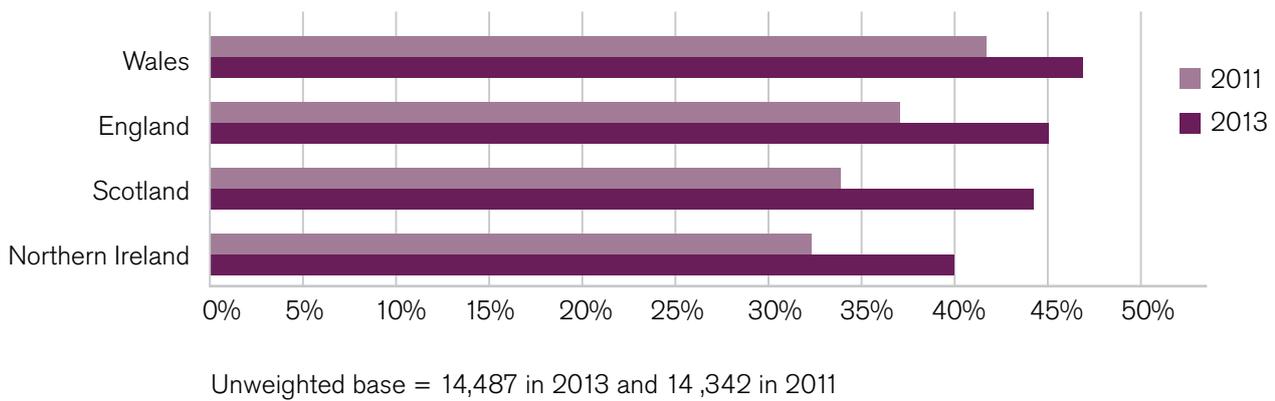


## 2.1 NORTHERN IRELAND INNOVATION CONTEXT

R&D&I has been identified as a key theme for rebalancing the economy and the Innovation Strategy delivers a vision for Northern Ireland to be recognised as one of the UK's leading high-growth, knowledge-based regions.

Northern Ireland has a relatively small business base engaging in R&D&I and the UK Innovation Survey 2014 placed Northern Ireland at the bottom of the UK regional league, with only 40% of companies engaged in innovative activity.

**FIGURE 4 – SHARES OF INNOVATION ACTIVE BUSINESS (ALL ENTERPRISES)**



## 2.1.1 EU REGIONAL INNOVATION PERFORMANCE

The LHS sector has been identified as one of the priority sectors that will drive the future growth of Northern Ireland's economy. By investing in novel sub-sectors, encouraging innovation and stimulating R&D, Northern Ireland will be able to exploit leading edge technologies in a commercial manner to take the local economy to a higher plane<sup>4</sup>.

Northern Ireland's regional innovation performance is a critical component in the overall development of a number of key sub-sectors, including the life & health sciences. Research has indicated that a good general innovation ecosystem is a necessary precursor for an effective life & health sciences strategy.

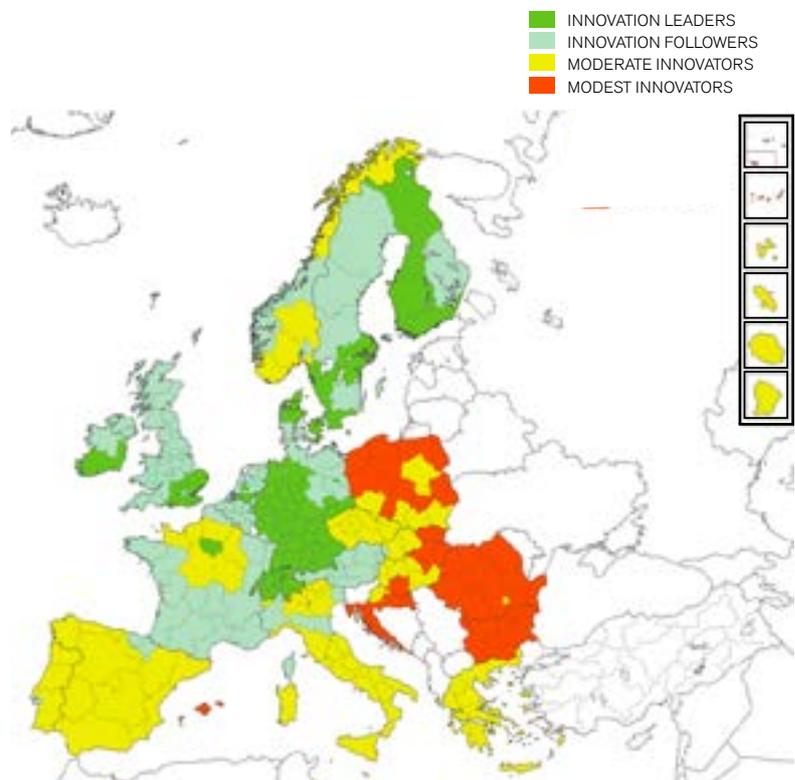
Certain key elements are required for the successful development of the life & health sciences in Northern Ireland, including:

- a strong R&D base that would facilitate innovation
- the presence of working partnerships and collaborative networks
- the existence of a strong skills base
- adequate physical infrastructure and communications
- large firms acting as anchors for the sector
- a strong entrepreneurial culture
- access to sources of finance<sup>5</sup>.

In this context then, it is relevant to examine Northern Ireland's regional innovation performance. The EU innovation survey groups European regions into different and distinct innovation performance groups based on their relative performance on the Regional Innovation Index compared to that of the EU. The thresholds in relative performance are the same as those used in the Innovation Union Scoreboard.

- Regional innovation leaders are those regions which perform 20% or more above the EU average.
- Regional innovation followers are regions performing between 90% and 120% of the EU average.
- Regional moderate innovators are regions performing between 50% and 90% of the EU average.
- Regional modest innovators perform below 50% of the EU average.

Northern Ireland is classified as a regional innovation follower. Interestingly, a significant proportion of regions within the Republic of Ireland are classified as innovation leaders, as is the south eastern part of England. Although the rest of the UK is classed similarly to Northern Ireland, there are significant UK regional differences, especially when investigating the constituent parts of the innovation classification.



<sup>4</sup> <http://lifesciences.investni.com/research.asp>

<sup>5</sup> Life Science Innovation Strategies in Sweden, Ireland and Ontario: Lessons Learned for Scotland' – A report prepared for Scottish Enterprise Dr Alessandro Rosiello and Dr Michele Mastroeni, ESRC Innogen Centre, University of Edinburgh, April 2010

## NI FACTOR RANKING IN EU REGIONAL INNOVATION SURVEY FACTOR

EU Regional Innovation Survey Factor	NI rank within UK (out of 12)
Population with tertiary education	11
R&D expenditure in the public sector	7
R&D expenditure in the private sector	8
SMEs innovating in-house	12
Innovative SMEs collaborating with others	9
EPO patent applications	11
SMEs introducing product/ process innovation	11
SMEs introducing marketing/organisational innovations	11
Employment in knowledge intensive activities	12
Sales of new to market & new to firm innovations	11

Source: EU Regional Innovation Survey

This innovation survey, albeit for the whole economy, demonstrates an R&D&I malaise that impacts on Northern Ireland economic performance. Driving forward from this point will require a phenomenal improvement, particularly as none of the other regions are standing still on R&D&I. In the context of life and health sciences, the following sections provide a snapshot of current capacity within the sector and examine the extent to which Northern Ireland LHS businesses demonstrate innovation.



## 2.2 NORTHERN IRELAND LIFE & HEALTH CAPABILITY

The 2008 MATRIX Northern Ireland Technology Capability Study judged the life sciences sector as 'impressive and significant; however, this remains fragmented between academic research, public sector research and private company research.' Across academia, the public sector and private sector, Northern Ireland was judged as follows:

- **Private sector:** 'The private aspect of the sector remains dominated by three leading companies - Almac, Norbrook and Randox, who have little interaction with the rest of the sector in Northern Ireland. Their success is based on their own capability to supply their markets quickly and efficiently. Within the private sector, there are clear capabilities in medical devices and diagnostics, pharmaceuticals, medical disposals, biotechnology and clinical trials.'
- **Academia:** 'The academic part of life sciences in Northern Ireland is filled with significant capability, albeit sometimes small in scale. The research in the sector tends to be fundamental in nature and this drives limited exploitation opportunities. This implies that any meaningful commercial research is exported outside of Northern Ireland to leading companies in the UK or Europe and the USA.'
- **Public sector:** 'The public sector capability is driven by the work of the DHSSPS. This unit benefits from having a dual remit of health and social care and therefore has a R&D directorate which promotes and supports R&D within the HPSS. This R&D tends to span both healthcare and community/social care. This does provide some additional 'end-to-end' capability. The R&D strategy is focussed on wellbeing and health but seems to be disconnected from the other companies in the sector in Northern Ireland'

## 2.2.1 PRIVATE SECTOR

The life & health sciences sector in Northern Ireland can best be described as niche and increasingly vibrant. Accounting for around 7,500 jobs and approximately £800m in sales, the sector is dominated by three large companies (Almac, Norbrook and Randox) and a further 130 companies or so across several sub-groups. This section of the report profiles the innovation capacity of Northern Ireland's life and health sciences companies.

### Global context

Latest estimates of the global life science sector place annual turnover at over US\$1.1 trillion with a (CAGR) of 6.7%. The pharmaceuticals market accounts for 72% of total life science revenues.

### Pharmaceutical sub-sector

The global pharmaceutical market was estimated to be worth around US\$792b in 2011. There is an emerging trend among the large pharmaceuticals to move towards more collaborative, lower cost approaches to the development of new drugs as their patents on key products expire. Drugs worth US\$132bn lost their patents between 2009 and 2013. This shift in the type of products coming out of pharmaceutical research labs provides excellent opportunities for smaller pharmaceutical firms to aid in the R&D of a new series of targeted drugs. The generic drugs market is expected to see a 10% CAGR between 2013-2015.

There is also a growing trend of pharmaceutical and biotechnology businesses converging, with a focus on higher margin biopharmaceuticals to treat diseases.

### Medical biotechnology

The global medical biotechnology market accounted for 19% of the total pharmaceutical market in 2011 US\$142b with a CAGR of 11%. The industry comprises over 10,500 firms and employs around 525,000 people worldwide. The sector is being driven by, among others, the emergence of stem cell technology and regenerative medicine. The field of medical biotechnology is still very much in its infancy but it is attracting a lot of attention and investment due to its potential application across a wide range of diseases and ailments.

### Medical technology

The global medical technology market had an estimated value of US\$325b in 2011 and a CAGR of 7% between 2005-2011. In 2011 the top five medical technology segments by global sales were in vitro diagnostics, cardiology, diagnostic imaging, orthopaedics and ophthalmics. In vitro diagnostics are expected to remain the largest sub-sector until at least 2018, although CAGR for the sector is expected to fall to 4.4% over the same period.

### Industrial biotechnology

The industrial biotechnology market has an estimated global market size of between US\$50-60b and this is forecast to increase to US\$300b by 2030, with the biofuels and chemical markets most likely to fuel this growth. At present, less than 12% of chemicals used in consumer products are made through industrial biotechnology processes. Biodiesel production increased 400% between 2005 and 2010 and the demand is expected to reach 65 million barrels by 2020.

In 2014, the Patient Protection and Affordable Care Act (PPACA), commonly called the Affordable Care Act (ACA) or "Obamacare", came into effect. It provides an extension of health insurance to more than 30m uninsured US citizens and will undoubtedly provide a boost to the life sciences sector worldwide. However, in a global context, the focus of life science attention is quickly shifting towards large emerging markets. The increasingly ageing and affluent populations of countries like the BRICS nations (Brazil, Russia, India, China, and South Africa) as well as the modernisation and Westernisation of their health sectors, is leading to huge increases in the healthcare expenditure in these economies. This attention on the emerging economies is also resulting in increasing inward investment. China is becoming an attractive location for investment by life science firms due to its highly skilled yet low cost R&D environment and the increasingly stringent regulatory requirements in Europe and the USA.



**United Kingdom context - overview**

The UK life sciences sector employs 176,000 people in 4,980 companies with an estimated combined turnover of over £50b. The pharmaceutical sector alone generates around £30b per annum with 17 of the top 20 global pharmaceutical manufacturers having a presence in the country. The medical technology industry is the largest employer in the UK life sciences sector, with 71,144 jobs, but its turnover is significantly smaller than the pharmaceutical figure at only around £16b per annum.

In December 2011, the Prime Minister launched the Strategy for UK Life Sciences. This strategy is built around three key pillars - building a UK ecosystem, attracting talent and overcoming barriers - and is committed to a broad range of initiatives and improvements including the Biomedical Catalyst Fund, formation of the Cell Therapy Catapult, improving NHS management of clinical trials and aligning financial, operational and performance incentives in the NHS.

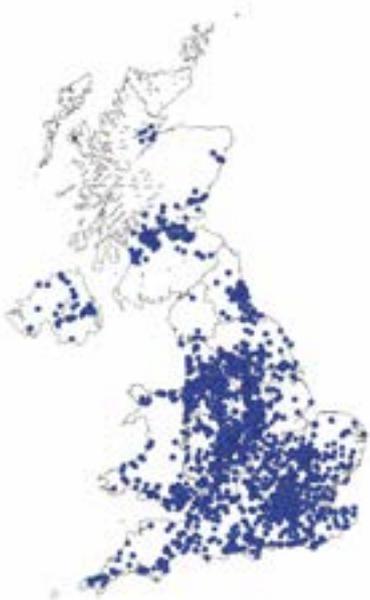
In the academic year 2012/13, there were 436,257 students enrolled in university courses directly related to life sciences. Key regions were London (72,314), the South East (59,687) and the North West (45,531).

**Regional strengths**

Surfacing the National Offer (SNO) is one of the resources used by the Investment Services Team (IST) in UK Trade & Investment (UKTI) to support the identification and short-listing of UK locations for FDI projects. SNO identifies concentrations of local capability across sectors and sub-sectors throughout the UK.

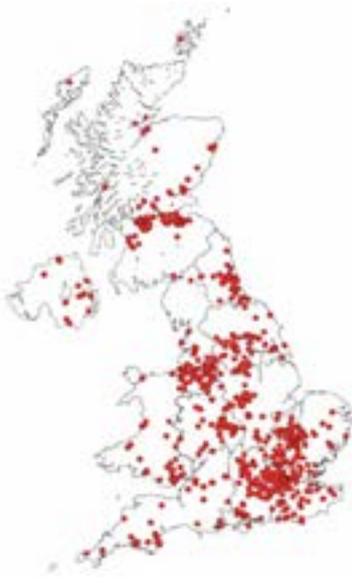
**FIGURE 5 – SNO IDENTIFICATION OF CONCENTRATIONS OF LOCAL CAPABILITY ACROSS THE UK**

**MED TECH COMPANIES**



The West Midlands hosts the majority of medical technology companies (over 550)

**BIO TECH COMPANIES**



The East of England hosts the majority of companies in this segment.

**PHARMA COMPANIES**



Concentration in the South East including London



## Cambridge

Cambridge is the UK's leading centre for life sciences and has an array of strengths. The intellectual focus provided by Cambridge University, which boasts 20% of the world's Nobel Prize winners in medicine and chemistry, also made Cambridge a natural starting point for biotechnology in the UK. It contains world-leading centres of research excellence: the Sanger Centre, leading genomic research, the John Innes Centre for plant research, the Babraham Institute providing world class immunology research, and the Laboratory for Molecular Biology that has generated a number of firsts, including the antibody technologies that have produced most of the world's new biologic medicines. The cluster is home to around 25% of Europe's biotechnology companies and the world's largest medical research charity, the Wellcome Trust, also has a base there.

Support services for biotechnology in Cambridge are delivered by One Nucleus, a not-for-profit, membership organisation network that has strong ties with UKTI. The network provides a wide range of support including an annual biopartnering event, business mentoring, training and education in all aspects of bioscience business and has strong links to other international bodies, particularly in Europe.

Demand for lab and office space is extremely high in Cambridge and large open spaces are limited. The price of suitable property in the city is therefore very expensive. For this reason there is a concentration of science parks around the periphery to cater for the smaller life science firms that would be unable to establish themselves in the city itself.

The region is served by the Greater Cambridge Greater Peterborough Enterprise Partnership. The Science, Innovation and Industry Council (SIIC) within the partnership is responsible for drawing together leading professionals in the area to drive the development of the sector across the Local Enterprise Partnership (LEP) area. The 'Make it Here' campaign, run by the Institute for Manufacturing, was initially developed by the (SIIC) group and has launched its first event, aimed at promoting the region as an area to manufacture a range of high tech products. David Gill and Alex Plant, members of the SIIC group, have also been heavily involved in working with Government to develop proposals for the Business Bank to ensure that it meets the needs of the science and innovation sector.

## South East England

The South East of England is an important cluster for a wide range of life sciences companies.

Benefiting from proximity to London and the world's busiest international airport, Heathrow, the South East submarket is a mature cluster that provides research sites for three of the top 10 major global pharmaceutical companies and a number of biotechnology firms.

Oxford is another cluster of importance for life sciences within the broader southeast region, with more than 100 biopharmaceutical and healthcare companies taking advantage of close links to the city's Oxford University. Again, due to the demand for suitable space and high property prices, much of the office and lab space is located out of town in science and business parks. The region is served by the South East LEP and in December 2013 they submitted a strategic economic plan to the UK Government. The plan bids for £1.2b from government to leverage £10b investment into the south east by 2021. At the heart of the Growth Deal, is a proposal to establish a family of investment funds - the South East Fund (to be known as SEFUND ), which will lever in substantial new sums of private, public and European investment. SEFUND will extend access to finance schemes to businesses across the South East LEP area and invest to kick start property development.

## London

Although many larger pharmaceutical and biotech companies base their operations outside central London, GSK and AstraZeneca hold large offices in the city proper. The cluster has representation from more than 100 bioscience businesses, not to mention 28 universities and five renowned medical schools. It is also home to University College London (UCL) Partners, one of Europe's largest academic health science partnerships of hospitals and medical research centres.

## North West England

North West England is the UK's third largest bioscience cluster. Manchester University, one of the largest universities in the country, provides the focal point and recently collaborated with GlaxoSmithKline and AstraZeneca on a new research centre. AstraZeneca also has a large base in the area. The North West of England is further supported by the strong academic research capabilities of the Universities of Liverpool, partner hospitals and locally based national support facilities such as the National Bio-manufacturing Centre. The region is home to Europe's largest clinical academic campus, Europe's largest cancer treatment centre and the largest clinical trials unit in the world. The region's investment promotion is split between several organisations including the Manchester Inward Development Agency Service (MIDAS) and the Liverpool city region LEP. Life science is a priority sector throughout the organisations, and the region also benefits from the Northern Health Science Alliance Ltd (NHSA), a new partnership established by the leading universities and NHS hospital trusts in the North of England to improve the health and wealth of the region by creating an internationally recognised LHS system.

## Northern Ireland capability

Northern Ireland's life & health sciences sector is comprised of approximately 130 companies employing around 7,500 people and generating sales of approximately £800m per annum.

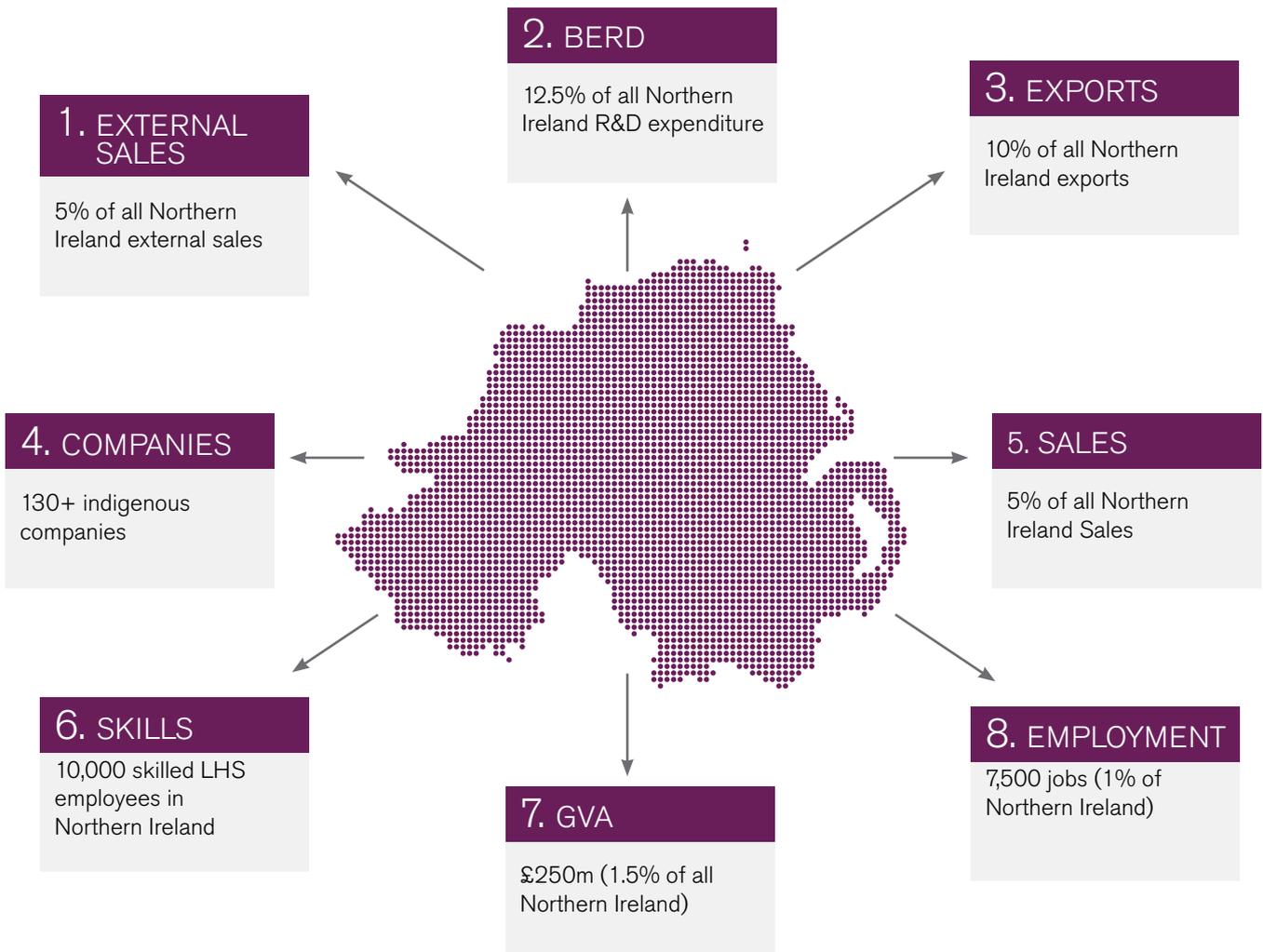
A significant proportion of the companies in the sector deal in pharmaceuticals, medical devices and solutions (screening, imaging etc.) but diagnostics, clinical trials and agri-health are also well represented. The sector is estimated to account for 12.5% of total Northern Ireland R&D.

Profiling trends in the sector is somewhat limited by the extent of detailed data availability. That said, employment, turnover, export and R&D data is available since 2009 for companies that we estimate account for 75% of the Northern Ireland sector. Even then, data is best described as 'patchy' but it does provide some insight into how the sector is performing relative to the Northern Ireland economy as a whole.

## Sector performance

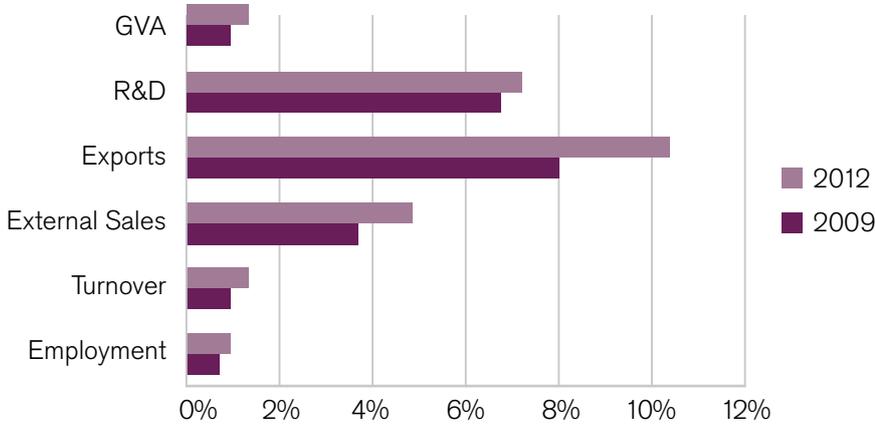
The economic downturn in Northern Ireland (and globally) has been well documented, with strong declines in output and employment which began in 2008 and lasted until 2012/13. Many reports noted that the recession in Northern Ireland was deeper and longer than the rest of the UK but one bright spot during the downturn was in the performance of the life and health sciences sector. Across all key metrics, the performance of the sector is well above the Northern Ireland average. While connected health companies are performing well and pointing towards exciting opportunities for Northern Ireland, the sector remains driven by the well established players in the more 'traditional' life sciences space. For example, at the time of writing, Randox and Heartsine, have announced around 700 new jobs, underlining the success of the sector.

Additionally Randox has recently announced the expansion of their Donegal facility and recruitment there. While this is not within Northern Ireland, it is indicative of growth for Northern Ireland and may produce "spillover" benefits for the Northern Ireland economy.





**FIGURE 6 - CONTRIBUTION OF THE LIFE & HEALTH SCIENCES SECTOR TO THE NORTHERN IRELAND ECONOMY**



Source: OCO calculations based on Invest NI, DETI and National Statistics data

It is clear from the analysis that the sector is dominated by 'traditional' life sciences sector companies rather than the 'newer' connected health companies. Further, the 'big three' of Almac, Randox and Norbrook between them account for approximately half of the employment in the sector and close to 60% of the known R&D expenditure.

As the sector grows, and increases in its importance to the Northern Ireland economy, it is important to be able to assess how innovative and 'outward looking' it is in an international context. This is the focus of the remainder of this section.

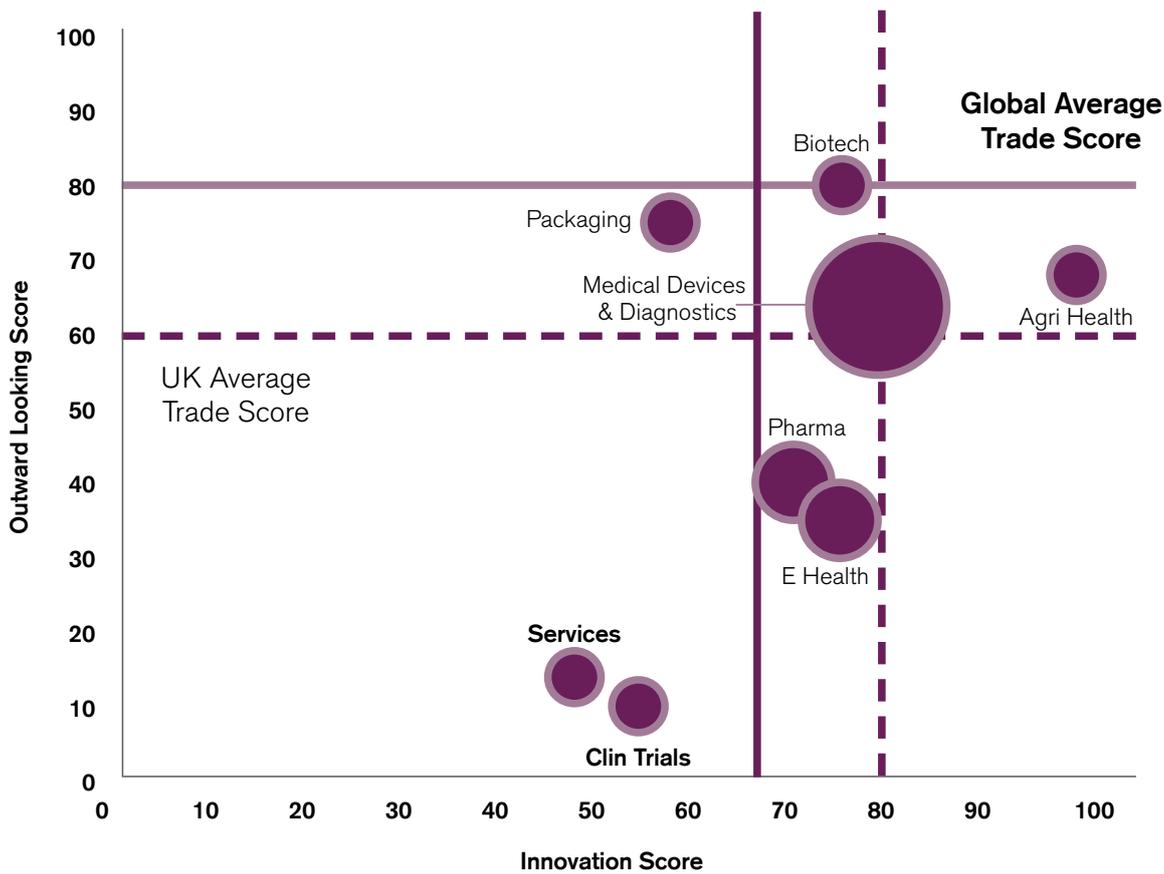
### Assessing innovative capability

We have undertaken a bespoke Velociti assessment of Northern Ireland life & health sciences companies and have generated a score that encompasses R&D capability and exploitation capacity.

In respect of company innovation and development, the Velociti algorithm assesses 'hard' metrics such as R&D spend as well as a range of 'quality' indicators, as follows:

- Innovation based collaboration with a university or other company.
- Evidence of patents owned, acquired or pending.
- Market release of significant new product or service in the past 12 months.
- Evidence of new products in development or in clinical trials.
- Receipt of an industry award or accolade.

**FIGURE 7 - NORTHERN IRELAND LIFE & HEALTH SCIENCE INNOVATION CAPABILITY**



Source: OCO VELOCITI

Northern Ireland displays a particular strength in agri health – an innovation leader on a global scale - while strength is also evident in medical disposables, e-health, pharmaceuticals and biotechnology. Northern Ireland’s relatively low export propensity also comes through in this figure, with all sub groups scoring below the global average. Obviously these sub group aggregations mask pockets of excellence which exist within the sub group populations. The following section presents a selection of ‘innovation leaders’.

## Norbrook Laboratories

Norbrook is a privately owned group of companies specialising in the development, licensing, manufacture and marketing of veterinary pharmaceuticals, human pharmaceuticals and the active ingredients used in the production of these pharmaceuticals.

Norbrook has recognised the synergies which exist between the manufacture and distribution of veterinary and human medicines and has expanded into human medicines in recent years. Its expertise in research and development, regulatory and licensing protocols, active substance and finished product development has enabled the company to develop its business successfully within the human pharmaceuticals market.

Norbrook employs around 1,500 people and manufactures several pharmaceutical drugs, the most well-known of which are the antibiotic drugs Noroclav and Betamox, as well as non-steroidal anti-inflammatory drugs (NSAIDs) such as Carprive, Loxicom and Flunixin.

## Almac

The Almac Group is an established contract development and manufacturing organization that provides an extensive range of integrated services to over 600 companies globally within the pharmaceutical and biotechnology sectors.

Almac's research business units cover five main branches: diagnostics, sciences, clinical services (employing 873), clinical technologies and pharmaceutical services. There is also a marketing unit called Galen.

The services they provide range from R&D, biomarker discovery development and delivery, active pharmaceutical ingredient (API) manufacture, formulation development, clinical trial supply, IXRS® technology (IVRS/IWRS) through to commercial-scale manufacture.

The international company is a privately owned organisation that has grown organically over 30 years and now employs in excess of 3,300 highly skilled personnel. In September 2013 Centre for Cancer Research & Cell Biology (CCRCB) and Almac Discovery launched a £13m joint programme collaboration in the area of cancer.

Almac is involved in three European funded collaborative projects in the area of precision medicine, two of which are Industry-Academia Partnerships with academic and clinical organisations in the Republic of Ireland.

Almac is internationally recognised for its clinical trials management and clinical test delivery as well as recently having launched a next-generation sequencing service to support clinical trial enrichment and companion diagnostics<sup>6</sup>.

Almac has recently developed its ALM AADx gene expression test which has attracted significant interest from the pharmaceutical industry and demonstrates Almac's strength as a major player in clinical trials research, personalised medicine and in the development and validation of the next generation of multiplex companion diagnostic (MCDx) tests<sup>7</sup>.

Almac Diagnostics has obtained funding for three projects from Innovate UK (formerly the Technology Strategy Board) and is also involved in local and European Regional Development Fund (ERDF) funded industry-academia clinical local collaborative projects, including PathXL. QUB and the Belfast Health Trust. In addition, Almac Discovery and QUB have committed to a unique £13m collaboration around the discovery and clinical development of novel therapeutics for cancer.

## Radox

Radox Laboratories Ltd. (Radox) was established in 1982 and is the largest diagnostic manufacturer in UK and Ireland. The principal activity of Radox is the design, manufacture and marketing of a vast range of high quality products for laboratory diagnostics. Radox products are used in over 130 countries worldwide by hospital laboratories, veterinary clinics and laboratories, pharmaceutical and CRO companies, forensic laboratories and food and wine testing laboratories.

Currently, Radox employs, 1, 300 staff and a large R&D department that employs 300 research scientists and engineers. Buoyed by continued success, the company recently announced plans to expand its workforce further. The majority of Radox staff are educated to degree level and many were educated at QUB or the UU.

From the beginning of a business which manufactured and sold seven clinical chemistry kits, the company has not only expanded its portfolio to over 1,500 products, but has also diversified into many other aspects of science through a heavily committed R&D programme.

The Radox Group incorporates Radox Laboratories, Radox Teoranta, Radox Toxicology, Radox Testing Services and Radox Food Diagnostics. Other divisions of Radox Laboratories include, Confidante, Radox Life Sciences and Radox Pharma Services. Radox Health is a separate trading entity.

<sup>6</sup> UK Life Sciences Proposition – 'Unlock your business potential: UK stratified medicine'

<sup>7</sup> <http://www.almacgroup.com/2014/06/almacs-ground-breaking-aadx-gene-expression-marker-attracts-significant-commercial-interest-from-pharma/>

## SELECTED OTHER COMPANIES WHICH HAVE DEMONSTRATED SIGNIFICANT INNOVATION CAPABILITY

Company	Sub Group	Description
<b>O4 Research</b>	Clinical trials	<ul style="list-style-type: none"> <li>O4 Research is a provider of integrated trial management solutions to the pharmaceutical, biotechnology and medical device industries.</li> <li>Excellent track record in conducting clinical trials across therapy areas with particular focus on analgesia, cardiovascular, CNS, dermatology, endocrinology and vaccines and anti-infectives.</li> </ul>
<b>Actavis</b>	Pharma	<ul style="list-style-type: none"> <li>in 2013, Actavis acquired Warner Chilcott plc, creating an US\$11b leading specialty pharmaceutical company with over US\$3b in pro forma sales. The combination capitalizes on the complementary specialty pharmaceuticals strengths and market positions of the two organizations. Actavis is a leader in women's health and urology, as well as a company with important positions in gastroenterology and dermatology.</li> </ul>
<b>Althexon Ltd</b>	Biotechnology/ biologic peptides	<ul style="list-style-type: none"> <li>Althexon is a biotechnology company, with its headquarters in Belfast and a research presence in both North America and East Asia.</li> <li>Its objective is to discover and develop novel, venom derived biologic peptides for a wide range of therapeutic indications.</li> </ul>
<b>Amtec Ltd</b>	Medical technology	<ul style="list-style-type: none"> <li>Amtec Medical Limited is develops and markets intelligent, innovative medical technology.</li> </ul>
<b>AquaQ Analytics Ltd</b>	E-health	<ul style="list-style-type: none"> <li>AquaQ Analytics Limited is a provider of specialist data management, data analytics and data mining services.</li> </ul>
<b>Biocolor Limited</b>	Medical devices & diagnostics	<ul style="list-style-type: none"> <li>Biocolor is a fully developed biotech company that designs, produces, markets and supplies high quality bioanalytical assays to bioscience researchers.</li> </ul>
<b>Biokinetic Europe</b>	Clinical trials	<ul style="list-style-type: none"> <li>BioKinetic Europe is an independent owner-managed contract research organisation (CRO) with a reputation for effectively managing Phase I-III clinical trials.</li> <li>It operates two clinics at its site in Belfast.</li> <li>It works with a range of global sponsors involved in drug development from small, medium and large –sized pharmaceutical companies to biotech firms and university spin-outs.</li> </ul>
<b>Celerion</b>	Clinical pharmacology	<ul style="list-style-type: none"> <li>Celerion provides one of the most experienced clinical pharmacology research networks in the industry with a global clinical capacity of more than 730 beds.</li> <li>Celerion has one of the largest clinical pharmacology science teams in the industry producing more than 200 clinical study reports annually and has developed over 4,000 protocols in total.</li> </ul>
<b>CIGA Healthcare</b>	Diagnostics	<ul style="list-style-type: none"> <li>CIGA Healthcare specialises in the production of Rapid Diagnostic Tests for home use, clinical laboratories, the professional market and the healthcare sector.</li> <li>CIGA Healthcare has several international partners, distributing Suresign products to over 70 countries.</li> </ul>
<b>Fortress Diagnostics</b>	Medical devices & diagnostics	<ul style="list-style-type: none"> <li>Fortress Diagnostics is a rapidly expanding, innovative, primary diagnostics manufacturer specialising in the development, manufacturing and distribution of a range of medical diagnostic and point of care tests for a global market.</li> </ul>
<b>Exploristics</b>	Statistical & data analytics	<ul style="list-style-type: none"> <li>Exploristics is a Belfast based specialist in statistical and data analytics and has won business worth around £200,000 from US industry leaders.</li> <li>Exploristics is carrying out projects to support new drug developments for the treatment of cancer and other serious medical conditions and help develop better, more predictive models for the earlier diagnosis of pancreatic cancer.</li> </ul>



<b>Fusion Antibodies</b>	Therapeutics/ Diagnostics	<ul style="list-style-type: none"> <li>▪ Fusion Antibodies was founded in 2001 as a QUB spin out.</li> <li>▪ It offers a range of services covering discovery, validation and production of cGMP-ready proof-of-concept material for novel therapeutic and diagnostic targets.</li> </ul>
<b>Haemoband</b>	Biotechnology	<ul style="list-style-type: none"> <li>▪ Haemoband is a medical device manufacturer which produces the innovative Haemoband Multi-Ligator product, which delivers speedy and effective treatment of haemorrhoids.</li> </ul>
<b>Heartsine Technologies Limited</b>	Cardiology	<ul style="list-style-type: none"> <li>▪ Heartsine was formed in 1997 as an R&amp;D initiative in the field of cardiac defibrillation involving the UU and RVH.</li> <li>▪ It has developed a public access device (PAD) which has received US FDA approval. The PAD is designed specifically for the public access sectors.</li> </ul>
<b>Intelesens</b>	Medical devices	<ul style="list-style-type: none"> <li>▪ Intelesens is a cutting-edge medical device company whose technology connects patients wirelessly to their healthcare provider. Intelesens has over 40 staff and is 30% owned by a major healthcare provider.</li> </ul>
<b>IoT Tech Limited</b>	E-health	<ul style="list-style-type: none"> <li>▪ IoT offers a highly innovative and effective integrated service to both the private and public sector care providers, offering care delivery monitoring, remote access control, social alarm functions and energy monitoring.</li> </ul>
<b>Kainos</b>	E-health	<ul style="list-style-type: none"> <li>▪ Kainos are a consultancy and software house. Their flagship Electronic Medical Records (EMR) solution, Evolve, is digitising millions of paper records in hospitals.</li> </ul>
<b>Linnodee Diagnostics</b>	Diagnostics	<ul style="list-style-type: none"> <li>▪ Linnodee produces a range of rapid and reliable tests for laboratory diagnosis and on-farm detection of economically important diseases of production animals.</li> <li>▪ It focuses primarily on the veterinary sector, but has also applied its expertise in the field of medical diagnostics to the development of Leptorapide, a rapid test for the diagnosis of Leptospirosis in humans.</li> </ul>
<b>PathXL</b>	Digital pathology	<ul style="list-style-type: none"> <li>▪ PathXL is a global leader in providing integrated image and data solutions for digital pathology.</li> </ul>
<b>Provita</b>	Animal health products	<ul style="list-style-type: none"> <li>▪ Provita develops, manufactures and markets natural animal health products.</li> </ul>
<b>Redburn Solutions</b>	E-health	<ul style="list-style-type: none"> <li>▪ Redburn Solutions is a business integration company specialising in portals, mobile and business intelligence.</li> </ul>
<b>Sepha</b>	Pharmaceutical packaging	<ul style="list-style-type: none"> <li>▪ Sepha produces a comprehensive range of deblistering and leak detection machines for the blister packaging industry.</li> </ul>
<b>Sisaf Ltd</b>	Drug delivery	<ul style="list-style-type: none"> <li>▪ Sisaf is an innovative drug delivery company specialising in the design and formulation of topical delivery systems for a wide range of medical, cosmetic and skin care conditions.</li> </ul>
<b>Sophia Search Ltd</b>	E-health	<ul style="list-style-type: none"> <li>▪ Sophia Search develops software solutions and support services for the healthcare sector.</li> </ul>
<b>TG Eakin Limited</b>	Medical disposables	<ul style="list-style-type: none"> <li>▪ TG Eakin Limited is a medical device manufacturer, dedicated to the production of high-quality skin protection products for use in stoma and wound care.</li> </ul>
<b>Terumo</b>	Medical devices & diagnostics	<ul style="list-style-type: none"> <li>▪ Terumo BCT, a global leader in blood component and cellular technologies, is the only company with the unique combination of apheresis collections, manual and automated whole blood processing, and pathogen reduction coupled with leading technologies in therapeutic apheresis and cell processing.</li> </ul>
<b>Venn Life Sciences</b>	Clinical trials	<ul style="list-style-type: none"> <li>▪ Venn Life Sciences, formed in 2013, is a European CRO that provides clinical trials management services.</li> <li>▪ It operates in France, Germany, Ireland, the Netherlands and the UK.</li> <li>▪ It operates a clinical resourcing business, placing experienced clinical teams and individuals on projects throughout Europe.</li> </ul>
<b>Yarra Software</b>	E-health	<ul style="list-style-type: none"> <li>▪ Yarra develops software solutions and support services for the healthcare sector.</li> </ul>



In summarising the core capabilities in Northern Ireland in life & health sciences it is clear that definite strengths exists in agri health, medical disposables, e-health and pharmaceuticals. The disparate nature of the largest sub group - medical devices and diagnostics - placed downward pressure on the average score, but there are considerable strengths within the sub group with highly innovative companies such as Heartsine, Intellisens, Terumo, CIGA, Haemoband and Biocolor leading the way.

## 2.2.2 ACADEMIC RESEARCH DATA

The December 2014 REF results are a measure of academic performance and are a key indicator of performance in the academic sector. The REF results provide a measure that it is more relevant to the economy than the previous RAE results and capture changes which have arisen since the 2008 RAE results and subsequently will have a key impact of this report.

Welcoming the 2014 REF report, Minister Farry – DEL-NI said: “Our local universities are to be congratulated for the quality and strength of the research they have undertaken. These results confirm that our universities are undertaking internationally recognised research. Over 70% of the research activity submitted by QUB and UU was considered world leading or internationally excellent.”

The REF results, unlike the results of RAE 2008, include an assessment of the research impact (whether economic, societal or cultural) of each submitted unit.

QUB and UU submitted research in 30 of the 36 Units of Assessment to be considered under the REF.

## QUB REF RESULTS SHOWING INFORMATION BY UNIT OF ASSESSMENT

Unit of Assessment	%4*+3*	GPA	Research Power <sup>8</sup>	Research Power Rank	Research Intensity <sup>9</sup>	Research Intensity Rank	No. of submitting institutions	%4*+3* Research impact
UoA 1: Clinical Medicine	<b>70</b>	2.88	211.97	<b>19</b>	2.62	<b>8</b>	31	95
UoA 2: Public Health	<b>69</b>	2.89	85.54	<b>5</b>	2.85	<b>6</b>	32	70
UoA 3A: Pharmacy	<b>92</b>	3.36	110.88	<b>28</b>	3.36	<b>2</b>	94	100
UoA 3B: Nursing and Midwifery	<b>78</b>	2.91	55.38	<b>52</b>	2.91	<b>7</b>	94	100
UoA 4: Psychology Psychiatry and Neuroscience	<b>74</b>	2.99	74.5	<b>31</b>	23.85	<b>24</b>	82	100
UoA 6: Agriculture, Veterinary and Food Science	<b>84</b>	3.26	108.9	<b>11</b>	3.20	<b>1</b>	29	100
UoA 8: Chemistry	<b>82</b>	2.93	100.6	<b>18</b>	2.93	<b>13</b>	37	100

## UU REF RESULTS SHOWING INFORMATION BY UNIT OF ASSESSMENT

Unit of Assessment	4*/3*	GPA	Research Power	Research Power/GPA Rank	No. of submitting institutions	No. of submitting institutions	%4*+3* Research impact
UoA 3A: Nursing and Health Science	<b>86</b>	3.04	97.74	<b>33</b>	1.92	94	<b>100</b>
UoA 3B: Biomedical Sciences	<b>87</b>	3.24	240.08	<b>5</b>	2.50	94	<b>95</b>
UoA 13: Biomedical Engineering (Materials)	<b>79</b>	2.89	5.5	<b>19</b>	19.36	32	<b>100</b>

The rankings of some of these disciplines is compared against a multiple of headings and as new analysis appears towards the end of the REF announcements one can expect the rankings of nursing, biomedical sciences, biomaterials, pharmacy and others to be clearer.

<sup>8</sup> Research power is calculated by multiplying the Grade Point Average by the full-time equivalent number of staff submitted to the Unit of Assessment by the institution.

<sup>9</sup> Research intensity is calculated by multiplying the Grade Point Average by the proportion of eligible staff submitted to the Unit of Assessment by the institution.

## ACADEMIC CAPABILITY SUMMARY TABLE - QUB

Research Centre	Staff	Attracting External Funding?	Spin Out/ Licencing/ Collaborations	Measures of Esteem
The Centre for Cancer Research and Cell Biology	300	About £15m in last financial year	Almac Diagnostics PathXL Almac Discovery	One of the 15 UK Cancer Research UK Centres of Excellence.
Northern Ireland – Molecular Pathology Laboratory (NI-MPL)	10	£1m in first 15 months	Merck-Serono Leica Diagnostics Almac PathXL Randox Diagnostics	First integrated laboratory of its kind in the UK and Ireland accredited to perform molecular diagnostics
Centre for Infection and Immunity	Up to 200	Lead partners in new €6 million global research programme	Randox Celerion	A new €6 million global research programme, known as CF Matters.
Centre for Experimental Medicine	60	£32m supported by Wellcome-Wolfson  Fundors include Age UK, the EU and BBSRC		State-of-the art research facilities.  Partnering in €6 million EU-FP7 funded REDDSTAR project.
Centre for Public Health	30	£9m UKCRC grant 2013-2018	N/A	One of five UK Clinical Research Collaboration (CRC) centres of excellence. Launched NI's largest ever public health research project. Professor Mike Clarke is among 400 scientists named on the worldwide list of the most 'Highly Influential Biomedical Researchers'.
School of Pharmacy	Around 60	MRC, EPSRC and BBSRC as well as major charities	GSK Stevenage Warner Chilcott Ltd Merck KGaA Almac Discovery Fusion Antibodies Ltd	Dr. Ryan Donnelly was winner of the 2013 BBSRC 'Innovator of the Year' award.  The school has developed a number of substantial research relationships with industry. In collaborative partnerships with companies such as Almac Discovery and Fusion Antibodies Ltd., the school has developed novel therapeutics to inhibit tumour angiogenesis/metastasis. Pharmaceutical development of a microbicide-release vaginal ring product is now in Phase 3 trials. The school is also engaged in the out-licensing of drug delivery technologies and the development of products, including Ametop™ and Femring™.
School of Biological Sciences	Around 135	MRC, TSB, INI, EPSRC	N/A	Research conducted at the institute isolated and characterised the causative virus of post-weaning multisystemic wasting syndrome in pigs. Professor Chris Elliott spearheads a major initiative to develop techniques to safeguard the food supply. With partners across the globe, he is undertaking cutting edge research to develop early warning techniques to detect food contamination issues.

## ACADEMIC CAPABILITY SUMMARY TABLE – UNIVERSITY OF ULSTER

Research Centre	Staff	Attracting External Funding?	Spin out/Licencing/ Collaborations	Measures of Esteem
Biomedical Sciences Research Institute (BMSRI)	About 80	Norbrook (£1m) SAAD Group (£1.8m)  SRIF3 programme (£3.2m)	Collaboration: Randox, Altnagelvin Hospital, Norbrook.  Licensing: Nestle, Sanofi Aventis, DSM.  Spin out companies: Gendel Ltd, EFMB, Diabetica Ltd and more recently Jenarron Ltd.	In 2008 the BMSRI opened a new 4,000m <sup>2</sup> SAAD Centre for Pharmacy & Diabetes  2008: £2M 1,000m <sup>2</sup> Clinical Translational Research and Innovation Centre (C-TRIC).  Additional major clinical research centres opened as partnerships, including: the Northern Ireland Functional Brain Mapping Facility (£5.5m), 50% funded by Invest NI; and the £11.5m Northern Ireland Centre for Stratified Medicine with 22 new posts.
The Intelligent Systems Research Centre (ISRC)	About 30	ISRC was opened in 2006 with £20m invested by Invest NI, Ilex and UU	Interest from Merck, Biogen and Orasi.	The facility will be the only brain imaging system anywhere in Ireland and one of only a small number in the UK to use the recently developed brain imaging modality, magnetoencephalography (MEG), to measure brain activity.
Centre for Stratified Medicine	About 25	£11.5m facility - broken down as follows:  Invest NI (£ 5.6m) Department of Health (£1.5m) UU £4.4m	N/A	The new Northern Ireland Centre for Stratified Medicine is the only one of its kind on the island of Ireland.
Nanotechnology and Integrated Bioengineering Centre (NIBEC)	60	Since 2008 the Institute has announced a further £10M of funding including a £1.7m Research Council (EPSRC) grant in the area of Health Technology (MATCH); two multi-million pound cross-border collaborative projects funded by DEL, in Biosensors and Tissue Engineering and a major industrial START (£1M) programme with AVX Ltd in the field of Nanoparticle research.	Spin outs: Intelesens Heartsine Heartscape Spin in: SiSaf	The multi-million pound purpose-built facilities house some of the most sophisticated nano-fabrication, biological and characterisation equipment in the world.  NIBEC attracts on average £3m of research funding (EPSRC, TSB, INI, SFI, DEL, Wellcome Trust) per year.  NIBEC holds a current IP portfolio of 35 patents and the centre's international profile and impact is being constantly raised through numerous research collaborations between many leading UK/ROI universities (Cambridge, St Andrews, Glasgow, Birmingham, Brunel, Nottingham, DCU, TCD, Tyndall); numerous International collaborations across the globe and a cohort of industrial partners. It also supported by stakeholders from the NHS and other public sector organisations.



Institute of Nursing and Health Research	About 45	Institute external grant support from a variety of sources including government R&D Office, DHSSPS; DEL, charities (e.g. Wellcome Trust; Multiple Sclerosis Society, Northern Ireland; National MS Society, US) and industry.	The Centre for Health and Rehabilitation Technologies (CHaRT), one of five research centres within the institute, is the largest multidisciplinary grouping of allied health professionals, clinical scientists, and PhD students in the UK and Ireland.	Strong publication record in international journals, and external grant support from a variety of sources.  Centre for Intellectual and Developmental Disabilities has around 150 articles in peer reviewed journals and £1.5m in research income.  The Centre for Maternal, Foetal and Infant Research is the European co-ordinating centre of EUROCAT - European Surveillance of Congenital Anomalies, funded by European Commission DG Sanco Public Health Programme and a WHO Collaborating Centre for the Surveillance of Congenital anomalies.
Connected Health Innovation Centre (CHIC)	30 industry members	CHIC is the result of a £6.8m investment by a consortium of leading technology companies plus £5m R&D offer from Invest NI.	Collaborations are underway with a range of member companies.	CHIC has a £5m budget and over 30 signed up companies due to its unique industry led research.

See Appendix 1A for complete profiles on universities and research institutions in Northern Ireland.

### World Class Research & Facilities

In addition to Northern Ireland's two main universities examined above there is a range of profiles of individual research centres and facilities in Appendix 1A.

These detailed profiles include overviews of the following research centres:

- The Centre for Cancer Research and Cell Biology
- Molecular Pathology and Bio-banking
- Centre for Infection and Immunity
- Centre for Experimental Medicine
- The Centre for Public Health
- Queens School of Pharmacy
- The Institute for Global Food Security (not covered in the report)
- University of Ulster: The Biomedical Science Research Institute (BMSRI)
- University of Ulster: The Centre for Stratified Medicine
- University of Ulster: NIBEC Nanotechnology and Integrated Bio-engineering sector
- University of Ulster: Intelligent Systems Centre
- University of Ulster: Institute of Nursing and Health Research
- University of Ulster: School of Biomedical Sciences
- University of Ulster: Smart Environments Research Centre
- The Connected Health Innovation Centre



## 2.2.3 PUBLIC SECTOR

The Northern Ireland public health and social care sectors are a highly significant driver of economic performance. Not only does the sector support approximately 66,000 jobs, it has an annual budget of around £4.5b. With this scale of purchasing power and with increasing pressures on healthcare resources and budgets, the Northern Ireland HSC sector is a key driving force for the life & health sciences sector. In addition, it has the capacity to produce large, unique and transformational data sets that could be used to further disease management and therapeutic development.

R&D plays a central role in the planning and delivery of HSC. With an annual budget of around £12m, HSC R&D supports research and works closely with clinical and academic researchers based in HSC trusts and universities, policy-makers, practitioners and members of the public, including patients and clients, other public sector organizations, charities and businesses across the UK and internationally.

The importance of public sector health R&D will be dealt with later in this chapter. Before that, an overview of the sector specific infrastructure and capabilities will be provided. Northern Ireland has a number of important sector specific bodies and networks. The Northern Ireland Clinical Research Network (NICRN), for example, has facilitated 30 clinical trials in the five HSC trusts in the field of diabetes which have generated over £1.2m in additional income and benefited over 2,000 patients between 2008 and 2012. The following sections outline Northern Ireland's public infrastructure and sector specific capabilities. These include:

- clinical trials capability
- Northern Ireland's 'big data' capability
- Northern Ireland's connected health ecosystem
- The Northern Ireland Biobank
- Northern Ireland Cancer Trials Centre (NICTC) and Network (NICTN)
- cardiovascular capability

## 2.2.4 PUBLIC INFRASTRUCTURE AND CAPABILITY

### Clinical trials capability

Northern Ireland is gathering increased momentum around providing clinical trial services to the world's leading pharmaceutical companies. Companies, university centres and the Northern Ireland health service now offer a complete range of services including protocol design, management of clinical supplies, lead investigators, trial management, statistical analysis and production of reports.

The Northern Ireland Clinical Research Network develops and enables a well-resourced network of skilled staff which provides investigators and patients from throughout Northern Ireland with access to and help in developing high quality clinical research studies across all HSC structures.

Funded by HSC R&D, the aims of the NICRN are:

- to promote research within Northern Ireland
- to develop close partnerships and productive working relationships with key individuals and groups across the network and the wider research community
- to ensure that targets, including accrual of patients into trials, are achieved and maintained.

The NICRN provides single-point access to the NHS and encompasses the hospital, community and primary care sectors in Northern Ireland. The NICRN co-ordinating centre works with industry to remove barriers and reduce start-up times. It adds value by facilitating standard contractual agreements providing a cadre of expert clinical staff and assures delivery of target accruals.

The NICRN is funded by HSC R&D and supports high quality clinical trials across all HSC trusts. The NICRN received £5.5m in funding from HSC R&D from 2006/07 to 2011/12 (an average of £900k per annum).

The NICRN comprises of ten special interest groups, each headed by a prominent, specialist clinician. The special interest groups are:

- critical care
- child health
- dementia
- diabetes
- heart disease
- primary care
- renal
- respiratory medicine
- stroke
- vision<sup>10</sup>.

There has been very significant investment in clinical infrastructure to support clinical trials, including a UK Clinical Research Collaboration registered clinical trials unit and a £4m clinical research facility supported by the Wellcome Trust and Wolfson Foundation. The Northern Ireland Clinical Research Facility was established in order to provide state-of-the-art facilities to support clinical research.

The NICRF is a joint venture with the HSC, QUB and UU.

The capability to perform well-designed early phase clinical trials is a critical key step in translational research. The progression of research projects from lab to clinic is facilitated by close proximity to the Belfast City Hospital and Royal Victoria hospital campuses and excellent scientist-clinician relationships.

Northern Ireland's capacity to deliver Phase I to Phase IV clinical trials in areas such as cancer, diabetes, eye disease and respiratory disease is of major benefit to research themes and industrial collaborations within the Institute of Health Sciences at QUB, for example the Northern Ireland Clinical Trials Centre, Almac and the Centre for Cancer Research and Cell Biology (QUB) are currently collaborating on a pilot study in patients receiving neoadjuvant therapy.

<sup>10</sup> <http://www.dhsspsni.gov.uk/evaluation-hsc-rd-final-report-june-2012.pdf>

## Cardiovascular capability

Craigavon Cardiovascular Research Unit is a modern purpose built research facility which is positioned strategically beside a cardiac catheterisation suite. The unit is one of the most active clinical trials centres in the UK with an expertise in the area of cardiovascular therapeutics, interventional cardiology (including new stent designs, drug elution/biodegradable polymers, bifurcation devices, left main intervention, advanced coronary imaging, renal denervation), electrophysiology (including atrial fibrillation, implantable devices, AED technology, resuscitation science, novel medical sensor technology), cardiovascular diagnostics and cardiovascular pharmacology trials.

David McEneaney the Director of the Cardiovascular Research Unit, Craigavon Area Hospital has been a co-investigator in more than twenty clinical trials of cardiovascular therapeutic agents and devices<sup>11</sup>.

The unit has a reputation for its streamlined administrative process, experienced researchers (with consultants often serving as national principal investigators or trials leads) and high quality of data management. The unit is closely integrated with the Centre for Advanced Cardiovascular Research in the Nanotechnology and Integrated Biotechnology Centre (NIBEC), University of Ulster<sup>12</sup>.

## Northern Ireland Cancer Trials Centre (NICTC) and Network (NICTN)

NICTC and NICTN are jointly funded by HSC R&D and Cancer Research UK (CR-UK). This joint financial support is augmented by additional core funding to support network activities by HSC R&D Division. NICTN promotes high quality cancer care in Northern Ireland by inclusion of patients on a geographically more equitable basis into cancer clinical trials, translational research and other well-organised cancer research studies.

NICTC is part of the Experimental Cancer Medicine Centre (ECMC) Network, a network of 18 centres across the UK driving the delivery of early phase and translational cancer research. The centre provides a full range of first-in-human Phase I to Phase IV trials, along with genetic epidemiology, questionnaire, quality of life, translational and other high quality studies.

The established capabilities and strengths of NICTN lie in the following areas of clinical and translational research; haematological malignancy, GI, GU, gynaecological, breast and lung cancer, radiation and paediatric oncology. Other priority areas for NICTN going forward include:

- supportive and palliative care
- surgical trials
- imaging trials
- prevention and early diagnosis trials; and
- survivorship studies.

The NICTN builds on the work of the NICTC to deliver the highest quality and standard of care to cancer patients through leading edge clinical and translational research. The network achieves this by:

- ensuring high quality patient care by participation in clinical research
- co-ordinating and promoting cancer clinical trial activity throughout Northern Ireland
- driving the development of early phase cancer clinical research
- integrating with QUB and UU basic science and translational research programmes
- developing and training clinical research staff.

NICTN staff are present in all five HSC trusts across Northern Ireland, allowing the inclusion of patients on a geographically equitable basis into a proportion of their clinical trials and translational research. NICTC is responsible for the co-ordination of this activity throughout Northern Ireland, particularly Phase III trials and epidemiology studies.

<sup>11</sup> <http://www.intelesens.com/about/cabdme.html>

<sup>12</sup> <http://secure.investni.com/static/library/invest-ni/documents/life-life-sciences-sector-capability-brochure-bio2014.pdf>



## Northern Ireland's 'big data' capability

The healthcare sector is typically characterised as being reactive and an early adaptor of new methods and technologies; it needs to be in order to ensure best care is given to patients. The National Institute for Health Research (NIHR), for example, has a series of biomedical research centres and units based across the UK in NHS and university partnerships. These centres act as early adopters of new technologies and techniques and drive the translation of fundamental biomedical research into clinical research that benefits patients.

Additionally in Northern Ireland the Centre for Connected Health and Social Care promotes improvements through the use of technology and fast-tracks new products and innovation into the health and social care system.

With this in mind, it is clear that the rise of 'big data' is going to provide many opportunities for companies and over 200 non-fee-paying members who are able to exploit its healthcare applications.

The last decade has seen the rapid digitisation of patient records and years of aggregated research and clinical trials data. A large, and ever growing, bank of data is now available and increasing numbers of stakeholders are now looking to develop applications and tools to identify value and opportunities within this.

Northern Ireland has been chosen as one of four UK locations to host a new £7m 'big data' centre. The Northern Ireland centre is a joint partnership between QUB and UU, funded by the Economic and Social Research Council (ESRC) and HSC R&D.

The facility will aim to help unlock the research potential of the vast amounts of administrative data collected on a daily basis. The project will aim to combine different administrative datasets to provide a better understanding of the social, environmental and health issues that affect people's lives and to contribute more robust evidence to inform policy development and evaluation.

The Honest Broker Service enables the provision of anonymised, aggregated and in some cases pseudonymised health and social care data to HSC organisations, and anonymised data for ethically approved health and social care related research. The aim is to enable non-identifiable data to be shared within HSC to maximise the uses and health service benefits which can be gained from it, including planning, commissioning of services and public health monitoring.

Big data offers a range of potential benefits. It could be used, for example, to directly link prescribing within target groups to the needs of that same population. With appropriate data linkage it would be possible to identify how many patients received what medication following an in-patient surgical procedure, and to determine whether this was consistent with current best practice<sup>13</sup>.

The use of big data has already transformed the way diabetes is managed and treated in Scotland, culminating in the production of an information rich database containing a large number of patients that have agreed to take part in clinical research on diabetes and making patient recruitment into clinical trials very fast and successful. It has improved clinical outcomes and the quality of care of patients with diabetes in Scotland, with decreased amputation rates and decreasing rates of diabetic retinopathy<sup>14</sup>.

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<sup>13</sup> <http://www.ehi.co.uk/resources/industry-view/126>

<sup>14</sup> UKTI Proposition – Unlock your Global Business Potential: The UK digital health and care opportunity'



## Northern Ireland's Connected Health Ecosystem

The Connected Health Innovation Centre (CHIC) is focused on business led research in the area of connected health. CHIC seeks to lead transformational research which aligns care needs with technology providers, researchers and clinical experience. CHIC targets research in areas such as e-health, digital health, tele-health, tele-monitoring, disease management, and home based care. Key focuses for the research are vital signs sensing development, integrated care, assisted living and point of care diagnostics. Its membership of approximately 25 fee paying companies covers a broad section of Northern Ireland's connected health sector.

Companies include:

- Accenture: A global management consulting, technology services and outsourcing company, with approximately 261,000 people serving clients in more than 120 countries.
- I+: An SME working in e-health and ambient assisted living systems. I+ has specific expertise in distributed architecture for data sharing and integration of heterogeneous data sources, modelling and development of system intelligence.
- Randox: Home grown, international clinical diagnostic company. Randox develops, manufactures and markets diagnostic reagents and equipment for laboratory medicine, with a distribution network of 130 countries.

## ECHA

European Connected Health Alliance (ECHA) is a not for profit, community interest company designed to bring people and organisations in the life and health science industries together. It provides a much needed partnership of organisations, companies and government bodies, facilitating transformation in healthcare delivery and the creation of economic benefits. Its international network provides opportunities to learn from other regions, share challenges and identify common solutions.

In bringing together commercial, academic and healthcare stakeholders, ECHA facilitates focused leadership for the development of connected health markets across Europe and beyond.

The primary focuses of ECHA are:

- Promotion of connected health – to provide leadership, education and focus supporting European and global implementation of connected health technologies.
- Development of connected health capabilities – to secure and engage in collaborative research and development.
- Participant and member support – to support the strategic and tactical marketing and business development needs of ECHA members.
- Education – to develop and provide educational opportunities, in support of broad scale deployments of connected health.
- Development of an international network of permanent connected health ecosystem.
- Connected Health Integration Platform (CHIP) – CHIP is an initiative underway in Northern Ireland which builds upon the regional deployment of a populated Electronic Care Record, to define a generic interface for the development and deployment of HSC applications and also to facilitate the migration from legacy to future health support systems.

## The Northern Ireland Biobank (NIB)

NIB is a collaborative project between QUB and the Belfast HSC Trust (BHSCT). The vision of the biobank is to host and distribute a collection of well defined, quality assured biological samples to support translational research programmes in Northern Ireland and beyond. NIB has approval from ORECNI (reference 11/NI/0013) to collect, store and distribute samples, including tumour and non-tumour control tissues and patient-matched blood samples with urine and saliva samples when appropriate, to researchers.

Phase 1 of the Northern Ireland Biobank, led by CCRCB researchers Dr Jacqueline James and Professor Peter Hamilton, established a collection of high quality tumour tissues and bloods from consenting patients being treated for cancer in the Belfast HSC Trust. This bank of tumour samples complements both the Experimental Cancer Medicine Centre (ECMC) and the CR-UK Centre initiatives within CCRCB and will promote translational cancer research across the School of Medicine, Dentistry and Biomedical Sciences.

The local digital pathology company PathXL was awarded the tender by QUB to create and support the IT system for the Biobank<sup>15</sup>. Financial support for the NIB initiative has been secured from HSC R&D Division of the Public Health Agency, Cancer Research-UK and the Belfast Friends of the Cancer Centre. Queens University is the host institution and will administer the award. The NIB Steering Committee oversees the good practices of the bank.

The tumour samples held in the Northern Ireland Biobank are surplus to clinical need and are redirected to the CCRCB by Belfast HSC Trust pathologists. Tissue and bloods are accrued from individuals with gastrointestinal, breast, lung, head and neck, gynaecological and genitourinary malignancies; the bank will also support the storage of samples retained during trials undertaken in the Northern Ireland Cancer Clinical Trials Centre and Network. The Northern Ireland Biobank is supported by a secure information management system which will be accessible to data managers in the Northern Ireland Cancer Registry<sup>16</sup>.

NIB works closely with the trust's Tissue Pathology Department to access the NHS tissue archives and thereby further enhance the biobank resources through the selective creation of unique tissue microarrays (TMAs) and DNA libraries for particular cancer types. All of these samples are linked anonymously with robust clinical outcome data which we have been able to gather through partnerships with clinical care teams in the trust.

Working closely with the Northern Ireland Molecular Pathology Laboratory (NI-MPL), NIB has been able to rapidly facilitate translational cancer researchers, resulting already in a number of high impact publications.

## MRC All Ireland Hub for Trials Methodology Research

The hub was established in March 2011 and is co-hosted by QUB and UU in Northern Ireland, with hub director, Professor Mike Clarke, based in the Centre for Public Health at QUB.

The main areas of focus for the hub include:

- Identification of the research priorities of practitioners, patients and the public, and the implementation of clinical trials in these areas (with a particular focus on public health and mental health).
- Methods to keep these trials simple and pragmatic.
- Development of methods to improve the use of systematic reviews in the design, conduct and interpretation of clinical trials.
- Evaluation of different means of presenting the findings of trials (to target decision makers and policy makers), with comparisons of various techniques, including the use of social media.
- Use of record linkage data and information available in the Northern Ireland Cancer Registry and other databanks to identify potential participants for research and to target the dissemination of research findings.

<sup>15</sup> <http://www.nibiobank.org/documents/news/FINAL%20CCRCB%20Bulletin%20December%202010.pdf>

<sup>16</sup> <http://www.publichealth.hscni.net/sites/default/files/directorates/files/Research%20Infrastructure.pdf>



## **R&D infrastructure**

The remit of HSC R&D is to support research that delivers benefits for patients, clients, services and professionals, as well as the general population. The outgoing R&D strategy was based around five strategic priorities which are:

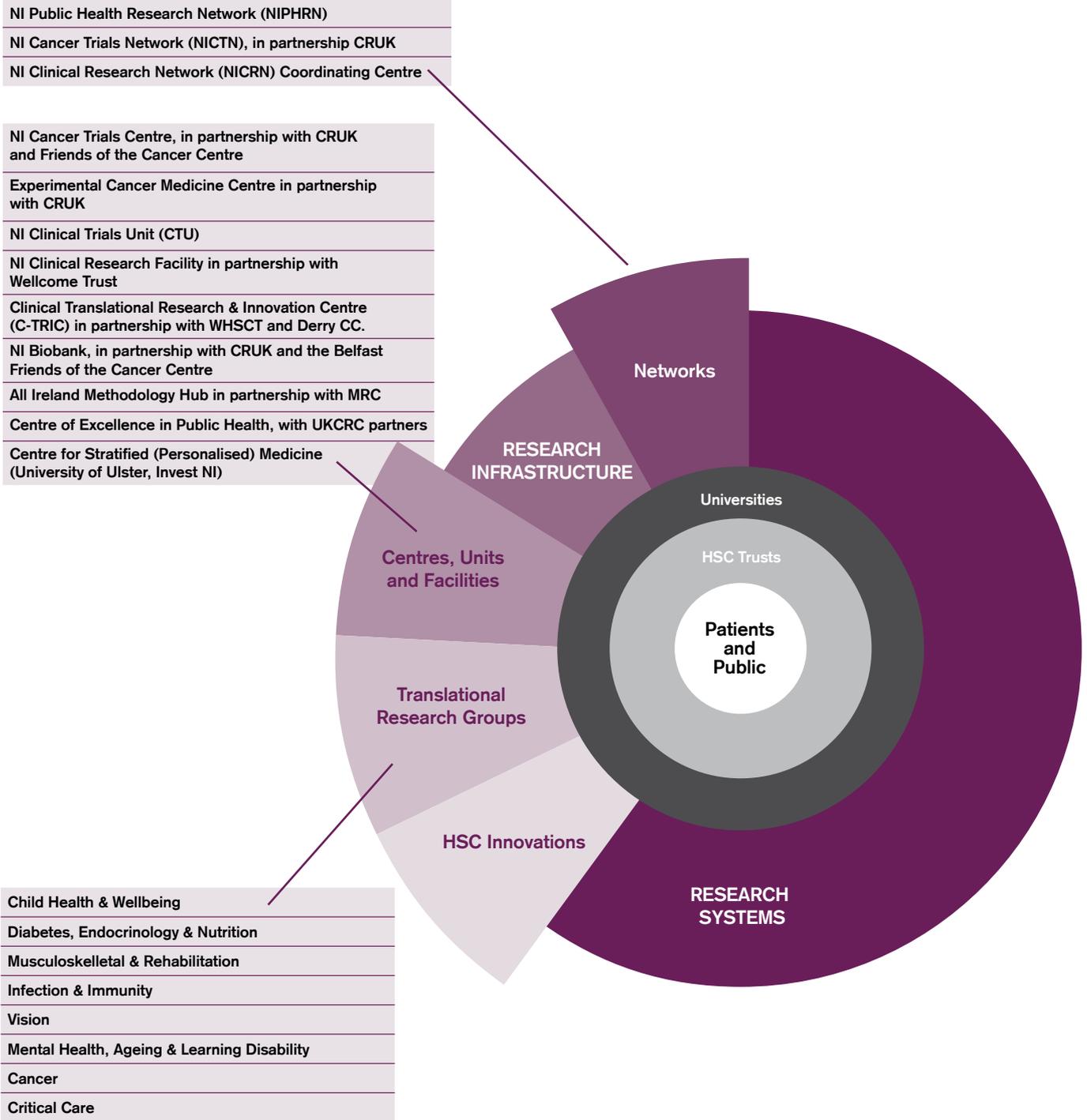
- developing and enabling infrastructure;
- building research capacity;
- funding R&D;
- supporting innovation by translating R&D into practice; and
- ensuring patient and public involvement.

A new Strategy for Health and Social Care Research and Development in Northern Ireland has been issued for consultation. Four objectives underpin this new strategy. These are:

- To support research, researchers and the use of evidence from research to improve the quality of both health and social care and for better policy making.
- To compete successfully for R&D funding and optimise local funding to deliver returns on investment for health and wellbeing, academia and commerce.
- To support all those who contribute to health and social care research, development and innovation by enhancing our research infrastructure, benefitting from local, national and international partnerships.
- To increase the emphasis on research relevant to the priorities of the local population.

The research infrastructure within the HSC is a collaborative effort across a range of networks, centres and translational research groups. These, as well as programme and systems are shown below.

**FIGURE 8 – ILLUSTRATION OF THE NORTHERN IRELAND COLLABORATIVE RESEARCH STRUCTURE**



## NORTHERN IRELAND HSC RESEARCH INFRASTRUCTURE

Infrastructure Element	Purpose
HSC R&D	To support the development of HSC research and manage trust research governance, including the costing of research proposals and agreement of research contracts using standardised methodologies.
Data	<p>ADRC: Administrative Data Research Centre enables research on routinely collected, population-based data</p> <p>HBS: Honest Broker Service makes available appropriately anonymised data collected via HSC organisations and primary care services</p>
Research Networks	<p>Provide a framework for clinical academic oversight of HSC research; provide experienced staff to support project development, management and performance</p> <p>NICRN: Northern Ireland Clinical Research Network</p> <p>NICTC/NICTN: Northern Ireland Cancer Trials Centre / Network</p> <p>NIPHRN: Northern Ireland Public Health Research Network</p>
Clinical Research Facility	<p>NICRF: Provides access to high quality, appropriately supported facilities for clinical research</p> <p>Also provided by C-TRIC (Clinical-Translational Research Innovation Centre)</p>
Clinical Trials Unit	<p>NICTU: UKCRC-accredited to provide expertise in research design, statistics, health economics, data monitoring and management to support HSC research. Works closely with MRC All Ireland Methodology Research Hub</p>
Intellectual Property Advice and Management	HSC Innovations on behalf of all HSC trusts
Research Ethics Committees	ORECNI: Manages a regional research ethics service, independently of HSC R&D or trusts
Northern Ireland Biobank	Collects and stores cell and tissue samples under high quality, ethically-approved conditions for provision to researchers



HSC R&D supports research that provides high quality evidence to improve care for patients, clients and the general population, and adds to our understanding of health, disease, treatment and care. It works closely with clinical and academic researchers based in HSC and universities, policy-makers, practitioners and members of the public, including patients and clients, other public sector organizations, charities and businesses that are involved in health and social care research across the UK and internationally.

HSC Innovations provides the intellectual property management service for Health and Social Care employees throughout Northern Ireland. The service was established to support the identification and development of new ideas arising from Northern Ireland's HSC organisations.

Initially funded jointly by Invest NI, the Department for Business, Innovation and Skills and HSC R&D, the service is currently funded solely by HSC R&D.

This service has been set up to provide Health and Social Care employees with support for the identification, assessment and development of new ideas and technologies and to ensure that intellectual property rights are protected and managed so that new products that provide benefits for patients can be developed. HSC Innovations also provides an interface for external organisations who wish to collaborate with health and social care employees/organisations in developing these ideas into products.

Through the provision of expertise and links to financial support it is able to drive forward technology transfer projects from the identification and assessment of ideas through to the development and commercialisation of healthcare products. HSC R&D generates significant multiplier effects such as the following: the annual budget of £12m leverages an additional £4.14 of R&D spending for every £1 invested<sup>17</sup>.

Additionally one in five funded studies is impacting positively on increased length or quality of life<sup>18</sup>.

The total HSC R&D budget per capita in Northern Ireland, however, is significantly less than the rest of the UK (at £7.63 it is less than half that in England).

## **AFBI<sup>19</sup>**

Treating the LHS sector in the broad terms of this study brings the Agri Food Bio Institute (AFBI) into view. Originally part of the Department of Agriculture and Rural Development (DARD), the AFBI is the largest public sector science and technology organisation in Northern Ireland with around 800 people. They were formed as an NDPB in 2006 with an approximate annual budget of £40M. DARD retains the strategic direction role for the sector within Northern Ireland and AFBI exists to operationalise part of that direction. The organisation has specialists in plant science, veterinary science, agriculture, food & environmental science and economics. The primary role relates to the strategy and activity of DARD although they have received additional funding from other sources.

AFBI has a responsibility to provide an emergency response capability to DARD and other government departments in the event of national emergencies (e.g. situations such as the foot-and-mouth epidemic).

A key strength of AFBI is in the multidisciplinary skills (veterinary science, plant science, agriculture, food and environmental science, and economics) available across the institute and the ability to bring these skills to bear on real problems.

The organisation has a diverse range of resources such as its extensive library, a seagoing vessel for analysis of maritime environments and reference laboratories for a range of areas such as milk testing. It has internationally recognised capability and has been building significant links in China on the strength of its international reputation.

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<sup>17</sup> Results from an independent evaluation conducted by RSM McClure Watters.

<sup>18</sup> Results from an independent evaluation conducted by RSM McClure Watters.

<sup>19</sup> The area of animal health and agri food could not be addressed in enough detail as part of this capability assessment and foresight exercise. This particular scope could be addressed in a separate exercise. AFBI's emerging capabilities constitute an opportunity.

## KEY LEARNINGS FOR NORTHERN IRELAND

<b>Key Learning 1</b>	While much 'air time' is devoted to the potential for connected health to offer significant health and wealth returns, the sector remains dominated by traditional, highly innovative and outward looking firms. These anchor organisations are most likely to continue driving significant growth in the sector.
<b>Key Learning 2</b>	There are significant 'pockets of excellence' across the sector in both an innovation and outward looking context.
<b>Key Learning 3</b>	While there are clearly evidenced, demonstrable outcomes from HSC R&D efforts, it should be noted that the total HSC budget is significantly less in Northern Ireland per capita than in the rest of the UK. In addition, Northern Ireland is widely perceived to be a slow adopter of new and innovative medicines and clinical procedures, with significant barriers to entry in place through inefficient procurement methods.
<b>Key Learning 4</b>	A clear message coming from the research is that collaboration has increased within Northern Ireland's life & health sciences ecosystem. There are several initiatives that have driven this behaviour but a significant point raised during consultations was that funding applications are increasingly demanding collaboration between industry and academia and it is this that is driving collaborative behaviour.
<b>Key Learning 5</b>	The academic sector has proven that it has a significant capability across a range of areas. Academia is also playing a much increased role in collaboration with the private sector.

## SUMMARISED SWOT OF CAPABILITIES OF NORTHERN IRELAND LHS ECOSYSTEM

The following table summarises a SWOT analysis resulting from the ecosystem capability assessment exercise;

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>▪ Proximity between business, academia, Government and HSC</li> <li>▪ Recognised strengths in oncology, cardiology devices, diagnostics and precision medicine</li> <li>▪ Strong research base with an international reputation</li> <li>▪ Flexibility and reactivity to market needs and demands</li> <li>▪ Solid indigenous base including three major employers</li> <li>▪ Integrated HSC</li> </ul>	<ul style="list-style-type: none"> <li>▪ Degree of insularity within some local LHS sectors</li> <li>▪ Lack of dedicated leadership in the sector</li> <li>▪ Inconsistent and piecemeal approach to fundraising</li> <li>▪ Low international profile</li> <li>▪ Small economy - critical mass</li> <li>▪ Lack of FDI</li> <li>▪ Bureaucratic mindset</li> <li>▪ Capability linked to funding attraction</li> <li>▪ Commercialisation capability</li> <li>▪ Product development not centred on patient needs</li> <li>▪ Fragmentation of stakeholders across a multitude of boards and networks</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>▪ Massive worldwide growth and strong market drivers</li> <li>▪ Invest NI support and funding potential</li> <li>▪ Strong Government fiscal incentives, both existing and planned, such as R&amp;D tax credit schemes (available since 2007), Patent Box (implemented April 2012) and the potential future corporation tax advantage</li> <li>▪ Branding - Northern Ireland is known globally and the brand can be built on (perhaps around cardio heritage to begin with)</li> <li>▪ Catapult funding</li> <li>▪ Private healthcare services</li> <li>▪ Big data - utilising Northern Ireland's IT skills</li> <li>▪ Engineering skills</li> <li>▪ Innovative or locally biased procurement</li> <li>▪ Maximising the innovation potential of the HSC</li> </ul>	<ul style="list-style-type: none"> <li>▪ Much of the industry focus is shifting to East Asian markets</li> <li>▪ Very close to LHS industries and supply chains in RoI, Scotland and South East England (though this could also be an opportunity)</li> <li>▪ Lack of direction from Government - not currently focused on LHS</li> <li>▪ Brain drain reducing availability of appropriately skilled workers</li> <li>▪ Over-regulation at EU level driving pharma overseas</li> <li>▪ Failure to keep pace with other, stronger regions</li> <li>▪ Lack of commercial focus or drive</li> <li>▪ Negative innovation ranking and general image of Northern Ireland</li> <li>▪ Lack of facilities</li> <li>▪ Innovative or locally biased procurement</li> <li>▪ Maximising the innovation potential of the HSC</li> </ul>

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UK & INTERNATIONAL PERSPECTIVE

3



## 3 UK & INTERNATIONAL PERSPECTIVE

Life & health sciences is one of the priority sectors that has been identified by the Northern Ireland Executive. In its Programme for Government 2011-2015, the Executive committed to growing the economy and to modernising the delivery of the local health service. In recent years, Northern Ireland industry, academia and Government have made significant commitments to the development of our LHS capabilities. However, the sector is highly competitive and many other world regions are also concentrating on strengthening their offers.

The last chapter dealt with the existing and emerging capability within the LHS sector. Chapter 3 deals with how Northern Ireland is using the sectoral capabilities and strengths that it has to attract FDI. Northern Ireland has underachieved somewhat in its ability to attract foreign investment. This is in spite of two leading universities, several large life science firms indigenous to the country and a range of funding and support available from the public sector.

This chapter also looks at how the sector compares internationally. This breaks down as follows:

- An overview of Northern Ireland LHS FDI activity or FDI perspective by source countries of investment, primary industry of FDI and main activity of FDI.
- An international comparator assessment of LHS in other countries and regions. These include Scotland, Singapore, the Republic of Ireland and San Diego.
- A national benchmarking exercise comparing the cost to quality ratios across a number of LHS sub-sectors.
- A section outlining the main conclusions or learnings for Northern Ireland's, including limited success in attracting FDI and areas of future growth.

## 3.1 NORTHERN IRELAND CONTEXT

Northern Ireland's life and health sciences sector is one of considerable strengths with a growing focus on collaboration between the academic, business and clinical (ABC) sectors which is improving the perception of the country among foreign potential investors.

### 3.1.1 ACADEMIC SECTOR

Northern Ireland's two world-class universities and six regional colleges of further and higher education provide the country with a strong science base and continual development of a highly skilled workforce.

Northern Ireland's six regional colleges are key economic drivers. They directly meet the training needs of local and international companies and provide a full suite of business support services, including product development and rapid prototyping. The colleges are the largest provider of professional and technical training in the region. They make a significant, high quality contribution to addressing the current and future skills needs of local and regional business<sup>20</sup>.

The colleges have a strong engagement with industry, offering training and learning development through further and higher education with employers across Northern Ireland. Through the DEL funded employer support programme the six FE colleges collaborate across a number of priority sectors, including the life sciences, in delivering a range of mentoring and business support programmes to SMEs<sup>21</sup>.

In the 2012/13 academic year there were around 10,100 students studying life science related courses in Northern Ireland<sup>22</sup>. These courses cover fields including pharmacology, biotechnology, food sciences and veterinary sciences.

QUB is internationally recognised as a leading institute in a broad range of life science sectors. The university has a strong track record of high quality research that links academic teams with clinical end users in state of the art, dedicated research centres in partnership with industry and the NHS. Key research centres include the McClay Research Centre for Pharmaceutical Sciences, the Centre for Cancer Research and Cell Biology (CCRCB), the Centre for Infection and Immunity (Cii), the Centre for Experimental Medicine (CEM), the School of Pharmacy and the Centre for Public Health (CPH).

UU is one of the largest universities in the UK and is a strong centre for life science research. The university also states that it is strongly committed to the inclusive economic, social and cultural advancement of Northern Ireland and to the enhancement of its reputation globally.

Key centres of research include the Biomedical Sciences Research Institute (BMSRI), Centre for Stratified Medicine in Ageing, Nanotechnology and Integrated Bioengineering Centre (NIBEC), the Clinical Translational Research and Innovation Centre (C-TRIC), the Centre for Cardiovascular Research (CACR), the Connected Health Innovation Centre (CHIC).

### 3.1.2 BUSINESS SECTOR

Northern Ireland's LHS business sector is comprised of approximately 130 companies employing around 7,500 people<sup>23</sup>. A large proportion of this number deal in pharmaceuticals, medical devices and solutions (screening, imaging etc.) but diagnostics, clinical trials and agri-health are also represented. Key companies in the sector include Almac group, Norbrook holdings, Randox Laboratories, Actavis and Terumo BCT.

There is also a growing connected health sector in the region. Around 60 companies are currently involved in this innovative sector and the number is likely to increase significantly over the coming years as the technologies become more embedded into the health sector and the number of potential applications increase. Key companies in this sector include Kainos, Novosco, Aura Healthcare Ltd and Total Mobile.

Northern Ireland has significant strengths in sales generated from foreign markets – around 80% of the estimated £900m annual turnover is generated through exports. Further developing Northern Ireland's reputation globally should be a key focus of all stakeholders involved in the sector.

### 3.1.3 CLINICAL SECTOR

The clinical sector in Northern Ireland is taking a more prominent role in R&D and the commercialisation of novel products than ever before. The DHSSPS allocates a sum annually to the HSC R&D fund which is used to support, commission or directly conduct research across a broad spectrum of fields within the sector.

The work of the R&D office for Health and Personal Social Services and the research it supports is funded by the HPSS R&D Fund. In 2014-15 a total of £14.3 m will be administered by HSC R&D Division. This includes:

- capacity building initiatives (approximately £2m per annum)
- infrastructure support (approximately £6m per annum).

<sup>20</sup> <http://www.anic.ac.uk/business-overview.aspx>

<sup>21</sup> <http://www.anic.ac.uk/business-overview.aspx>

<sup>22</sup> HESA Student Data 2012/2013

<sup>23</sup> <http://niassembly.gov.uk/Assembly-Business/Official-Report/Committee-Minutes-of-Evidence/Session-2014-2015/October-2014/Life-and-Health-Sciences-Sector-Invest-NI/>

## 3.2 FDI PERSPECTIVE

Although a relatively small sector by comparison to other regions of the UK, Northern Ireland has underachieved somewhat in its ability to attract foreign investment. This is in spite of two leading universities, several large life science firms indigenous to the region and a range of funding and support available from the public sector.

### Northern Ireland FDI

Between January 2003 and May 2014, there had been a total of 14 foreign investments made into Northern Ireland in the life sciences sector. These projects represented a total capital investment of £73.5m and created 1,146 jobs for the local economy. The 14 FDI projects were a 50:50 split between new and expansions with the majority of the Capex and jobs created, £52m and 865 respectively, coming through the expansion projects.

### ANNUAL LIFE SCIENCE FDI INTO NORTHERN IRELAND (2003-2014)

Year	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
2013	2	11.3	5.7	449	224	2
2012	1	3.4	3.4	50	50	1
2011	1	0.2	0.2	10	10	1
2010	1	10.5	10.5	53	53	1
2009	3	9.4	3.1	102	34	3
2008	2	24.1	12.1	249	124	2
2007	1	3.3	3.3	37	37	1
2005	1	8.0	8.0	86	86	1
2004	1	0.2	0.2	10	10	1
2003	1	3.1	3.1	100	100	1

The United States of America, which has the LHS sector in the world, was the most important source market for FDI into Northern Ireland over the last decade.

### SOURCE COUNTRIES OF LIFE SCIENCE INVESTMENT INTO NORTHERN IRELAND (2003-2014)

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
United States	9	41.2	4.6	369	41	8
Sweden	2	26.1	13.0	321	160	1
Japan	1	3.9	3.9	416	416	1
Ireland	1	0.2	0.2	10	10	1
Netherlands	1	2.1	2.1	30	30	1

Medical devices, pharmaceuticals, biotechnology and software and IT services were the key LHS sources of FDI into Northern Ireland. The medical device projects, in particular, resulted in significant capital investment and job creation.

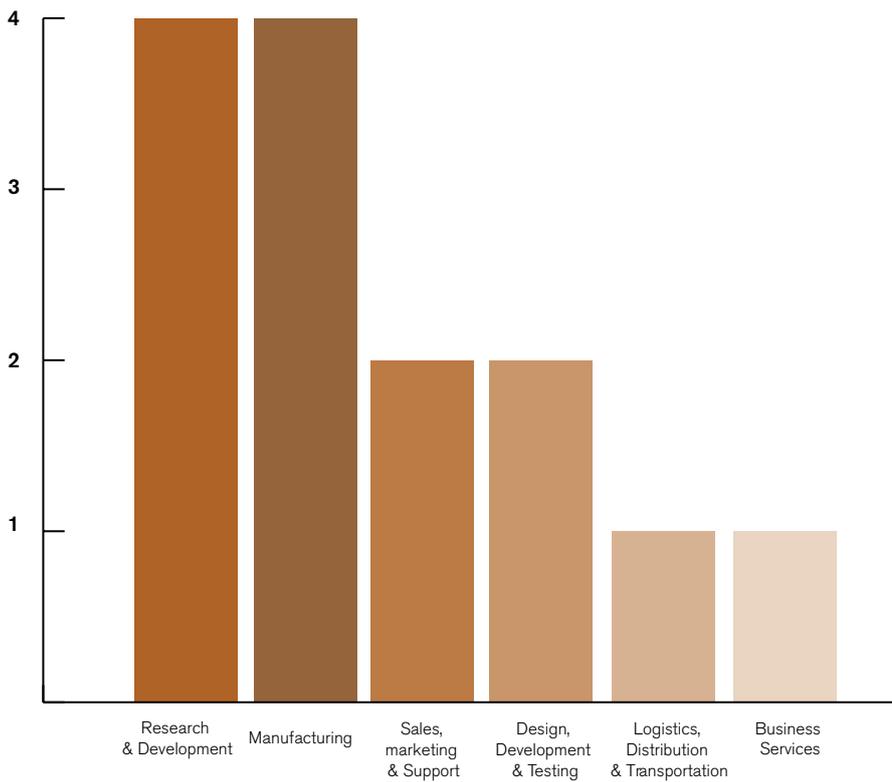


**PRIMARY SECTOR OF COMPANIES INVESTING IN NORTHERN IRELAND IN THE LIFE SCIENCES CLUSTER (2003-2014)**

Industry Sector	Projects	Capex	Avg Capex	Jobs Created	Avg Jobs	Companies
Medical Devices	4	30.2	7.6	747	186	3
Pharmaceuticals	3	19.6	6.5	167	55	2
Software & IT services	3	9.8	3.3	140	46	3
Biotechnology	2	10.7	5.4	70	35	2
Healthcare	1	0.2	0.2	10	10	1
Plastics	1	3.0	3.0	12	12	1

R&D and manufacturing were the most important FDI project activities in Northern Ireland. These activities generally provide significant Capex and job creation to the economy and future investments of this type should be targeted.

**FIGURE 9 – ACTIVITY OF LIFE SCIENCE FDI PROJECTS INTO NORTHERN IRELAND BETWEEN 2003 AND 2014**



## Competitor FDI

The table below shows the comparative performance of Northern Ireland against several other locations worldwide and against the UK as a whole. It can be seen that Northern Ireland has struggled to attract significant FDI in terms of Capex as well as average jobs created. Meanwhile, the Republic of Ireland, despite its size, is seen to be competing well and has attracted a high number of FDI with large average Capex and jobs created.

Location	Population (millions)	FDI LS projects (2003-2014)	% global LS Projects	Jobs Created	Avg Jobs	Jobs Created per 100,000 pop	Capex £m	Avg Capex £m	Project Type
Northern Ireland	1.8	14	0.22%	1,146	81	63.6	73.48	5.24	7 new 7 expansions
Scotland	5.3	81	1.29%	4,922	60	92.9	1,046.41	12.93	36 new 42 expansions 3 co-locations
Wales	3.1	28	0.44%	2,139	76	69	242.00	8.62	15 new 10 expansions 3 co-locations
United Kingdom	63.2	484	7.66%	25,503	52	40.4	4,676.79	9.67	318 new 146 expansions 20 co-locations
Republic of Ireland	4.6	232	3.65%	23,181	99	503.9	8,056.80	34.7	113 new 98 expansions 21 co-locations
Singapore	5.3	201	3.18%	19,338	96	364.9	6,789.38	33.75	165 new 26 expansions 10 co-locations
San Diego cluster	3.1	41	0.65%	2,025	49	65.3	527.00	12.85	34 new 7 expansions
Finland	5.4	37	0.59%	962	26	17.8	242.00	6.53	31 new 5 expansions 1 co-location

## Source countries of investment

The tables below show the top source countries of LHS FDI into a selection of key competitor regions and the UK as a whole. It can be seen that the USA is the top source for all of the regions (excl. San Diego) and that other key source markets include, Sweden, Germany, India, Japan, Switzerland and the UK.

### TOP SOURCE COUNTRIES OF LHS FDI ACROSS COUNTRIES

#### United Kingdom

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
USA	259	2,869.76	11.09	13,575	52	203
Germany	28	230.98	8.25	1,277	45	26
India	25	163.41	6.53	1,339	53	18
Japan	23	293.43	12.75	2,108	91	18
Australia	18	141.73	7.88	1,021	56	17

#### Scotland

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
USA	46	615.56	13.37	2,975	64	34
Sweden	7	85.68	12.26	249	35	7
Japan	4	32.46	8.13	313	78	3

#### Republic of Ireland

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
USA	152	5,980.78	39.36	16,574	109	92
UK	28	805.03	28.76	2,438	87	16
Japan	10	192.36	19.22	597	59	7
Switzerland	7	55.99	8.01	482	68	5
Germany	4	183.06	45.76	579	144	4

#### Wales

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
USA	19	195	10.29	1,598	84	15
Sweden	2	10	5	204	102	2
Japan	1	24	24	200	200	1

#### Singapore

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
USA	96	3,762.19	39.17	11,055	115	68
UK	19	808.72	42.56	1,785	93	9
Japan	19	359.09	18.91	1,339	70	16
Switzerland	15	1,353.95	90.23	1,789	119	10
Germany	12	97.13	8.07	1,040	86	12

#### San Diego cluster

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
UK	11	85	15.77	635	115	11
Canada	5	65	23.59	200	75	5
Australia	3	45	15.21	235	78	3

#### Finland

Source Country	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
USA	7	52	7.51	196	28	7
Germany	7	47	6.78	160	22	6
Sweden	4	12	3.08	58	14	4

## Primary industry of FDI

The tables below show the primary industry of life and health science FDI into a selection of key competitor regions and the UK as a whole. It can be seen that pharmaceuticals is the main industry in most regions, with medical devices and biotechnology also important sources of investment.

### PRIMARY INDUSTRIES WITHIN LHS FDI ACROSS COUNTRIES

#### United Kingdom

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Pharma	160	1,672.94	10.47	10,412	65	121
Medical devices	104	831.33	8.01	5,703	54	93
Biotechnology	81	941.33	11.64	2,676	33	67
Software & IT Services	54	412.18	7.64	1,706	31	51

#### Scotland

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Pharma	28	292.94	10.47	1,711	61	24
Biotechnology	18	330.76	18.35	716	39	14
Medical Devices	16	182.81	11.46	1,266	79	12
Software & IT Services	8	12.69	1.60	244	28	7

#### Republic of Ireland

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Pharma	97	5,068.68	52.29	10,545	108	54
Medical devices	72	1,409.15	19.54	7,627	105	50
Biotechnology	20	924.39	46.25	1,530	76	14

#### Wales

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Medical devices	12	90.96	7.58	1,101	91	10
Pharma	8	76.4	9.55	511	63	7
Biotechnology	3	5.16	1.72	63	21	3

#### Singapore

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Pharma	90	4,878.21	54.21	8,541	94	62
Medical Devices	39	518.37	13.32	4,549	116	33
Biotechnology	32	891.53	27.89	2,676	83	26

#### San Diego cluster

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Pharma	16	240	15	1,154	72.13	16
Biotechnology	13	168	12.9	390	30	13
Healthcare	3	43	14.33	135	45	3
Medical Devices	4	18	4.5	188	47	4

#### Finland

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Pharma	16	96	6.04	382	23	15
Medical Devices	10	52	5.29	187	18	10
Business Services	3	16	5.54	86	28	3

## Main activity of FDI

The tables below show the primary activity of LHS FDI into a selection of key competitor regions and the UK as a whole. It can be seen that manufacturing and R&D activities are an important activity for many regions and that they generally provide significant levels of Capex and jobs. Sales and marketing, while also a common activity of FDI projects in the competitor regions, tends to provide smaller amounts of Capex and jobs per project.

## PRIMARY ACTIVITIES WITHIN LHS FDI ACROSS COUNTRIES

### United Kingdom

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Sales & Marketing	132	202.54	1.56	2,247	17	129
Manufacturing	95	1,081	11.39	7,700	81	79
R&D	91	1,283.17	14.13	4,866	53	71
Headquarters	57	495.84	8.71	2,888	50	56

### Scotland

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Sales and Marketing	28	350.25	12.51	1,770	63	26
Manufacturing	19	371.23	19.54	1,257	66	16
R&D	8	61.56	7.72	373	46	8
Headquarters	8	17.99	2.24	199	24	8

### Singapore

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
R&D	57	1,852.70	32.49	4,285	75	42
Manufacturing	46	4,185.80	91	9,140	198	36
Sales & Marketing	38	223.39	5.85	1,369	36	37
Design & Training	17	157.17	9.27	1,087	63	16

### San Diego cluster

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Sales & Marketing	16	32	2	482	30.13	16
R&D	6	71	11.83	172	28.66	6
Headquarters	6	88	14.66	406	67.66	6
Manufacturing	5	230	46	441	88.2	5

### Republic of Ireland

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Manufacturing	107	5,966.12	55.77	14,322	133	73
R&D	41	1,132.47	27.64	2,745	66	30
Sales & Marketing	22	243.50	11.08	1,366	62	21
Design & Testing	19	259.43	13.68	1,121	59	16

### Wales

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Manufacturing	9	81	9.03	966	107	8
Sales and Marketing	5	6	1.37	79	15	5
R&D	5	54	10.95	219	43	5
Logistics & Distribution	4	52	13.01	358	89	4

### Finland

Industry	Projects	Capex £m	Avg Capex £m	Jobs Created	Average Jobs	Companies
Sales & Marketing	19	27	1.49	330	17	19
Manufacturing	8	129	16.12	271	33	7
Design & Testing	5	47	9.59	237	47	5
R&D	3	29	9.90	110	36	3

## 3.3 INTERNATIONAL COMPARATOR ASSESSMENT

Latest estimates of the global life and health science sector place annual turnover at over US\$1.1trillion with a CAGR of 6.7%. The sector is also highly internationalised and in a state of constant evolution. All of this means that it is a highly competitive sector with a large number of world regions aiming to attract as much of the market as possible. While Northern Ireland may have improved its offer in recent years, so too have many others. Investigating the strengths of rival offers will be key to Northern Ireland in growing its economy and improving its delivery of healthcare.

### 3.3.1 SPOTLIGHT ON SCOTLAND

Scotland is an important hub in the United Kingdom LHS sector, with more than 650 life science companies, increasing by an average of 20% a year. The sector employs around 17,000 people and has two areas of real strength in medical technologies and pharmaceuticals. In addition, there are several other small, but growing, clusters of companies serving other markets including animal health, consumer care, agriculture, food science and environmental technologies.

Scottish Development International (SDI) lists LHS as a key sector for the Scottish economy. Life Sciences Scotland, through SDI, represents the entire LHS community in Scotland, from industry and academia to healthcare and government. In 2011 it released the Scottish Life Sciences Strategy with the ambitious target of doubling the sector's turnover to £6.2b and GVA to £3b. In the short term, SDI aims to secure international partnerships and inward investment in areas including stem cells & regenerative medicine as well as clinical and translational medicine, attracting innovative companies to locate and link with newly constructed, world class research centres such as the Edinburgh BioQuarter. In the longer term they have stated that more investment and support will be made available to indigenous life science companies to grow into successful international businesses.

There is also a longer term plan to develop the NHS as a key customer for LHS companies in Scotland and a pivotal stimulator of innovative products and services.

The strategy is based around three areas of action for the Scottish LHS sector:

- **ANCHOR:** The need to create an attractive, dynamic environment to retain current LHS resources (companies, scientists etc.).
- **BUILD:** The need to create a more robust business base out of a broadly based population of largely smaller players and the need to assist companies to increase their chances of achieving sustainable growth.
- **ATTRACT:** The need to strengthen ability to attract key skills and management talent, as well as investment from both companies and financial institutions and the need to adopt a dynamic, innovative environment with effective marketing of Scotland's unique offering.

Scotland has attracted significant levels of FDI over the last decade. Between January 2003 and May 2014, there have been a total of 81 foreign investments made in the LHS sector. These projects represented a total capital investment of over £1b and created 4,922 jobs for the local economy.

## ANNUAL LHS FDI INTO SCOTLAND (2003-2014)

Year	Projects	Capex £m	Avg Capex £m	Jobs Created	Avg Jobs	Companies
2013	8	61.4	7.7	386	48	8
2012	13	69.3	5.4	323	24	13
2011	2	17.9	8.9	46	23	2
2010	10	50.2	5.0	278	27	10
2009	7	59.4	8.5	311	44	7
2008	8	95.5	12.0	620	77	7
2007	7	312.2	44.6	1,151	164	7
2006	9	155.5	17.3	574	63	9
2005	8	174.9	21.8	888	111	8
2004	7	30.7	4.4	204	29	7
2003	2	30.4	15.2	141	70	2
Total	81	1,057.5	13.1	4,922	60	66

### Reputation

The Scottish offer is built around its global reputation and the reputation of its universities and research capabilities. The country is ranked 15th in the 2012 Anholt-GjK Roper Nations Brand Index, outstripping many similarly sized countries, and the presence of its universities is cited as a determining factor for site selection by over half of the companies that invest in the country.

### Academic and research infrastructure

Scotland is able to boast a number of world renowned universities including the universities of Edinburgh, St. Andrews and Glasgow. There is a great deal of collaboration between these facilities as well as with industry and clinics. The Scottish Universities Life Sciences Alliance (SULSA) is a research partnership between the universities of Aberdeen, Dundee, Edinburgh, Glasgow, St Andrews and Strathclyde that is supported by the Scottish Funding Council. The aim of the partnership is to increase Scotland's global competitiveness in life science research through pooling together the resources of the country's leading universities. Recent achievements include leveraging £370m in research in 6 years from a £27m investment from the Scottish Funding Council, as well as funding 90 collaborative PhD studentships with industry and the SULSA universities.

There is also a significant strength around the area of cancer research. Cancer Research UK spent around £34 million in Scotland in 2012-13 including projects in Edinburgh, Glasgow, Dundee and the University of Stirling which is home to Cancer Research's UK Centre for Tobacco Control Research.

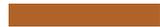
At the Glasgow Centre for Cancer Research a programme of work (drawing upon £24m of funding from Cancer Research) has been established to seek out potential drug targets and develop drug treatments of the future. Cancer research scientists in Scotland have manufactured the first brain cancer drug and Dundee based scientists are investigating the causes of non-melanoma skin cancer<sup>24</sup>.

Edinburgh has a particularly strong research infrastructure in place. The Queen's Medical Research Institute in the city brings together four world class research centres specialising in cardiovascular science, inflammation research, reproductive biology and regenerative medicine. The institute houses more than 600 researchers and aims to tackle a wide range of diseases at the most fundamental cellular level.

The Edinburgh Science Triangle is a multi-disciplinary partnership which aims to promote the city region as a world-class science destination. It is a pioneering collaboration of universities, research institutes and science parks supported by the City of Edinburgh Council. The partnership provides a supportive community and offers access to knowledge and expertise, resources and facilities, new technologies, accommodation and services, business support and networks across the scientific spectrum. The partnership is made of seven research centres, collaborating to make the triangle one of the leading life sciences clusters in Europe. These are:

- **Alba Innovation Centre** - A leading business incubator and enabling environment. Businesses receive in-house intensive advisory support and opportunities for creative development and specialist networking.

<sup>24</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/255788/bis-13-1115-scotland-analysis-science-and-research.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/255788/bis-13-1115-scotland-analysis-science-and-research.pdf)



- **BioCampus** - Scotland's first dedicated national bio-manufacturing campus designed to meet the needs of specialist manufacture of next generation biotechnology related products.
- **Edinburgh BioQuarter** - The only location in the UK, and one of only a few in Europe, to offer a world renowned medical school, a state of the art teaching hospital and bespoke biomedical research and development facilities.
- **Edinburgh Technopole** - A world class science park blending cutting edge research facilities across multi sectors of life sciences, medicine, electronics and informatics in state of the art laboratory and office buildings.
- **Heriott-Watt Research Park** - This research park was the first of its kind in Europe with an emphasis on research, development, design, engineering, training and prototyping activities leading to manufacture.
- **Pentlands Science Park** - A centre of excellence in animal health, focused on veterinary science. World class facilities which are exclusive to Scotland and complement laboratory based research.
- **Roslin BioCentre** - A thriving scientific community and home to an impressive array of world leading research and development companies and a wide variety of flourishing life science related organisations.

### Government support

Scottish Enterprise is firmly focussed on growing the LHS sector in the country and they are available to offer a range of schemes to attract inward investment and support indigenous firms.

Scottish Seed Fund offers investment finance for early stage businesses based in Scotland, usually transitioning from end phase product development to full commercialisation. Investments are a minimum of £20,000 upwards on an equity basis in businesses that meet the eligibility criteria. Scottish Enterprise will match investment from private sector sources on a £1 for £1 basis up to a maximum of 50% of the total funding package or £250,000 (whichever is the lesser).

The Scottish Venture Fund (SVF) is aimed at companies with high growth and export potential trying to leverage additional new investment into their business. Funding is available to businesses planning a transformational change in their operations. Funding from £500k to £2m will be considered as part of collaborative funding packages valued at between £2m and £10m.

The Scottish Co-investment Fund (SCF) is available to start-up businesses or companies trying to make a step change in their business through expansive growth into new products and/or markets. They offer funding from £100k to £1m for equity finance deals with a total value of up to £2m. SCF is a £72m equity investment fund managed by the Scottish Investment Bank (SIB) and is partly funded by the European Regional Development Fund (ERDF).

The Scottish Loan Fund (SLF) provides loans from £250k to £5m to eligible SMEs having difficulty accessing more traditional forms of bank finance. The SLF is focused on established businesses that have growth potential and/or are engaged in exporting out of Scotland. What makes it attractive is that, although similar to traditional bank debt, it is far more flexible. For example, loans can be repaid over a flexible term of 3-7 years with capital repayment holidays available. Importantly to many SMEs there is no equity stake taken in the business so management retain full operational and equity control.

SMART: Scotland provides grants to SMEs undertaking technical feasibility studies and R&D projects that have a commercial endpoint. The scheme supports up to 75% or £100k of the feasibility study. Projects typically last 6 to 36 months, and the grant can cover up to 35% of the project costs. Invest NI's Grant for R&D programme is delivered under exactly the same EU R&D&I framework as the SMART programme and also has a technical feasibility strand. The Grant for R&D programme in NI isn't restricted to SMEs in NI - it is available to companies of all sizes. Through this and its Competence Centre programme, Invest NI's delivers up to £30m per annum to companies undertaking technical feasibility/experimental development/industrial research in Northern Ireland. Support rates range from 25% - 75% depending on size of company, nature of R&D proposed/ proximity to market.

Regional Selective Assistance (RSA) is an option for companies who are looking for investment that will directly result in the creation of, or safeguarding, of jobs in Scotland. It provided investment of £31m last year; both indigenous and foreign companies are eligible with the resulting impact on employment helping to ensure Scotland's economy remains globally competitive. RSA is a discretionary grant scheme and the amount offered depends on the size of the business, location of the project and Scottish Enterprise's assessment of how much is needed for the project go ahead. The EU recently completed its regular seven year review of state aid rules and as a result, companies with 250 or more employees are no longer eligible to apply for RSA.

## KEY LEARNINGS FOR NORTHERN IRELAND FROM L&H SCIENCES IN SCOTLAND

<b>Key Learning 1</b>	Scotland uses its global reputation and the reputation of its universities and research capabilities to attract investment to Scotland. The presence of its universities is cited as a determining factor for site selection by over half of the companies investing in Scotland. Northern Ireland could further leverage its research capabilities to attract further investment into the sector in the same way.
<b>Key Learning 2</b>	<p>The Edinburgh BioQuarter provides a unique example of a cluster providing a site for industrialists and research and development facilities. The BioQuarter allows Scotland to leverage its university/ research infrastructure to attract foreign investment.</p> <p>One spin-out from the University of Edinburgh (Edinburgh Molecular Imaging), has attracted £4m in investment from leading LHS venture capital fund Epidarex. Towards the development of optical molecular imaging. Epidarex Capital's close partnership with the University of Edinburgh and the Edinburgh BioQuarter is typical of its investment model of providing early-stage risk capital to top researchers and entrepreneurs who are developing highly innovative solutions for the global healthcare market<sup>23</sup>.</p>
<b>Key Learning 3</b>	Scotland has the Scottish Universities Life Sciences Alliance (SULSA), a research partnership of leading Scottish universities supported by the Scottish Funding Council. It offers an example of an initiative whereby research is pooled with the aim of enhancing the pull of Scottish research to attract international investment.
<b>Key Learning 4</b>	<p>The Northern Ireland Biobank provides a collection of readily accessible, high quality, well annotated tumour samples which are essential for the discovery of new biomarkers for cancer prognosis. This would suggest that there is a significant opportunity around the development of oncology and cancer research in Northern Ireland.</p> <p>The international research, however, sounds a cautionary note as it highlights that other countries are also extensively pursuing similar opportunities. Scotland, for example, has developed its strength around the area of Cancer Research.</p> <p>In Scotland, Cancer Research UK spent around £34m in 2012-13 on some of the UK's leading clinical and scientific research, including projects in Edinburgh, Glasgow, Dundee and the University of Stirling which is home to Cancer Research's UK Centre for Tobacco Control Research.</p>

### 3.3.2 SPOTLIGHT ON THE REPUBLIC OF IRELAND

The intense competition between Northern Ireland and the Republic of Ireland (RoI) when it comes to issues of economics and foreign investment are well documented. The issue of corporation tax between North and South has long been viewed as the last significant differentiator factor influencing investment into the Republic. However, with the devolution of corporation tax powers set for the coming years, this issue will soon cease to exist. Northern Ireland, with enhanced incentives such as the Patent Box and R&D tax credits, along with the support of Invest NI is now very well placed to attract significant new inward investment and act as a highly competitive rival to the Republic.

IDA Ireland has published its Horizon 2020 strategy and set out its intention to focus on winning new investments in high-end manufacturing as well as research, development and innovation. LHS is positioned top of the list of priority sectors that they are intent on targeting, overtaking its recent focus on IT. It has established a dedicated team focussed on the needs of emerging technology companies. They work with sister organisations and other stakeholders across industry, clinical and academia as an alliance to support companies financially and in making connections. Since 2010 over 60 high growth global companies have set up in Ireland.

Horizon 2020 notes that companies that once exclusively thought of themselves as IT firms such as IBM are now developing solutions which apply that technology to better promote healthcare. Companies working at the forefront of nanotechnology and microelectronics are developing applications for LHS.

RoI has been very successful at attracting FDI over the last decade. Between January 2003 and May 2014, there had been a total of 232 foreign investments made into RoI in the LHS sector. These projects represented a total capital investment of over £8b and created 23,181 jobs for the local economy.

#### ANNUAL LHS FDI INTO THE ROI (2003-2014)

Year	Projects	Capex £m	Avg Capex £m	Jobs Created	Avg Jobs	Companies
2014	8	257.1	32.2	800	100	8
2013	18	516.9	28.7	1,291	71	17
2012	20	862.5	43.1	1,879	93	18
2011	26	777.9	29.9	2,091	80	23
2010	19	237.3	12.5	1,700	89	18
2009	25	608.0	24.3	1,419	56	21
2008	29	870.9	30.1	3,442	118	26
2007	20	921.0	46.1	2,069	103	18
2006	18	814.4	45.3	1,871	103	16
2005	13	275.9	21.2	876	67	12
2004	20	1,514.1	75.7	3,210	160	19
2003	16	400.9	25.1	2,533	158	13
Total	232	8,056.8	34.7	23,181	99	148

## Business environment

Perhaps one of Rol's biggest draws to foreign investors today is its reputation and rating for having an excellent business environment. Ireland states that 93% of overseas companies in Rol rate their investment in Ireland as a success. It was recently rated as best country in the world for business by Forbes and the best country in Western Europe to invest into by Site Selection Magazine.

Rol is seen as a mature LHS market, with 13 of the top 15 medical technology companies and 9 of the top 10 pharmaceutical companies located there. Dublin is also ranked as the best city in the world for human capital.

Rol has a population of 4.58m people. The LHS sector represents 42% of exports or upwards of €45b of exports<sup>25</sup>. The LHS sector employs over 50,000 employees directly<sup>26</sup>. This includes the operations of six of the top seven diagnostic companies in the world. Thirteen of the top 15 pharmaceutical companies in the world have substantial operations in Rol and 6 out of 10 of the world's top selling drugs are produced there.

The Rol medical device sector comprises 160 firms and employs 24,000 people. It generates annual sales of greater than €6b and includes the operations of 8 of the world's 10 largest medical device companies. Rol's biggest home grown medical device company, Creganna-Tactx, employs over 800 people world-wide and provides a range of contract manufacturing and contract R&D services to start ups and global companies alike<sup>27</sup>.

More than 50% of medtech companies based in Rol have dedicated R&D facilities.

## Government support

The Irish Government is seen to be highly supportive of the LHS sector and has invested substantially to create a competitive research infrastructure within the country. The technology centres programme is a Government funded initiative (€100m) to develop the innovation and R&D capabilities of companies in Rol, delivered jointly by Enterprise Ireland and IDA Ireland. The facilities are public-private research centres of excellence structured to lie at the boundary between the academic environment and industry. Covering analytics, energy, manufacturing & materials, food & health and business processes & financial services, the 14 centres include 3 that are directly related to the LHS sector. These are the Pharmaceutical Manufacturing Technology Centre, Food and Health Ireland and the Applied Research for Connected Health Centre.

Pharmaceutical Manufacturing Technology Centre - The vision of the PMTC is to support and develop the Irish pharmaceutical industry (small and large molecule) by improving manufacturing competitiveness and enhancing the research and development mandate and activity of Irish pharmaceutical manufacturing sites and companies. It will be hosted from 2014 by University of Limerick and will benefit from the very substantial investment at UL in physical infrastructure as well as the facilities at the research partner sites. The PMTC will also be partnering with NIBRT in biopharmaceutical related projects.

Research themes will include:

- advanced rapid microbial analytical techniques
- enabling and control of continuous processing
- soft sensor modelling tools
- Active Pharmaceutical Ingredient (API) real time release Process Analytical Technology (PAT)
- pharmaceutical packaging technologies for anti-counterfeiting

## City and region analysis

The following analysis provides a breakdown of three importance regions in Rol in terms of the LHS sector.

### Dublin

The Dublin region hosts the Irish Drug Delivery Network, the BioNanoInteract cluster, Molecular Therapeutics for Cancer, Immunology Research Centre, Biomedical Diagnostics Institute (BDI) and the Regenerative Medicine Institute.

The (BDI) at Dublin City University (DCU) is a Science Foundation Ireland CSET (Centre for Science, Engineering and Technology). Established in October 2005, the BDI, an Academic-Industrial-Clinical partnership, carries out cutting-edge research programmes focused on the development of next-generation biomedical diagnostic devices.

Dublin also hosts, inter alia, the Colles Institute and The Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN).

<sup>25</sup> [http://www.ibec.ie/Sectors/PCI/PCI.nsf/e3124752f3e585e0802574420058f1ae/522dfaa837376d16802576f10031e49a/\\$FILE/Dave%20Shanahan%20IDA.pdf](http://www.ibec.ie/Sectors/PCI/PCI.nsf/e3124752f3e585e0802574420058f1ae/522dfaa837376d16802576f10031e49a/$FILE/Dave%20Shanahan%20IDA.pdf)

<sup>26</sup> [http://www.ibec.ie/Sectors/PCI/PCI.nsf/e3124752f3e585e0802574420058f1ae/522dfaa837376d16802576f10031e49a/\\$FILE/Dave%20Shanahan%20IDA.pdf](http://www.ibec.ie/Sectors/PCI/PCI.nsf/e3124752f3e585e0802574420058f1ae/522dfaa837376d16802576f10031e49a/$FILE/Dave%20Shanahan%20IDA.pdf)

<sup>27</sup> <http://www.enterprise-ireland.com/en/Start-a-Business-in-Ireland/Startups-from-Outside-Ireland/Key-Sectors-and-Companies-in-Ireland/Medical-Devices-sector-profile.html>

## Galway

Galway hosts a number of specialised life sciences clusters connected to the National University of Ireland Galway (NUIG). These include:

- The Network of Excellence for Functional Biomaterials (NFB)
- The Glycoscience Research Cluster
- The Regenerative Medicine Research Institute
- The Centre for Bioanalytical Sciences (CBAS), which It focuses on the area of molecular mechanisms involved in the development of novel cell and tissue-specific biotherapeutics<sup>28</sup>.

## Cork

Cork hosts a number of major companies in the LHS sector including Pfizer and Janssen Biologics. Galway hosts a number of specialised LHS clusters connected to the National University of Ireland Galway (NUIG). Cork, in particular, has a strong role to play in this success. It has become synonymous with the sector, with companies such as Pfizer and Janssen Biologics operating in the county. Startups, like Radisens Diagnostics, can develop by using the Rubicon Centre, an incubation centre located on the campus of Cork Institute of Technology<sup>29</sup>. Cork also hosts the Alimentary Pharmabiotic centre which specialises in research on host-microbe interactions which relate to a range of inflammatory, infectious and other disorders<sup>30</sup>.

Cork also hosts the Analytical & Biological Chemistry Research facility (ABCRF) which is a state of the art interdisciplinary research centre housed in the Cavanagh Pharmacy Building in University College Cork. (UCC). The Biomerit Research Centre (BRC) is also situated on Cork. Its objectives are to maximise education and research in to innovative biotechnology<sup>31</sup>.

Food for Health Ireland (FHI) is a leading global innovation centre for the development of nutritional functional ingredients to improve health, wellness and quality of life. FHI's mission is to leverage the world class scientific capabilities of its Irish academic partners University College Dublin (UCD), UCC, University of Limerick (UL), Teagasc Food Research Centre Moorepark, DCU, NUIG and NUI Maynooth), with the market expertise of its industry partners (Carbery Group, Dairygold Food Ingredients, Glanbia plc, Kerry Group and the Irish Dairy Board), into a pipeline of innovative, nutritional, functional ingredients and products for the global food industry. FHI is funded by Enterprise Ireland and FHI's industry partners. In 2013, FHI started its second phase of funding (€21m),

focusing on the development of its outstanding scientific capabilities and the commercialisation of the outputs of the first and second phase.

Innovative technologies include:

- enzyme hydrolysis
- bacterial fermentation
- nutrigenomics
- metabolomics
- proteomics
- bioinformatics.

UCC hosts the Alimentary Pharmabiotic Centre, NutraMara, Food for Health Ireland Research Centre (referred to above) and Cereal Science Cork. Food research at UCC ranks 4th in the world<sup>32</sup>.

Applied Research for Connected Health (ARCH) is a research initiative which conducts innovative and applied research to support the deployment, adoption and reimbursement of connected health solutions. The research initiative is steered by a group of industry partners who are actively involved in the connected health sector. ARCH is led by UCD and is based at NexusUCD, the university's industry partnership centre. ARCH also has researchers based in University of Limerick (UL) and RTI International. ARCH is aligned to the Dublin East Hospital Group, and is currently undertaking research in partnership with the Mater Misericordiae University Hospital and St Vincent's University Hospital.

Research themes include:

- healthcare economics
- business & revenue modelling
- implementation & evaluation
- standards & quality.

Innovative technologies include integrated connected health solution to manage dementia.

<sup>28</sup> <http://www.enterprise-ireland.com/en/publications/reports-published-strategies/life-sciences-research-guide-.pdf>

<sup>29</sup> <http://www.siliconrepublic.com/innovation/item/22606-digcork11>

<sup>30</sup> <http://www.ucc.ie/research/apc/content/>

<sup>31</sup> <http://www.enterprise-ireland.com/en/publications/reports-published-strategies/life-sciences-research-guide-.pdf>

<sup>32</sup> Science Watch Volume 17 No 4 July/August 2006

## Tax incentives

As well as favourable corporation tax, ROI has had an R&D tax credit scheme since 2004. Administered by the Irish Revenue Commissioners, the scheme is open to all companies in ROI that are undertaking qualifying research and development activities within the European Economic Area. Qualifying R&D expenditure generates a 25% tax credit for offset against corporation taxes in addition to a tax deduction at 12.5%. The 25% rate of credit applies to incremental expenditure on R&D incurred by Irish tax resident companies that are trading or are members of a trading group. The tax credit is primarily available for offset against the current year or immediate prior year corporation tax liability and is in addition to the corporate tax deduction that is otherwise available for the expenditure. The scheme effectively lowers the real cost of R&D spend by up to 37.5%. The scheme also allows companies to claim for a cash refund if they do not have a tax liability in the current or immediate prior period. Alternatively the tax credit can be offset against future tax liabilities. Northern Ireland competes

very well against these Irish tax incentives. As with the ROI scheme, the UK R&D tax credit schemes apply to both profit and loss making companies and companies located in NI can enjoy an overall saving of c50% (SME) or up to 30% (large company) per pound spent on R&D. This is even before Patent Box is factored in.

## TABLE ILLUSTRATING THE KEY LEARNINGS FOR NORTHERN IRELAND FROM L & H SCIENCES IN ROI

<b>Key Learning 1</b>	A key learning for Northern Ireland relates to the strategic positioning of the LHS sector in ROI. IDA Ireland is intent on targeting, overtaking the recent focus on IT. They have established a dedicated team focused on the needs of emerging technology companies.
<b>Key Learning 2</b>	Another key learning relates to the importance of collaboration and the development of sectoral competences. Galway, for example, hosts a number of specialised LHS clusters connected to NUIG. These include: <ul style="list-style-type: none"><li>▪ the network of excellence in functional biomaterials (NFB)</li><li>▪ the Glycoscience Research Cluster</li><li>▪ the Regenerative Medicine Research Institute</li><li>▪ the Centre for Bioanalytical Sciences</li></ul>
<b>Key Learning 3</b>	There is also a cautionary note around the strength of the ROI medical device sector. The research suggests that Northern Ireland should carefully consider its approach in developing its medical device sector given Irish & international strengths in the medical devices sector.  The Irish medical sector is a major competitor. with more than 160 firms and employing over 24,000 people. It generates annual sales of greater than €6b and includes the operations of 8 of the world's 10 largest medical device companies. More than 50% of medtech companies based in ROI have dedicated R&D facilities and 80% of global stent production is carried out from Ireland.

### 3.3.3 SPOTLIGHT ON SINGAPORE

Focused on developing a vibrant biomedical sciences research ecosystem, Singapore has built up a strong scientific foundation with seven research institutes and five research consortia in key fields that include clinical sciences, genomics, bioengineering, molecular/cell biology, medical biology, bio-imaging and immunology. More than 50 companies are carrying out biomedical sciences R&D that includes drug discovery, translational and clinical research, frequently collaborating with the research institutes.

In the years ahead, as Singapore builds on its foundation in good science and capabilities in translational and clinical research, the city-state is well positioned to support the industry in its efforts to accelerate the drug discovery process with next-generation technologies, while focusing on key diseases such as cancer, metabolic diseases, neurological diseases, infectious diseases and eye diseases.

Singapore has developed significant strengths in the areas of medical technology innovation and manufacturing. Some initiatives include the Economic Development Board's medtech IDEAS (Innovate, Design, Engineer for Asia in Singapore) programme to train multidisciplinary teams of engineers, volatile organic compound specialists and regulatory experts in companies' global and Singapore-based R&D facilities and the Singapore-Stanford Biodesign Programme which is designed to meet the medtech industry's need for Asian medical device innovators familiar with the medtech innovation process as well as Asia's healthcare needs.

The country has also made significant inroads in biologics manufacturing, with AbbVie, Amgen, Novartis, Baxter, Lonza, GSK and Roche announcing their investments to set up major biologics facilities that amount to S\$2.7bn in capital expenditure. In less than five years, Singapore is now home to nine biologics manufacturing facilities, including three latest investments by Novartis, Amgen and AbbVie amounting to US\$500m, US\$200m and US\$320m respectively. Collectively, these biologics plants represent S\$2.7bn in investments and employ close to 2,000 people.

Looking forward, Singapore has committed S\$16.1bn in continued support of research, innovation and enterprise activities between 2011 and 2015. Out of that, S\$3.7b is dedicated to enhancing existing biomedical R&D infrastructure, integrating multi-disciplinary research and translating basic science into tangible outcomes. With substantial FDI and a firm commitment of continued support from the government, Singapore is well positioned to realise its goal of becoming the Biopolis of Asia.

There is a trend towards increased medical technology innovation in Asia, more than 30 medtech companies now carry out R&D in areas such as value engineering and product development for regional and global markets from Singapore. These include Becton, Dickinson & Company which has expanded its corporate R&D centre to develop surgical, immunisation and diagnostics products for Asian markets, and; Menicon, whose "Magic" one-day disposable contact lens product was developed in Singapore. Menicon opened its first R&D and manufacturing facility outside Japan in Singapore, with total investments of S\$123m<sup>33</sup>.

For its size, Singapore has been performing well in attracting FDI over the last decade. Thanks to large scale commitments and investments from the Government, it now finds itself as one of the top destinations in the region for life sciences, just as the industry is increasing its focus on the Asian markets.

<sup>33</sup> <http://www.edb.gov.sg/content/edb/en/industries/industries/pharma-biotech.html>

## SINGAPORE LHS FDI PERFORMANCE

Year	Projects	Capex £m	Avg Capex £m	Jobs Created	Avg Jobs	Companies
2014	10	407.1	40.7	861	86	9
2013	15	425.5	28.4	1,395	93	15
2012	17	224.8	13.2	1,252	73	17
2011	15	633.7	42.3	1,408	93	13
2010	14	254.3	18.2	1,570	112	14
2009	29	1,010.1	34.8	3,335	115	24
2008	19	402.8	21.2	1,545	81	18
2007	24	915.6	38.1	1,743	72	24
2006	13	636.4	49.0	1,504	115	13
2005	13	365.1	28.1	1,214	93	13
2004	18	670.9	37.3	1,773	98	15
2003	14	843.2	60.2	1,738	124	12
Total	201	6,789.4	33.8	19,338	96	149

### Government support

Singapore has quickly grown its LHS sector to become a leading region globally, particularly for R&D. Over 16,000 individuals are employed in the sector, a highly skilled and reliable workforce that includes more than 6,000 researchers from across the globe due to the country's open immigration policy. Collectively, more than S\$1.51b is spent on biomedical research in Singapore annually.

The Singapore Government plays a critical role in keeping the country a hotbed for foreign investment. Corporation tax is set at 17%, reduced from 20% in 2007, with a partial exemption of 75% on the first S\$10,000 and 50% on the next S\$290,000 (S\$1 = £0.48 April 2014). There is no capital gains tax and the maximum rate of individual tax rate is 20% on earnings after S\$320,000.

As well as lowering corporation tax, the government has taken other significant measures during the economic downturn to maintain Singapore's appeal for investors. Lowering employer's central provident fund (CPF) contribution rates and capping office rental rates etc. have led to the World Bank naming Singapore as the easiest place to do business anywhere in the world.

The Government has also supported the sector in more targeted ways. A core of clinician scientists has been built up in Singapore through initiatives such as the Singapore Translational Research (STaR) Investigator Award, which is designed to recruit and nurture world-class clinician scientists to undertake translational and clinical research in Singapore, as well as the Clinician Scientist Award (CSA), which provides research funding and salary support to enable medical researchers to devote more time to research.

Other initiatives to grow this base of clinician scientists include:

- **Translational & Clinical Research (TCR)** – This is a flagship programme which presents a platform for researchers and clinician scientists to collaborate in solving scientific problems and translate their research into quality healthcare solutions for patients (bench-to-bed solutions). Each awarded TCR flagship programme comes with a five-year budget of up to S\$25m.
- **The Competitive Research Programme (CRP)** – This is a funding scheme that supports a broad base of research ideas, through a competitive bottom-up approach. The scheme supports R&D programmes that help to identify new potential strategic research areas in which Singapore can invest to develop core capabilities for new industries of the future, including those in the biomedical sciences translational and clinical research areas. Each award is for a maximum of S\$10m per programme, over three to five years.
- **The Health Services Research Competitive Research Grants (HSR-CRGs)** – This is a Ministry of Health (MoH) research grant established in 2009 to promote the conduct of HSR and enable the translation of HSR findings into policy and practice. Principal investigators (PIs) from local public healthcare or academic institutions are eligible for this grant which provides a maximum of S\$1m over a two-year period.

## The Biomedical Sciences Initiative

The Singapore Biomedical Sciences (BMS) initiative was launched in June 2000 to develop the biomedical sciences cluster as one of the key pillars of Singapore's economy, alongside electronics, engineering and chemicals. To achieve its aim, the BMS initiative is led by the Research, Innovation and Enterprise Council (RIEC), chaired by Prime Minister Lee Hsien Loong, and coordinated by a BMS executive committee, chaired by A\*STAR Chairman and the Permanent Secretary for Health. The executive committee draws on the combined experience of the Biomedical Sciences International Advisory Council (BMS IAC), comprising renowned scientists, for strategic advice and guidance.

Three key agencies work in close coordination and in an integrated fashion to develop the BMS cluster: The Biomedical Research Council (BMRC) of A\*STAR, The Economic Development Board's (EDB) Biomedical Sciences Group (BMSG) and the Ministry of Health's (MOH) National Medical Research Council (NMRC).

This integrated approach involves various initiatives such as establishing research infrastructure, supporting the industry, providing venture capital support and strengthening manpower capabilities.

### Phase 1 (2000-2005): Building the foundation

The first phase of development (2000-2005) focused on establishing a firm foundation of basic biomedical research in Singapore.

Five of BMRC's research institutes developed core public research capabilities in the areas of bioprocessing, chemical synthesis, genomics and proteomics, molecular and cell biology, bioengineering and nanotechnology, and computational biology. In a partnership between BMRC and the Science and Engineering Research Council, the Institute of Chemical and Engineering Sciences' Chemical Synthesis Laboratory provides capabilities in chemistry. All these support the BMS cluster, comprising the four key sectors: pharmaceuticals, biotechnology, medical technology and healthcare services.

### Phase 2 (2006-2010): Strengthening translational and clinical research capabilities

The second phase of development (2006-2010) focused on strengthening capabilities in translational and clinical research, while continuing to build up basic research capabilities. Translational and Clinical Research (TCR) capabilities are essential to translate basic discoveries in the lab into clinical applications to improve human healthcare. BMRC's Singapore Institute for Clinical Sciences (SICS) and Institute of Medical Biology (IMB) conduct translational and clinical research to bridge the gap between bench and bedside. BMRC also launched consortia initiatives, which place significant emphasis on translational research in key areas, such as the Singapore Cancer Syndicate (SCS), Singapore Bio-imaging Consortium (SBIC), Singapore Stem Cell Consortium (SSCC) and Singapore Immunology Network (SIgN). These consortia also optimise Singapore's available resources, allowing for integrated development in strategic areas of biomedical research.

### Phase 3 (2011-2015): Capturing opportunities for greater economic and health impact

Building on this foundation created over the last 10 years, BMRC will support the next phase of the BMS initiative through focusing its efforts in three main areas to capture the growing opportunities arising from global trends in the BMS industry.

1. Enhanced industry engagements for greater economic outcomes
2. Focused on mission-oriented programmes, with high growth potential
3. Seamless integration and translation as key competitive advantages

To achieve this, several new initiatives have been introduced:

- A\*STAR, EDB and NMRC have also jointly set-up the Singapore Biomedical Sciences Industry Partnership Office (BMS IPO) to serve as the one-stop coordinating office between the various research agencies and performers in Singapore with MNCs seeking to establish multi-party collaborations.
- BMRC's research will focus on mission-oriented Programmes in the areas of biologics, medtech and also nutraceuticals and cosmeceuticals to draw on existing strengths and capitalise on growing market sector to create better economic value.
- BMRC will be establishing technology platforms that will bring together researchers and groups from different disciplines in synergistic ways, so as to provide multi-disciplinary solutions to problems that affect industry.



## Education and training

Aware that R&D is dependent on the presence of talent, the Government has shaped the local education system to develop graduates with skills for work in life sciences, promotes life sciences studies and adapts curricula to fit the industry's needs. Two leading research universities are the source for a large share of innovation in Singapore. The National University of Singapore (NUS) has three centres of excellence relevant to the industry: Cancer Science Institute of Singapore, Mechanobiology Institute, Singapore and Singapore Centre on Environmental Life Sciences Engineering. Nanyang Technological University (NTU) offers additional centres, including the Biomedical Engineering Research Centre, the Centre for Biotechnology, the Centre for Chiral and Pharmaceutical Engineering, the Computer-integrated Medical Intervention Laboratory and the Physiological Mechanics Laboratory in addition to several inter-disciplinary centres focused on nanotechnology. Both universities have expanded their research and industry-related graduate programs in recent years.

At the institutional level, the NUS has partnered Duke University to establish the Duke-NUS Graduate Medical School, Singapore's first graduate medical school. In 2010, Harvard's Beth Israel Deaconess Medical Centre announced its collaboration with NUHS where both parties will exchange scientific, academic and technical information, identify opportunities for cooperation, exchanges and joint research in common interest areas, and jointly organise academic and scientific seminars and conference. In addition, Singapore is investing in integrated facilities that will house research, education and training in one location. They include the Centre for Translational Medicine at NUHS and the new Khoo Teck Puat Building at the Singapore General Hospital campus, where Duke-NUS Graduate Medical School Singapore is co-located with the Singapore General Hospital.

EDB, the lead Government agency for economic growth in Singapore, has also partnered with GSK in 2010 to draw up a 10-year strategic roadmap which includes a joint endowment fund to support graduates in public health policy research along with plans to build up capabilities in sustainable manufacturing.

## Regulatory framework

As a leading location for innovation, the country has placed a great deal of commitment into developing a strong domestic regulatory framework to protect IP rights. It is currently rated the best place in Asia and 7th in the world for IP rights protection in the IMD World Competitiveness Report 2011. Similarly, the World Economic Forum's Global Competitiveness Report 2011-2012 ranks the island as having the best IP protection in Asia, and the second best in the world. Indeed, a consistently reliable IP environment spurred the World Intellectual Property Office (WIPO) in 2009 to set up its first Asian regional office here. The strong IP stance has resulted in more than 30 leading biomedical sciences companies establishing regional headquarters in the country in recent years.

**TABLE ILLUSTRATING THE KEY LEARNINGS FOR NORTHERN IRELAND FROM LHS IN SINGAPORE**

<p><b>Key Learning 1</b></p>	<p>Singapore's strategic prioritisation of biomedical sciences is an interesting from a Northern Irish perspective. In 2000 the Singapore BMS initiative was launched to develop the biomedical sciences cluster as one of the key pillars of Singapore's economy, alongside electronics, engineering and chemicals.</p>
<p><b>Key Learning 2</b></p>	<p>Singapore has developed an infrastructure to attract companies to the region for clinical trials and research. Northern Ireland, which also has strengths in clinical trials research could learn from this approach. Singapore's infrastructure includes, for example, investigational medicine units dedicated for early-phase trials in public hospitals, as well as the Singapore Clinical Research Institute, which focuses on supporting later-stage trials<sup>34</sup>.</p>
<p><b>Key Learning 3</b></p>	<p>Singapore has used cross-disciplinary programmes like the EDB's medtech IDEAS to develop the areas of manufacturing and biologics. The examination of Singapore and its strength in this area suggests again that the areas of manufacturing and biologics are extremely competitive and Northern Ireland needs to bear this in mind as it further develops these sectors.</p>
<p><b>Key Learning 4</b></p>	<p>The collaborative and integrated approach Singapore has adopted towards capturing global biosciences initiatives is noteworthy for Northern Ireland. Their approach is targeted towards industry specific problems and capitalises on existing strengths through mission-oriented programmes.</p>

<sup>34</sup> <http://www.edb.gov.sg/content/edb/en/industries/industries/pharma-biotech.html>

### 3.3.4 SPOTLIGHT ON SAN DIEGO

The LHS industry is a major driver of the innovation economy in the San Diego region. The region has more than 600 LHS companies and 80 research institutes employing over 42,000 people. The research institutes, along with the University of California San Diego, provide the sector with breakthrough technologies that fuel company growth and product development. Major pharmaceutical companies including Pfizer, Johnson & Johnson and Merck maintain a presence in the region to foster collaboration with major research institutes, universities and smaller biotech companies. The region attracts graduate students and postdoctoral trainees from around the world, many of whom stay in the area to pursue academic research or positions within industry.

The San Diego cluster, despite its size and international reputation, does not appear to have attracted significant levels of FDI since 2003. However, it must be remembered that the USA is the largest source market for LHS FDI in the world and much of San Diego's investment would have been indigenous and therefore not shown on this benchmark.

#### Federal incentives

The development of the LHS sector in San Diego was greatly aided by California's various tax credit and enterprise zone schemes. However, these schemes are in a transition period at the time of writing. The enterprise zone program wound up at the end of 2013 and is being replaced by three new categories of incentives designed to encourage economic development in the state:

- A new sales tax exemption, effective from 1st July 2014, provides a state-wide, partial sales and use tax exemption, up to US\$200m, for manufacturing and for companies that conduct research and development for biotechnology, physical, engineering, and life sciences throughout the state upon purchase of specific property.
- A new hiring credit allows some taxpayers located in specific enterprise zones, local agency military base recovery areas (LAM-BRAs), and designated census tracts with high unemployment and poverty to claim a credit for hiring specific employees.
- A new fund is to be created, administered by the Governor's Office of Business and Economic Development (GO-Biz) to negotiate agreements to provide tax credits for investments and employment expansion in California.

#### iHub programme

In an effort to harness and enhance California's innovative spirit, GO-Biz launched its forward-thinking Innovation Hub (iHub) program. This program improves the state's national and global competitiveness by stimulating partnerships, economic development, and job creation around specific research clusters through state-designated iHubs. The iHubs leverage assets such as research parks, technology incubators, universities, and federal laboratories to provide an innovation platform for start-up companies, economic development organisations, business groups, and venture capitalists.

### SAN DIEGO LHS FDI PERFORMANCE

Year	Projects	Capex £m	Avg Capex £m	Jobs Created	Avg Jobs	Companies
2013	9	102.0	11.3	161	18	9
2012	5	54.4	10.9	228	46	5
2011	5	84.9	17.0	294	59	5
2010	3	9.1	3.0	219	73	3
2009	11	177.2	16.1	625	57	11
2008	2	50.9	25.5	124	62	2
2005	4	11.2	2.8	223	55	4
2004	1	2.1	2.1	4	4	1
2003	1	41.5	41.5	147	147	1
Total	41	533.0	13.0	2,025	49	41

### 3.3.5 SUMMARY OF KEY LEARNINGS - RECOMMENDATIONS FOR NORTHERN IRELAND

#### Strategic positioning of the life & health sciences

The comparative research highlights the importance of effectively strategic positioning of the development of LHS. Scotland Development International (SDI), for example, lists life sciences as a key sector for the Scottish economy. Additionally IDA Ireland provides another example of this strategic positioning. IDA Ireland is intent on targeting LHS and overtaking the recent focus on IT. They have established a dedicated team focused on the needs of emerging technology companies.

In 2012 the RoI Government commissioned steering on priority areas for investment in publicly-performed research outlined 14 priority areas, five of which directly relate to LHS. One priority area relates to 'connected health and independent living' and the need to produce novel medical solutions for novel therapeutic situations. Another priority area is 'medical devices'. There is scope for a similar approach and strategic prioritisation of the life sciences within Northern Ireland.

#### Leveraging of infrastructure & the importance of a collaborative approach

Another key learning emerging for Northern Ireland from the international comparison is the importance of effectively leveraging universities and research facilities to attract investment to the LHS sector. Singapore has adopted this approach by developing sectoral consortia to attract foreign investment and talent. Northern Ireland should adopt an approach like Singapore which has set up bodies like the Singapore Immunology Network (SIgN), the Singapore Institute of Clinical Services (SICS) and the Singapore Bioimaging Consortium (SBIC) to build a critical mass in key sectors and attract foreign investment<sup>35</sup>.

Northern Ireland should also adopt an approach that includes more pooling of research in order to attract further foreign investment. Scotland, for example, has the Scottish Universities Life Sciences Alliance (SULSA), a research partnership of leading Scottish universities supported by the Scottish Funding Council. It offers an example of an initiative whereby research is pooled with the aim of enhancing the pull of Scottish research to attract international investment.

#### The importance of skills retention for LHS in Northern Ireland

Research has indicated that Northern Ireland loses about 5,000 of its best students every year to universities in Great Britain<sup>36</sup>. It also indicates that Northern Ireland needs to produce and retain at least an extra 2,000 graduates a year to be internationally competitive.

The research further suggests that the availability of graduates drives FDI and also encourages higher quality investment – which produces the greatest contribution to growth and economic output. Northern Ireland has the smallest proportion of high quality FDI of any UK region, with about half the proportion of high quality FDI of Scotland.

A key learning then emerges then around the link between skills retention and the attraction of high quality FDI. Additionally the Northern Ireland Adviser on Employment and Skills (NIAES) 2011 report, Identification of Priority Areas In Northern Ireland, identified LHS as an emerging sector for which Northern Ireland needed to upskill. If Northern Ireland is to successfully compete on an international stage then much greater emphasis needs to be placed on retaining its science students.

#### Highly competitive markets in areas like biomedical devices and cancer research

There is a key learning for Northern Ireland around the difficulty of competing in certain LHS markets. In terms of attracting FDI in areas like biomedical devices, cancer research and other speciality areas, Northern Ireland should appreciate the significant international sectoral strengths of other regions.

The medical technology market, with estimated sales of £223bn in 2012 and future growth areas in in vitro diagnostics and precision medicine, looks like a very attractive segment for development in Northern Ireland. The research shows, however, that certain sectors are extremely competitive. In Singapore, for example, more than S\$1.51b is spent on biomedical research in Singapore annually. Also in RoI the medical device sector comprises 160 firms and employs 24,000 people. It generates annual sales of over and includes the operations of eight of the world's ten largest medical device companies. Northern Ireland is a small country and should carefully target life science sectors where a genuine chance of competing internationally exists. The infrastructure and levels of investment put into particular sectors by certain countries/regions may completely rule Northern Ireland out of the race so careful thought about where it places its limited resources is needed.

<sup>35</sup> [http://www.a-star.edu.sg/portals/0/media/otherpubs/step2015\\_1jun.pdf](http://www.a-star.edu.sg/portals/0/media/otherpubs/step2015_1jun.pdf)

<sup>36</sup> <file:///C:/Users/DUBDC2/Downloads/1403886149--U4D---need-to-increase-graduate-numbers-2.pdf>



## **The importance of further developing capability to sell the Northern Ireland LHS**

The international research indicates that Northern Ireland could sell LHS in Northern Ireland more effectively and the creation of a thorough strategy for attracting investment would be beneficial.

SDI has a tiered 'anchor', 'build' and 'attract' strategy which explicitly deals with the needs to strengthen Scotland's ability to attract key skills and management talent, as well as investment from both companies and financial institutions. Scotland has attracted significant levels of FDI over the last decade as a result of effectively marketing Scotland's unique LHS offering. Between January 2003 and May 2014, there have been a total of 81 foreign investments made in the LHS sector. These projects represented a total capital investment of over £1b and created 4,922 jobs for the local economy.

## 3.4 NATIONAL BENCHMARKING

### Competitor capabilities benchmark

The tables below show Northern Ireland compared to competing regions for a number of different metrics. Northern Ireland has the smallest LHS cluster of the selection when measured by sector value and employee numbers. It also has the fewest universities; however, the two universities it does have are producing high numbers of LHS graduates.

#### TABLES ILLUSTRATING KEY INTERNATIONAL COMPARATIVE METRICS FOR LHS

Location	Population	Sector Value	CAG%	Sector Employees	No. of Companies	Number of universities	Total LS students	Corporation tax%
NI	1.8m	£0.9b	20	7,000	85	2	10,100	21
Scotland	5.3m	£3.1b	20	17,000	650	19	67,500	21
Singapore	5.3m	N/A	N/A	16,000	50	6	2,600	17
San Diego (county cluster)	3.1m	N/A	N/A	42,000	600	9	N/A	40
Rol	4.6m	£35b	6.3	52,000	350	10	22,450	12.5

Location	No. of Research Centres	Sector focus	Incentives
NI	20	Diagnostics, medical devices, cardiology, oncology	<p>UK wide incentives including R&amp;D tax credits, Patent Box etc. Invest NI provides circa £30million grant support (part-ERDF funded) per annum for companies engaging in relevant R&amp;D activities.</p> <p>In addition Invest NI provides support through a range of funds including: techstart NI (£29m integrated suite of funds and support for entrepreneurs, seed and early stage SMEs and university spin-outs.)</p> <p>CoFund NI provides equity funding in co-operation with other investors.</p> <p>The £50m Growth Loan Fund provides loan finance to local small and medium-sized businesses.</p> <p>The NI Small Business Loan Fund provides unsecured loans to individuals, private companies and social enterprises in the small, medium and micro enterprise size range.</p> <p>Two £30m Development Funds offer equity funding of between £450,000 and £2m made up of public and private money.</p>

Scotland	60	Medical technologies and pharmaceuticals	UK wide incentives including R&D tax credits, Patent Box etc. Scottish Seed Fund, the Scottish Venture Fund, the Scottish Co-investment Fund, the Scottish Loan Fund, SMART: Scotland and regional selective assistance.
Singapore	30	Clinical sciences, genomics, bioengineering, molecular/cell biology, bioimaging and immunology	S\$16.1b invested in continued support of research, innovation and enterprise activities between 2011 and 2015. There is no capital gains tax and the maximum rate of individual tax rate is 20% on earnings after S\$320,000.
San Diego (county cluster)	80	Biotechnology and medical devices	Three new categories of support are being introduced; a new sales tax exemption, a new hiring credit scheme and a new tax credit scheme for investments and employee expansion within the state.
Rol	70	Medical devices, IT, pharmaceutical manufacturing, diagnostics	Government investment of €100m into initiative to develop R&D&I capabilities through a series of public-private research centres. Enterprise Ireland has developed a €10m fund for international start ups which offers equity funding to leading edge teams to locate their start ups in Ireland. Innovation vouchers of up to €5,000 are available to SMEs for use in R&D R&D tax credits qualifying R&D expenditure generates a 25% tax credit for offset against corporation taxes in addition to a tax deduction of 12.5%.

Location	Average Employees per Company	LHS Employees per 1,000 pop	LHS Students per 1,000 pop.	Average number of LHS students per university	VC Availability <sup>37</sup> 1= very hard 7= very easy	Share of Global LHS FDI since 2003 <sup>38</sup>	Number of Clinical Trials since 2013 <sup>39</sup>
NI	82	3.99	5.61	5,050	3.5	0.22%	418
Scotland	26	3.21	12.74	3,553	3.5	1.29%	2,175
Singapore	320	3.02	0.49	433	4.2	3.18%	1,052
San Diego (county cluster)	70	13.55	-	-	4.3	0.65%	3,749
Rol	149	11.3	4.88	2,245	2.7	3.65%	705

<sup>37</sup>WEF Global Competitiveness Report 2013/14

<sup>38</sup>FDI Markets data 2013/14

<sup>39</sup>FDI Intelligence based on Clinicaltrials.gov (Apr 2013)

The following benchmarking shows Northern Ireland's cost and quality ranking compared against competing global<sup>40</sup> regions for the operation of a LHS R&D centre, a bio-pharma manufacturing centre, a clinical development/trials centre, a healthcare R&D centre, a medical devices manufacturing plant and a stem cells R&D centre.

### LHS R&D Centre

Northern Ireland ranks 1st in cost and 4th in quality (out of 4 locations) giving it an overall rank of 4th in this study based on the cost to quality ratio (cost 50%/quality 50%).

Northern Ireland performs relatively better in cost than quality with total costs of £2,42m, making it 26% more cost effective than the study average total cost of £3.27m. Northern Ireland has a quality score of 51.39, which is 49% below the study average quality score of 100.

#### INTERNATIONALLY COST AND QUALITY RANKINGS AS A LHS R&D CENTRE

Location	Overall		Quality		Cost		
	Rank	Rating (0-100)	Rank	Score	Rank	Index	Total Cost (GBP)
Singapore	1	100.00	1	135.87	4	116.39	3,807,448
San Diego (CA)	2	96.51	2	122.69	3	109.15	3,570,589
Scotland	3	85.17	3	90.15	2	100.47	3,286,560
Northern Ireland	4	83.25	4	51.39	1	74.00	2,420,673

### Bio-Pharma Manufacturing Centre

Northern Ireland ranks 1st in cost and ranks 4th in quality (out of 4 locations) giving it an overall rank of 4th in this study based on the cost to quality ratio (cost 50%/quality 50%).

Northern Ireland performs relatively better in cost than quality with total costs of £13.18m, making it 19% more cost effective than the study average total cost of £16.32m. Northern Ireland has a quality score of 59.86, which is 40% below the study average quality score of 100.

#### INTERNATIONAL COST AND QUALITY RANKINGS AS A BIO-PHARMA MANUFACTURING CENTRE

Location	Overall		Quality		Cost		
	Rank	Rating (0-100)	Rank	Score	Rank	Index	Total Cost (GBP)
Singapore	1	100.00	1	141.61	3	100.89	16,467,391
San Diego (CA)	2	82.95	3	95.84	2	95.86	15,645,751
Scotland	3	76.54	2	102.74	4	122.51	19,995,000
Northern Ireland	4	75.87	4	59.86	1	80.74	13,178,591

<sup>40</sup>The Republic of Ireland cannot be benchmarked alongside Northern Ireland, Singapore, Scotland and San Diego as FDI Benchmark classes the Republic of Ireland as a country and the others as regions

### Clinical Development/Trials Centre

Northern Ireland ranks 1st in cost and ranks 4th in quality (out of 4 locations) giving it an overall rank of 4th in this study based on the cost to quality ratio (cost 50%/quality 50%).

Northern Ireland performs relatively better in cost than quality with total costs of £932,017, making it 25% more cost effective than the study average total cost of £1.25m. Northern Ireland has a quality score of 51.91, which is 48% below the study average quality score of 100.

#### INTERNATIONAL COST AND QUALITY RANKINGS AS A CLINICAL DEVELOPMENT/ TRIALS CENTRE

Location	Overall		Quality		Cost		
	Rank	Rating (0-100)	Rank	Score	Rank	Index	Total Cost (GBP)
Singapore	1	100.00	1	135.45	4	113.20	1,409,367
San Diego (CA)	2	90.26	2	113.53	3	112.71	1,403,285
Scotland	3	89.06	3	99.16	2	99.24	1,235,526
Northern Ireland	4	82.13	4	51.91	1	74.86	932,018

### Healthcare R&D Centre

Northern Ireland ranks 1st in cost and ranks 4th in quality (out of 4 locations) giving it an overall rank of 4th in this study based on the cost to quality ratio.

Northern Ireland performs relatively better in cost than quality with total costs of £1.46 million; making it 26% more cost effective than the study average total cost of £1.98m. Northern Ireland has a quality score of 54.15; which is 46% below the study average quality score of 100.

#### INTERNATIONAL COST AND QUALITY RANKINGS AS A HEALTHCARE R&D CENTRE

Location	Overall		Quality		Cost		
	Rank	Rating (0-100)	Rank	Score	Rank	Index	Total Cost (GBP)
Singapore	1	100.00	1	129.38	4	116.35	2,298,135
San Diego (CA)	2	97.43	2	118.31	3	109.03	2,153,447
Scotland	3	91.54	3	98.25	2	100.54	1,985,817
Northern Ireland	4	87.02	4	54.15	1	74.08	1,463,163

## Medical Devices Manufacturing Plant

Northern Ireland ranks 1st in cost and ranks 4th in quality (out of 4 locations) giving it an overall rank of 1st in this study based on the cost to quality ratio (Cost 50%/quality 50%).

Northern Ireland performs relatively better in cost than quality with total costs of £5.49m, making it 41% more cost effective than the study average total cost of £9.27m. Northern Ireland has a quality score of 61.85, which is 38% below the study average quality score of 100.

### INTERNATIONAL COST AND QUALITY RANKINGS AS A MEDICAL DEVICES MANUFACTURING CENTRE

Location	Overall		Quality		Cost		
	Rank	Rating (0-100)	Rank	Score	Rank	Index	Total Cost (GBP)
Northern Ireland	1	100.00	4	61.85	1	59.20	5,486,169
Singapore	2	95.00	1	143.08	4	150.22	13,920,377
Scotland	3	91.20	2	101.75	3	96.56	8,948,021
San Diego (CA)	4	88.46	3	93.39	2	94.02	8,712,615

## Stem Cells R&D Centre

Northern Ireland ranks 1st in cost and ranks 4th in quality (out of 4 locations) giving it an overall rank of 1st in this study based on the cost to quality ratio.

Northern Ireland performs relatively better in cost than quality with total costs of £5.49m, making it 41% more cost effective than the study average total cost of £9.27m. Northern Ireland has a quality score of 61.85, which is 38% below the study average quality score of 100.

### INTERNATIONAL COST AND QUALITY RANKINGS AS A STEM CELLS R&D CENTRE

Location	Overall		Quality		Cost		
	Rank	Rating (0-100)	Rank	Score	Rank	Index	Total Cost (GBP)
Northern Ireland	1	100.00	4	61.85	1	59.20	5,486,169
Singapore	2	95.00	1	143.08	4	150.22	13,920,377
Scotland	3	91.20	2	101.75	3	96.56	8,948,021
San Diego (CA)	4	88.46	3	93.39	2	94.02	8,712,615

The table below illustrates some key indicators across countries and regions. The figure breaks up the UK into all of its constituent countries including Wales and includes another small country, Finland which has a thriving pharma and LHS sector.

#### KEY LHS INDICATORS ACROSS COUNTRIES AND REGIONS

Location	Population (millions)	FDI LHS projects (2003-2014)	% Global LHS Projects	Jobs Created	Avg Jobs	Jobs Created per 100,000 Pop.	Capex £m	Avg Capex £m	Project Type
Northern Ireland	1.8	14	0.22%	1,146	81	63.6	73.48	5.24	7 new 7 expansions
Scotland	5.3	81	1.29%	4,922	60	92.9	1,046.41	12.93	36 new 42 expansions 3 co-locations
Wales	3.1	28	0.44%	2,139	76	69	242.00	8.62	15 new 10 expansions 3 co-locations
United Kingdom	63.2	484	7.66%	25,503	52	40.4	4,676.79	9.67	318 new 146 expansions 20 co-locations
Republic of Ireland	4.6	232	3.65%	23,181	99	503.9	8,056.80	34.7	113 new 98 expansions 21 co-locations
Singapore	5.3	201	3.18%	19,338	96	364.9	6,789.38	33.75	165 new 26 expansions 10 co-locations
San Diego cluster	3.1	41	0.65%	2,025	49	65.3	527.00	12.85	34 new 7 expansions
Finland	5.4	37	0.59%	962	26	17.8	242.00	6.53	31 new 5 expansions 1 co-location



## 3.5 LEARNINGS & CONCLUSIONS

A number of learnings resulted from the examination of Northern Ireland within the UK and international perspective. These include the following key learnings:

- Northern Ireland has only attracted 14 FDI projects since 2003. RoI has attracted 232 in the same time. Other regions of the UK like Scotland (13%) and Wales (8%) are attracting much higher per capita shares of FDI.
- The average number of jobs created per FDI project is relatively high (81) in Northern Ireland but again, the low number of projects means that LHS jobs created per capita is low compared to many of the rival locations benchmarked (63.6 per 100,000).
- Northern Ireland's average Capex per project, £5.24m, is the lowest of the regions benchmarked. Why are we unable to attract larger scale investment?
- The USA is the most important source country of FDI for all of the benchmarked regions, but UK itself is among the top donors of FDI projects.
- Pharmaceuticals and medical devices are generally the top two LHS industries for FDI among the benchmarked regions, but healthcare services is growing fastest.
- Sales and marketing, although a common activity of LHS FDI in the benchmarked regions, generally provides quite low Capex and jobs. Manufacturing and R&D provide better outcomes.

Northern Ireland has real strengths and an international reputation in oncology, respiratory illnesses, diabetes, ophthalmology & vision science, and cardiac disease.

Small size allows for a reactive Government. Strategies can be quickly developed and implementation plans put in place with minimum bureaucracy.

Closed loop healthcare systems create unique advantages for Northern Ireland in the UK and EU regional context around patient data analytics and forecasting, which leverages established IT and data mining capabilities.

In a regional and small nation context Northern Ireland seems to be punching below its weight in terms of the volumes of investment capital it has attracted. The high number of expansions in the sector makes this a double whammy where Northern Ireland does not have the base.

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FORESIGHT FOR THE FUTURE  
OF THE LIFE & HEALTH SCIENCES

4

## 4 FORESIGHT FOR THE FUTURE OF THE LIFE & HEALTH SCIENCES

This foresight chapter begins by outlining the megatrends emerging across sectors up to 2020 and beyond. These include:

- growth of the connected living market to US\$730b by 2020
- growth of the wearable electronics market from US\$14b to US\$70b by 2024
- growth of the big data market to generate a revenue of over US\$122b by 2025
- the increasing impact of multi-factor sensory based tracking technology on products to 2016 and beyond.

It then places the LHS within the context of these megatrends before providing an overview focused on the life & health sciences. The LHS overview looks at the key drivers and impacts which will affect demand for healthcare going forward, namely, ageing and the resulting impact of the development of health economics to address the increasing cost burden.

It then identifies particular LHS sub-sectors where demands exist around the increased market opportunities for personalised healthcare which can be met by the development of health economics and the resulting increased analytical capability. These sub sectors include:

- **Oncology** - Targeted therapies, driven by improved analytical capabilities, will be a key driver in the global oncology market going forward
- **Respiratory illnesses** (autoimmune/ infection) - improvements in patient management techniques like telehealth and advancing inhaler technologies will benefit this industry as it moves increasingly towards personalised health.
- **Cardiology/cardiovascular** - the global cardiovascular market recorded sales of US\$170b in 2010 and is set to grow to US\$187b in 2016 at a CAGR of 1.6%. Within that, the cardiovascular devices market will feature prominently, driven by the increasing incidence of cardiovascular diseases (CVDs) with an increasing elderly population.
- **Dementia** – in the medium term (2012-2019) there will market opportunities around improved and validated methods for early diagnosis and methods for measuring responses to treatment more rapidly and objectively.

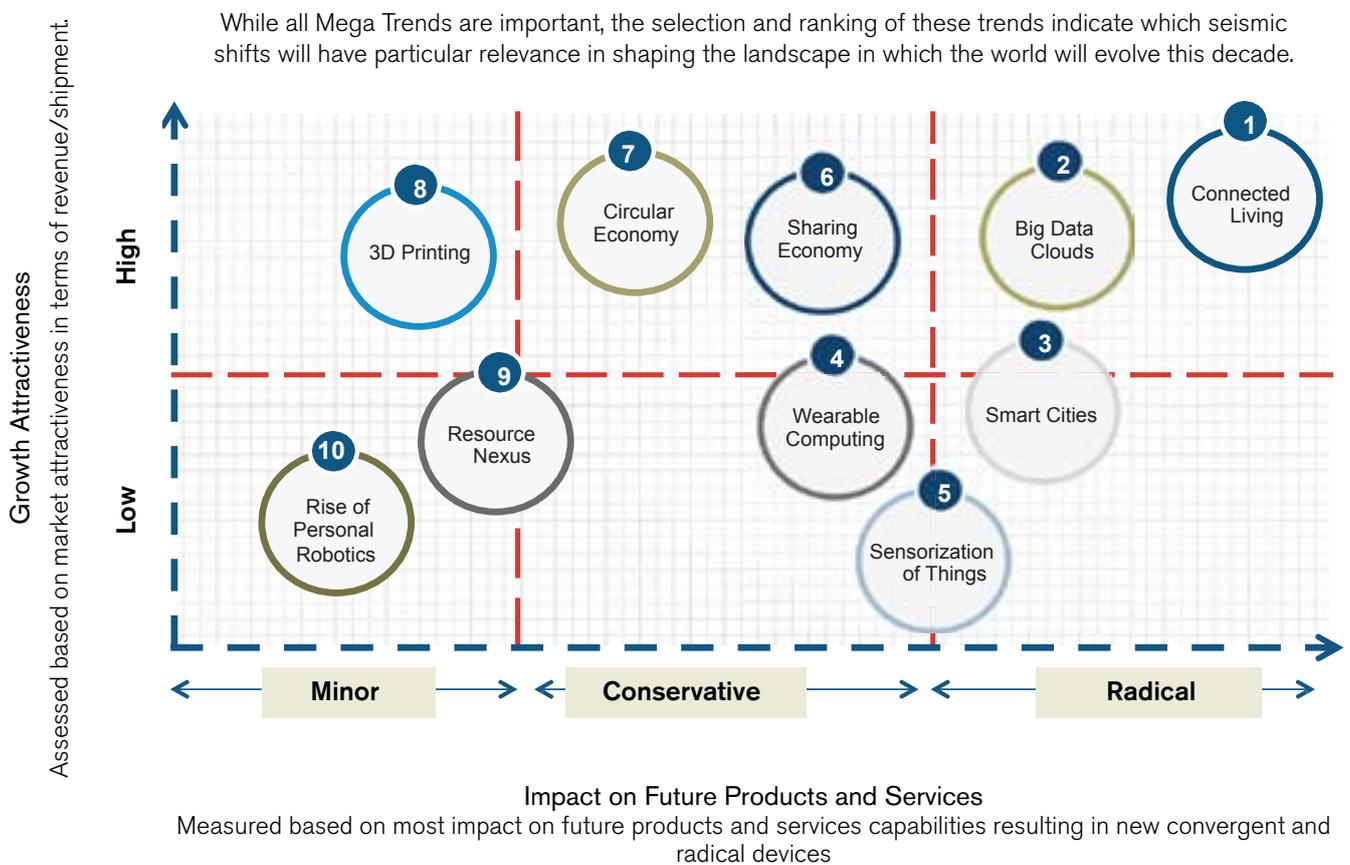
- **Diabetes** - in the medium term (2012-2019) there will be a focus on earlier diagnosis and intervention which will drive market opportunities. Self-monitoring blood glucose devices will also continue to be a growth market. Diseases associated with diabetic complications also represent a growth market and opportunities in this area link to ophthalmology opportunities.
- **Ophthalmology** - key opportunities within vision will be around conditions brought on by the driver of an ageing population. A key focus for the market will be the long-term self-management of ophthalmic conditions like glaucoma (35% of global ophthalmic market in 2010).
- **Obesity** - due to the launches of several novel drugs during the next decade, the obesity market will increase from US\$407m in 2012 to US\$8.4b by 2022, at a (CAGR) of 35.3%.
- **Rheumatoid arthritis** - by 2018, analysts forecast the immunology market will be worth over US\$38.5b as leading players focus on growing their rheumatoid arthritis franchises in the emerging markets.

Finally the chapter will look at the key enabling technologies and processes required to capitalise on these opportunities which includes big data, precision medicine and clinical trials, diagnostics and connected health.

## 4.1 MEGATRENDS

There are a number of transformational shifts that will come about by 2020, many of which will fundamentally change the LHS landscape. Research, illustrated in the figure below, has identified the top ten most significant of these shifts that will occur by 2020.

**FIGURE 10 - TOP TEN TRANSFORMATIONAL SHIFTS BY 2020**



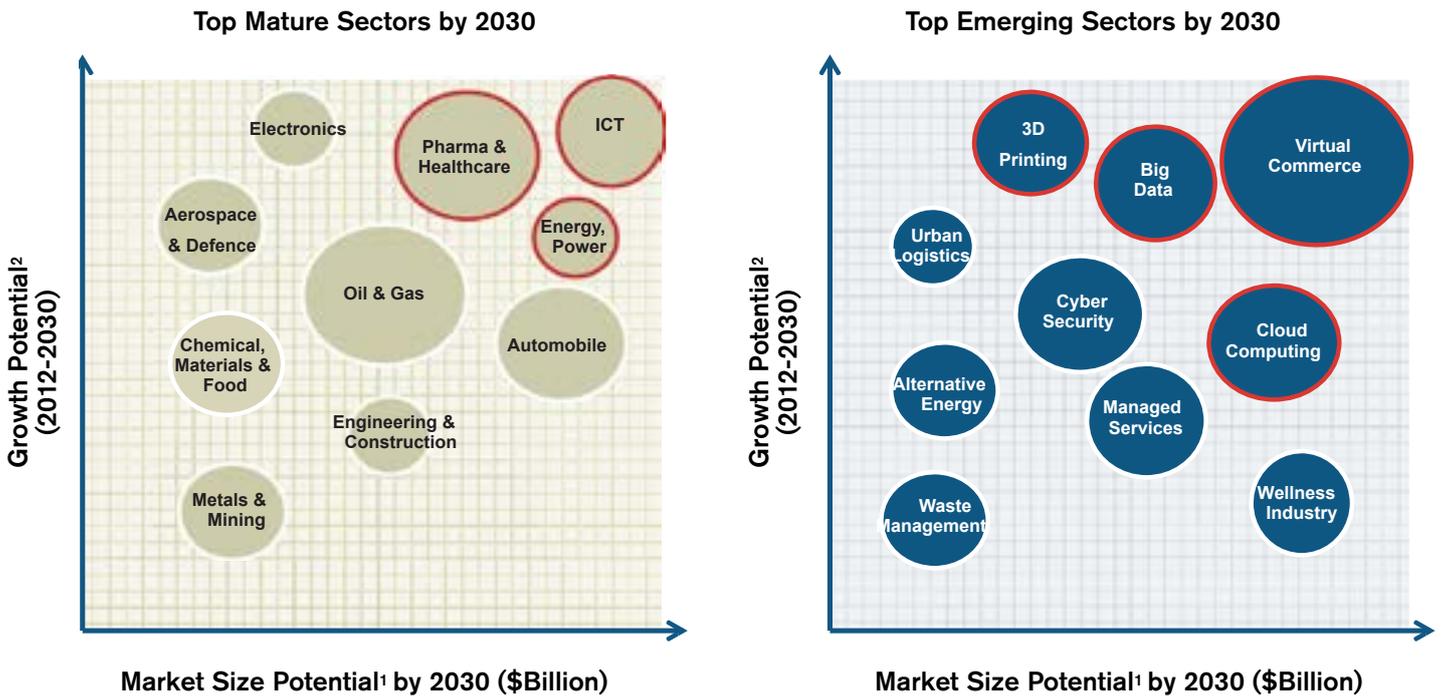


Within these trends there are a number which are particularly relevant to the development of LHS including:

- **Connected living** - the connected living market will be US\$730b in 2020. Technologies will lead to greater opportunities for earlier diagnosis, prevention and healthcare self-management.
- **Big data clouds** – cloud computing is and big data clouds are emerging as a mode of delivery for clinical decision supports and tools going forward.
- **Smart cities** – smart healthcare will make up 15.2% of the overall smart city market by 2020.
- **Wearable computing** - market research predicts that the whole wearable electronics business, will grow from US\$14b to US\$70b by 2024, with healthcare forming the main part.

- **Sensorization of things** - biosensors currently contribute more than 60% of the total wearable health technology revenue. The market was worth US\$2.7b in revenue in 2012 and is expected to reach US\$8.3b in 2018.
- **3D printing** - the dental and medical market for 3D printers is expected to expand by 365% to US\$867m (£523m) by 2025.

**FIGURE 10 - TOP MATURE AND EMERGING SECTORS BY 2030**



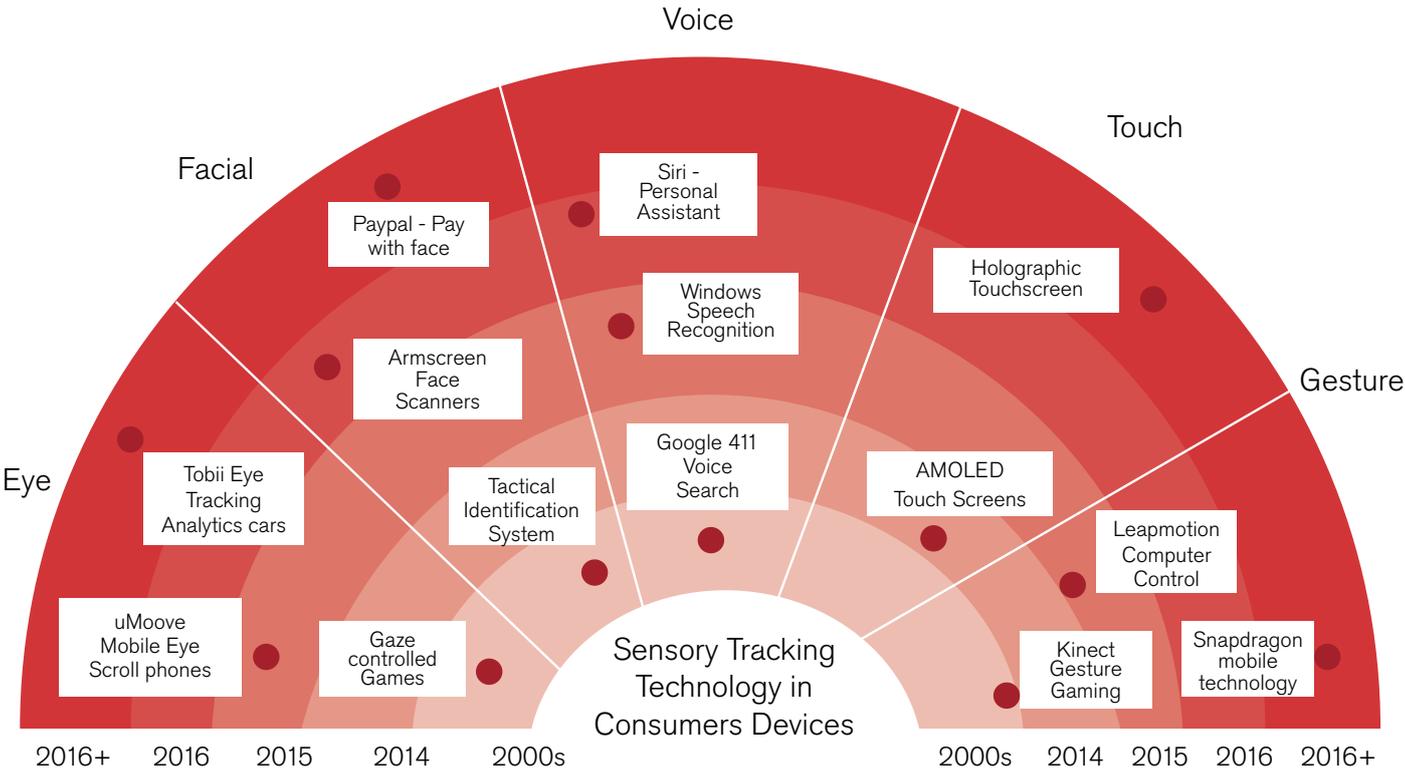
Within the top emerging sectors, one area which will have a major impact on the future of LHS is the area of big data. The global big data market is set to generate over US\$122b by 2025.

Additionally multi-factor sensory based trackers will also have a major effect on the field of personal devices which includes devices in the area of health and well-being. The figure below provides a radial timeline of the impact on products of sensory tracking technology.



**FIGURE 11 - ILLUSTRATION OF IMPACT ON PRODUCTS OF SENSORY TRACKING TECHNOLOGY**

The radical timeline diagram depicts which products are impacted in the next decade by sensory tracking technology in consumer electronics



Source: Frost & Sullivan Analysis



Wearable sensor technology promises the ability to transform healthcare. It provides the ability to get a continuous view of the patients' condition and to interact with the patient. This could transform care in three ways; healthier behaviours, better interventions and better treatments.

- **Healthier behaviours** - the ability to monitor the patient continually, combined with gamification, allows behaviour to be modified. For example, activity trackers can lead to changes in behaviour simply by making information visible to the individual, harnessing the 'Hawthorne effect' (a phenomenon whereby people improve or modify an aspect of their behaviour in response to the fact of change in their environment). This will drive wellness improvements. Longer term and continuous trend information is much more powerful than isolated data points which can be easily dismissed, rightly or wrongly.
- **Better interventions** – the ability to monitor the patient continuously allows more timely interventions to be made. These are often earlier, cheaper and lead to better outcomes for the patient. For example, certain behavioural changes and changes in sleep patterns are now known to act as early predictors of exacerbations in conditions such as MS, asthma, COPD, diabetes, cystic fibrosis and depression, to name just a few. Early interventions in all these cases can avoid deterioration, suffering and hospitalisation.
- **Better treatments** – the ability to collect longer term, continuous longitudinal data from patients living with different diseases, combined with information about their lifestyle, will provide researchers with a huge boost. By combining more reliable long term information about the progress of a disease with the associated genotypic and phenotypic information will lead to new and deeper understanding of diseases and disease mechanisms, which in turn will lead to new and improved ways of treating these diseases. In short, wearable technology could become the 'source' that feeds the 'big data' dream many are already talking about in healthcare.

The range of functions that wearable technology provides is also increasing with the advent of new devices such as Google Glass and new sensors. This means that in the near future wearable technology will be able to provide a wide range of functions over and above what is available today, such as:

- activity tracking
- sleep tracking
- coaching and feedback
- skin sensors such as heart rate, breathing, blood oxygen, and temperature
- augmenting reality by presenting additional information and guidance.

### **Megatrends support a shift in healthcare required by the ageing population**

Megatrends such as the use of big data, the use of wearable technology and the sensorization of things will support the shift healthcare required by the ageing population. These megatrends will facilitate a shift towards health economics and predictive analysis. This in turn will allow for an approach which is more focused on:

- preventative healthcare
- earlier diagnosis
- increasing personalisation of healthcare
- increasing self-management of health conditions (especially chronic ones).

## 4.2 FORESIGHT FOR LHS

### Overview

The foresight for LHS examines how the key **driver** of the growing ageing population and the resulting **impact** of the development of health economics will help meet the demands for increasingly personalised healthcare across several sectors.

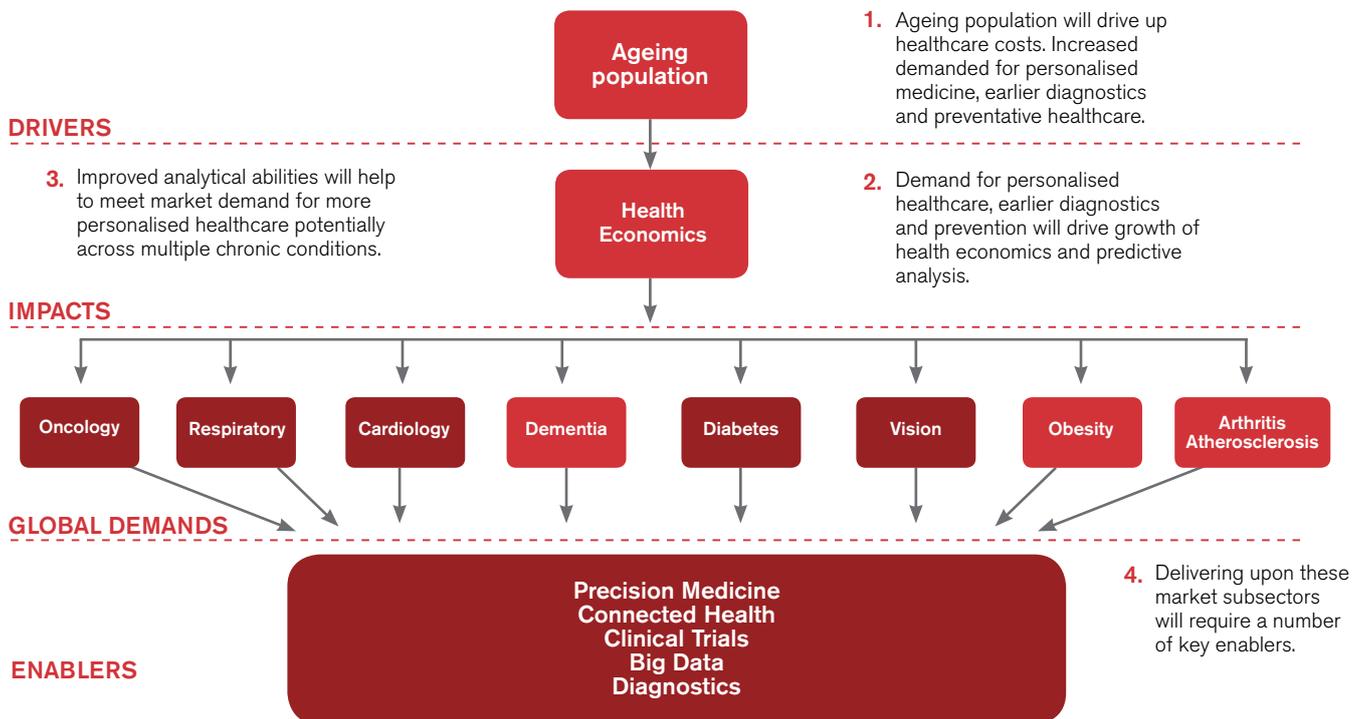
After summarising, at a very high level, the future **global demands** across sectors the overview will detail the key technological and infrastructural **enablers** that will be required in order to meet the demands across sectors. The figure below illustrates the relationship between the drivers, impacts, demands and enablers involved in the future development of the LHS going forward. Existing areas of strength are labelled in dark red; areas of opportunity in red.

### Drivers

The foresight exercise establishes first of all that one of the key drivers of future healthcare costs will be the increasingly ageing population.

The growth rate for the world's 65+ year-old population is projected to outpace that of the 0-4 year-old segment by 2020, thus increasing demand for LHS industry products and services<sup>41</sup>. The shared, long-term trends of an ageing population and an increase in the number of people living with chronic diseases are expected to drive demand for health care services in both developed and emerging economies in 2014 and beyond.

FIGURE 13 - ILLUSTRATION OF FUTURE LIFE & HEALTH SCIENCES DRIVERS AND IMPACTS



<sup>41</sup> <http://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/dttl-lshc-2013-global-life-sciences-sector-report.pdf>

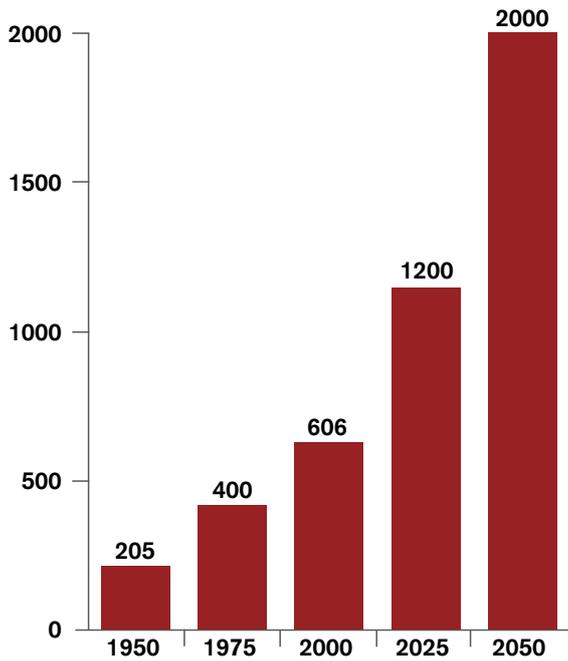


The global population aged 60 or above has tripled over the last 50 years and is expected to more than triple again over the next half-century, to reach nearly two billion in 2050<sup>42</sup>.

Dementia and related conditions are a huge burden on society, economically and socially. There are 7.7m new cases of dementia each year - a new case is diagnosed somewhere in the world every four seconds. Worldwide, as of 2013, there are 44.4m people with dementia and this number is predicted to grow to 75.6m in 2030, and 135.5m in 2050. Spend on dementia care currently represents 1% of global GDP, yet it is estimated that 75% of dementia cases go undiagnosed<sup>43</sup>.

This driver of an increasing ageing population and its associated cost burden will fundamentally change the way in which healthcare is delivered. There will be a paradigm shift in which health economics and predictive analysis will increasingly provide a new type of healthcare focused on earlier diagnosis, maintenance and prevention.

**FIGURE 14 - WORLD POPULATION OVER 60 (IN MILLIONS)**



**Impacts – focus on health economics**

Across the world, healthcare models are facing challenges, both physically and financially, to provide a growing, ageing population with an increasing burden of disease. The upward trend in spending means healthcare is becoming a more and more significant part of a nation's GDP, and the long-term sustainability of current models of provision is increasingly questioned. In order to reduce the cost burden healthcare is going to have to become increasingly personalised and more about prevention, self-maintenance and earlier diagnosis and treatment of conditions.

This increasingly personalised healthcare will require healthcare professionals to shift to a partnership model of personalised healthcare in which patients will play an active part in determining their own care and support needs.

There will also be an increase in the co-morbidity of chronic and long term conditions going forward. The development of rheumatoid arthritis, for example, almost doubles the risk of having a heart attack within the first ten years of getting a rheumatoid arthritis diagnosis, according to the American College of Rheumatology. There is a strong link between the inflammation associated with rheumatoid arthritis and heart disease.<sup>44</sup> Both diseases also have common biological pathways or biomarkers and many pharmaceutical companies are focusing on infection and inflammatory disorders within the same portfolio.

The area of infection is also a challenge in light of antibiotic resistance and our global economy, where infectious diseases can spread rapidly throughout the world.

The impact of all of this will be the development of health economics. Health economics will mean more predictive analysis, earlier interventions and more and more personalised healthcare. This health economics focus will allow key demands to be met across a number of health sectors.

<sup>42</sup> <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/dttl-lshc-2014-global-health-care-sector-report.pdf>

<sup>43</sup> <http://www.alz.co.uk/research/WorldAlzheimerReport2013.pdf>

<sup>44</sup> <http://www.webmd.com/rheumatoid-arthritis/guide/heart-disease-rheumatoid-arthritis>

## Global demands

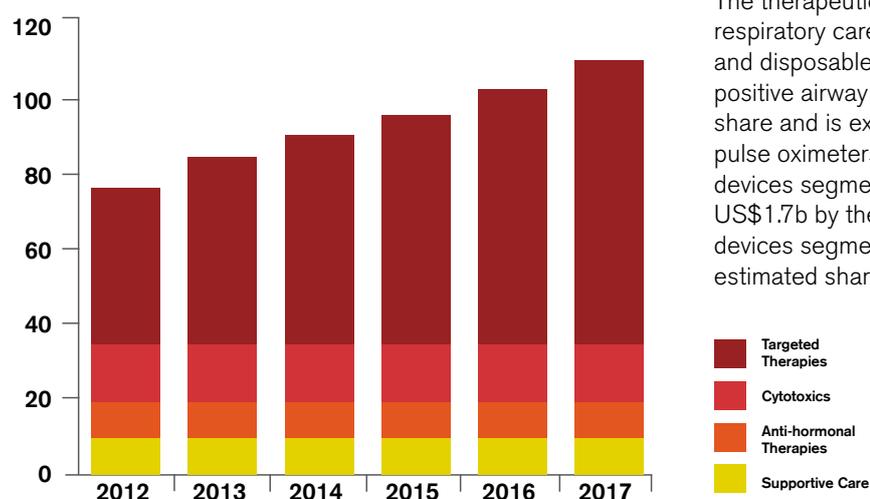
In particular there will be opportunities for more targeted and personalised care in a number of key sectors including:

- oncology
- respiratory illnesses (autoimmune/ infection)
- cardiology/cardiovascular
- dementia
- diabetes and its complications
- ophthalmology
- obesity
- rheumatoid arthritis/artherosclerosis

## Oncology

The global cancer market in 2010 was valued at \$54bn, an increase of 5.1% over the previous year's sales of US\$51.3b, and was forecasted to grow at a CAGR of 6.9% from 2010–16, reaching US\$81b in 2016. By 2030, the global cancer burden is expected to nearly double (from 2008 levels), growing to 21.4m cases and 13.2m deaths. And while that increase is the result of demographic changes – a growing and aging population – it may be compounded by the adoption of unhealthy lifestyles and behaviours related to economic development, such as smoking, poor diet, and physical inactivity<sup>45</sup>.

**FIGURE 15 - WORLDWIDE ONCOLOGY SALES ESTIMATES 2012-2017 BY THERAPY CLASS (IN USD BN)**



Targeted therapies, driven by improved analytical capabilities, will continue to revolutionize cancer treatment and are likely to be used in most cancer patients in the next ten years. Due to the high incidence and subsequent potential for market success, breast cancer and non-small-cell lung carcinoma (NSCLC) continue to drive high levels of R&D (along with other common diseases such as non-Hodgkin lymphoma, chronic myeloid leukaemia, and prostate cancer).

The global cancer market is becoming increasingly competitive, with two therapeutic classes, namely antineoplastics and cytostatic hormonal treatments, dominating this sector. Collectively, the leading ten brands accounted for almost 58.2% (or US\$31.4b) of the global cancer market in 2010.<sup>46</sup>

## Respiratory illnesses (Autoimmune/ infection)

The market for asthma and chronic obstructive pulmonary disease (COPD) therapies will reach US\$41.23b in 2017. That industry generated US\$34.15b in 2012, and its revenues will show strong growth to 2023<sup>47</sup>.

The market for asthma and COPD therapies accounted for 76% of the global respiratory market in 2012, as combination drugs continue to dominate the market<sup>48</sup>.

The global respiratory care devices market was expected to be worth US\$8.8b in 2010 and was estimated to reach US\$13.5b by 2015, growing at a CAGR of 8.8% from 2010–2015.

A large portion of growth then will be driven by the shift in healthcare identified at the start of this chapter. Therapeutics devices, for example, will help people maintain their health and handheld diagnostics tests and monitoring devices to allow for better diagnosis and management of conditions.

The therapeutics devices market dominates the global respiratory care device market, followed by monitoring devices and disposables. Within the therapeutics device market, positive airway pressure devices accounts for the largest share and is expected to be US\$5.2b by the year 2015. The pulse oximeters market dominates the respiratory monitoring devices segment and is expected to reach a market size of US\$1.7b by the year 2015. Within the respiratory diagnostic devices segment, spirometers dominate the market with an estimated share of US\$489m by 2015<sup>49</sup>.

<sup>45</sup> <http://www.cancer.org/myacs/newengland/global-cancer-burden-to-double-by-2030>

<sup>46</sup> [http://download.bion.com.cn/view/upload/201303/16084219\\_5745.pdf](http://download.bion.com.cn/view/upload/201303/16084219_5745.pdf)

<sup>47</sup> <https://www.visiongain.com/Sector/8/Pharma>

<sup>48</sup> <https://www.visiongain.com/Sector/8/Pharma>

<sup>49</sup> <http://www.marketsandmarkets.com/Market-Reports/respiratory-care-368.html><sup>48</sup> <http://www.cancer.org/myacs/newengland/global-cancer-burden-to-double-by-2030>



## Cardiology/cardiovascular conditions

Large changes are expected in the next decade, particularly with the ageing of population. This will increase disease burden, since the incidence and mortality of cardiovascular disease (CVD) are strongly associated to age.

According to the WHO, there will be about 23.6m deaths from CVD by 2030, primarily from heart disease and stroke. The incidence of CVD is expected to increase further in future due to an increase in behavioural risk factors, such as smoking, poor nutrition, lack of physical movement, type-A personality, high alcohol consumption and drug abuse. Behavioural risk factors are responsible for about 80% of coronary heart disease and cerebrovascular disease<sup>50</sup>.

The global cardiovascular market recorded sales of US\$170b in 2010 and is set to grow to US\$187b in 2016 at a CAGR of 1.6%. Within that the cardiovascular devices market will feature prominently, driven by the rise in CVDs with an increasing elderly population across the globe and an increase in risk factors such as diabetes, smoking, and hypertension, leading to the greater adoption of technological advancements.

The global cardiovascular devices market is forecast to grow at a CAGR of 4% during the period 2010-2017 to reach US\$43.4b by 2017. The cardiac rhythm management (CRM) devices category was the largest category in the global cardiovascular devices market in 2010, accounting for about 35% of the overall market.

The global CRM market was valued at US\$11.39b in 2010 and is forecast to grow at a CAGR of 4% to reach US\$15.16b in 2017. Within this category 'pacemakers' was the largest segment. The market for CRM has grown over the past five decades due to improved device function, advances in technology and implantation techniques, and a rapidly expanding set of clinical indications<sup>51</sup>.

## Dementia

Dementia is a major cause of disability and dependency among older people worldwide and impacts every country. There is a significant unmet clinical need in dementia care and currently no dementia disease modifying therapies available on the market.

In the medium term (2015-2019) there will be improved and validated methods for early diagnosis, new approaches to risk modifications, stratification for initial treatment recommendation and methods for measuring responses to treatment more rapidly and objectively<sup>50</sup>. In terms of dementia and other neurodegenerative diseases, in the longer the term (2019 –beyond) there will be further work on molecular stratification and validation of new biomarkers and measurement technologies and better methods for determining pre-disposition and new approaches to prevention and delaying onset<sup>52</sup>.

Northern Ireland does not currently have the depth of research capability required to grow this area at present. Significant investment in both academic and especially clinical settings would be required.

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<sup>50</sup> [https://www.asdreports.com/news.asp?pr\\_id=289](https://www.asdreports.com/news.asp?pr_id=289)<sup>51</sup> [http://download.bioon.com.cn/view/upload/201303/16084219\\_5745.pdf](http://download.bioon.com.cn/view/upload/201303/16084219_5745.pdf)

<sup>51</sup> [https://www.asdreports.com/news.asp?pr\\_id=289](https://www.asdreports.com/news.asp?pr_id=289)

<sup>52</sup> <http://www.c3health.org/wp-content/uploads/2009/09/Diabetes-in-Northern-Ireland-book.pdf>



Currently, there are 800,000 people living with dementia in the UK, a number that will grow to one million in less than ten years<sup>53</sup>. Dementia currently costs the UK economy US\$37b per year, more than cancer and heart disease combined<sup>54</sup>

The Prime Minister David Cameron launched his challenge on dementia report in 2012 which commits the UK to:

- boost dementia research by doubling current funding levels and mobilising the UK's world-class specialist facilities and strengths in neuroscience
- drive improvements in the way people with dementia are diagnosed, treated and cared for
- make communities more dementia friendly
- wearable technology to keep dementia sufferers safe.

Key technologies in the future will include:

- GPS
- actigraphy
- 3D gyroscopes
- GSM and body sensors.

Body worn devices on the patient can provide information on patient safety, activity, falls, body and ambient temperature and location as well as providing alert response mechanisms. These devices can also be waterproof and continue to operate during bathing and swimming.

Algorithms using data from body wearable devices can be used to assess gait – this is fast becoming a key to unlocking the progress of the disease. This information can be shared with care givers and clinicians to assess how best to support the patient.

Data from devices and supporting services can be used to unlock some of the mysteries of the disease. Phenomena such as sun-downing, seasonal influences and behaviour patterns are hidden from researchers and clinicians, outside of small studies or clinical trials. Data from large numbers of dementia sufferers and their environment could reveal new insights<sup>54</sup>.

## Diabetes - Trend towards earlier diagnosis and monitoring

In the medium term (2015-2019) of diabetes there will be more molecular tests for predicting those at risk of diabetes earlier interventions. There will also be better stratification of disease for new therapies and larger responder/non-responder data collections<sup>55</sup>.

The complications associated with diabetes are as important to the future of the market as the condition itself. Patients don't die from diabetes per se, but from complications of diabetes. The complications of diabetes will also have quality of life impacts that have associated economic and societal burden and will dominate the market in the future.

The blood glucose monitoring devices market is a very lucrative business within the diabetes care market with enormous future potential. The self-monitoring blood glucose market is primarily dependent on the number of diabetic patients. So with the growth in diabetic patients, blood glucose monitoring devices market is set to grow exponentially. At the end of 2013 there 382m people were diagnosed as suffering from diabetes and this figure is expect to rise further to 592m by 2035.

By 2013 self-monitoring blood glucose (SMBG) users had grown more than 50% from 2007. China has the highest number of SMBG device users while the US has the highest market share. The SMBG devices market is expected to grow with single digit CAGR, but its market is in double digit Billion US\$. The US controls the highest market share in the SMBG market worldwide. Four companies - Roche Diagnostic, LifeScan Inc., Bayer HealthCare and Abbott Laboratories - control nearly 50% market share of SMBG<sup>56</sup>.

In 2011 72,693 adults in Northern Ireland are registered as having diabetes. By 2020 over 94,000 people are expected to have diabetes in Northern Ireland – an increase due largely to obesity (41%) and ageing (29%).

Diabetes care costs Northern Ireland more than £1m per day or 10% of the healthcare budget and will be a key driver of the future landscape<sup>57</sup>. The rising burden placed by diabetes on the health system will cause it to be a key shaper of the future health landscape.

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<sup>53</sup> Alzheimer's Society

<sup>54</sup> Alzheimer's Society

<sup>55</sup> [http://www.abpi.org.uk/our-work/library/medical-disease/Documents/strat\\_med.pdf](http://www.abpi.org.uk/our-work/library/medical-disease/Documents/strat_med.pdf)

<sup>56</sup> [http://www.bizjournals.com/prnewswire/press\\_releases/2014/03/20/MN87221](http://www.bizjournals.com/prnewswire/press_releases/2014/03/20/MN87221)

<sup>57</sup> <http://www.c3health.org/wp-content/uploads/2009/09/Diabetes-in-Northern-Ireland-book.pdf>

There are a number of key actions outlined in the new diabetes strategy of the DHSSPS. These include:

- the creation of a resourced regional managed clinical network for diabetes drawing on established effective practice with appropriate clinical leadership
- the integration of diabetes clinical databases across acute and primary care to create an accurate diabetes register within a defined time frame
- the placement of personalised care planning and self-management at the centre of the diabetes strategy.

Northern Ireland can act as a test bed for the development of a range of different approaches to meet global diabetes future demands and trends. The area of diabetes care is also likely to be a future growth area for Northern Ireland, with future trends including:

- more aggressive treatment targets (i.e. initiating drug treatment sooner or to a lower target)
- widespread adoption of new therapy classes, such as SGLT2 inhibitors
- validation of clinical utility of new technologies such as continuous glucose monitoring (CGM) and artificial pancreas
- integrated care and how it is provided
- higher expectations of people with diabetes with regards to the standard of care they receive and their quality of life post diagnosis
- new IT systems to enable easier sharing of patient information among healthcare professionals to coordinate care
- specialist diabetes facilities
- training of healthcare professionals and education of people with diabetes and the wider population.

## Ophthalmology/vision Science

The ophthalmology market will be primarily driven in the future by the ageing population. In 2010 glaucoma was the largest segment in the global ophthalmic market and accounted for 35% share in 2010. It is predicted to grow at a CAGR of 2.5% to 2016. One of the key focuses with glaucoma is in the longer term self-management of ophthalmic conditions.

Age-related macular degeneration (AMD) represents one of the main areas of R&D interest for pharmaceutical companies, with a 109 compounds in various stages of development in 2010<sup>58</sup>.

The retinal disease segment was valued at US\$35b in 2010, and will be the fastest growing area, with a CAGR of 14.1% to 2016. The advanced AMD population will grow by 11% to 3.3m between 2010 and 2016 due to the ageing population. Other ophthalmic conditions are also expected to increase for the same reasons, including:

- Diabetic retinopathy (DR)
- Diabetic macular edema (DME)
- Retinal vein occlusion (RVO)

## Obesity

Obesity rates have doubled over the past 30 years, and globally 1.4b people are overweight and 500m are obese, according to WHO. By 2030, 50-60% of the population in many countries are expected to be classified as obese<sup>59</sup>.

According to medical experts, obesity is expected to become an indirect but leading cause of mortality and morbidity. It is a chronic medical condition that results in hypertension, type 2 diabetes mellitus, dyslipidemia, coronary heart disease and insulin resistance. Such factors contribute towards CVD, which is a leading cause of death.

These metabolic factors also significantly raise the risk for heart attacks, strokes and angina. Non-life threatening conditions linked to obesity include osteoarthritis, sleep apnea, gout and gallstones.

In addition, obesity predisposes to prostate, breast, and colorectal cancers<sup>60</sup>.

Due to the launches of several novel drugs during the next decade, the obesity market will increase from US\$497m in 2012 to US\$8.4b by 2022, at a CAGR of 35.3%, according to the forecasts of research and consulting firm Global Data<sup>61</sup>.

<sup>58</sup> <http://www.fuliachina.com/bbs/upfile/upattachment/2012-3/201231023433.pdf>

<sup>59</sup> [http://www.foodpolitics.com/wp-content/uploads/Globesity-Report\\_12.pdf](http://www.foodpolitics.com/wp-content/uploads/Globesity-Report_12.pdf)

<sup>60</sup> <http://www.companiesandmarkets.com/News/Healthcare-and-Medical/Global-anti-obesity-drugs-market-forecast-to-expand-at-10-9-CAGR-between-2014-and-2020/NI9209>

<sup>61</sup> <http://healthcare.globaldata.com/media-center/press-releases/pharmaceuticals/obesity-therapy-market-to-reach-84-billion-by-2022><sup>62</sup> [http://www.bizjournals.com/prnewswire/press\\_releases/2014/03/20/MN87221](http://www.bizjournals.com/prnewswire/press_releases/2014/03/20/MN87221)

## Rheumatoid Arthritis

In 2012, immunology drugs generated global sales of around US\$36.6b, of which two thirds were associated with the management of conditions related to rheumatoid arthritis (RA) (US\$24.5b), with the remainder of sales split evenly between the treatment of dermatological and gastroenterological conditions.

Revenues growth has been driven by improvements in diagnosis and early, more aggressive treatment of RA, the approval of new disease modifying anti rheumatic drugs (DMARDs), new formulations/devices and line extensions.

By 2018 analysts forecast that the immunology market will be worth over US\$38.5bn. This will in large part be the result of a growing focus on Rheumatoid Arthritis franchises in the emerging markets. The launch of innovative, targeted synthetic and biologic DMARDs to address unmet clinical needs and is set to carve out US\$3bn share of revenues in the European market.

### Enablers – Key technologies and processes to meet cross-sector demands

In order to take advantage of the demands and market opportunities referred to above, a number of key enabling elements will be required. These include:

- big data
- precision medicine and clinical trials
- diagnostics
- connected health.

### Big data

Big data is a key enabler in terms of meeting the demands for increasingly personalised healthcare across health sectors. The last decade has seen the rapid digitisation of patient records and years of aggregated research and clinical trials data. A large, and ever growing, bank of data is now available and increasing numbers of stakeholders are now looking to develop applications and tools to identify value and opportunities for the future delivery of healthcare.

Big data offers a range of potential benefits. It could be used, for example, to directly link prescribing within target groups to the needs of that same population. With appropriate data linkage it would be possible to identify the number of patients receiving a particular medication following an in-patient surgical procedure, and to determine whether this was consistent with current best practice.

The use of big data could be used, for example, to deliver upon future demands within the diabetes market. In Scotland, big data has already transformed the way in which diabetes is managed and treated, culminating in the production of an information rich database containing a large number of patients that have agreed to take part in clinical research on diabetes, making patient recruitment into clinical trials very fast and successful. It has improved clinical outcomes and the quality of care of patients with diabetes in Scotland, with decreased amputation rates and decreasing rates of diabetic retinopathy<sup>63</sup>.

Given that the HSC in Northern Ireland is a unique and considerable resource of data, the opportunity exists to use this resource to be at the vanguard in terms of shaping healthcare provision and management through big data analysis.

### Advanced drug delivery systems

Big data will also enable the development of new advanced drug delivery systems. By 2030, a blood sample taken at birth to determine a person's genome sequence will be the norm. Every five to ten years, the genome sequence will be analysed and updated for somatic mutations and epigenetic changes. This information will be used to predict disease predisposition and design personalised drug treatment<sup>64</sup>.

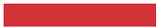
Bioprofile tools will allow clinicians, any time and anywhere, to routinely collect and analyse an individual's bioprofile and to objectively diagnose, screen, quantify disease severity and monitor progression and response to treatment. Visual presentation of the dynamics of the bioprofile over time would allow the condition to be monitored; it would also allow prediction and evaluation of the effectiveness of treatment; and prognosis of the disease.

Over the long term, personalisation of medication will lead to safer, more effective and accurate diagnosis, thus reducing treatment costs related to misdiagnoses and the side effects of drug treatment. This in turn will improve the quality of life and productivity of the population.

<sup>62</sup> <http://beforeitsnews.com/health/2014/01/global-rheumatoid-arthritis-disease-market-2018-forecast-analysis-in-new-research-report-2520864.html>.

<sup>63</sup> UKTI Proposition – Unlock your Global Business Potential: The UK digital health and care opportunity'

<sup>64</sup> Cost Foresight, Living the Digital Revolution



### Precision medicine and clinical trials

Precision or stratified medicine is another key enabler in terms of taking advantage of different health sector market opportunities. It will change the delivery and economics of medicine itself, particularly with the integration of genomic and other data to create much more tailored and individualised treatments.

Innovate UK has created a roadmap of the evolution of stratified medicine based on the clinical consensus of the different perceived technical needs and tractability of different disease areas<sup>65</sup>. It illustrates that stratified medicine will be required at a number of different intervals (short term, medium to long term and long term) to develop a number of health areas including oncology, respiratory conditions, diabetes and dementia.

Stratified and precision medicine are two related sectors of great immediate and long term significance to the health and competitiveness of the global medical and life sciences sector. This applies to healthcare providers, academic research and they key components of the Northern Ireland LHS sector, most notably CROs, diagnostics, research tools and IT and big data analytics, which we will term “bioinformatics”.

The panel defines stratified medicine as the process of using biomarkers to select groups of patients for clinical trials. These biomarkers are used to monitor response for the purposes of evaluation of a response further upstream and earlier in the drug discovery process. Biomarkers used for such “response evaluation” in clinical trials may progress to become companion diagnostics co-marketed with the drug. By using this definition, the panel believes that this area offers the largest market of relevance to Northern Ireland companies and researchers. It is also in effect a pipeline of new biomarkers platforms and services, of which only some will migrate eventually into the clinic.

Some of the diagnostic biomarkers subsequently become “companion diagnostics” that are mandated and co-marketed with the therapy. Currently the bulk of the market of around US\$20b resides in the provision of biomarkers, with associated products and services, for drug discovery as opposed to post market launch products co-marketed with the therapy.

### Stratified medicine reduces costs and allows for more targeted treatments

The benefits of stratified medicine are reduced time and cost of drug discovery and more targeted and effective treatments which have fewer side effects. This reduces costs on both sides of the healthcare divide and also significantly improves outcomes. When the biomarker use is extended to clinical practice, healthcare providers also benefit from overall reduced costs from better drug treatment and patient disease management. Stratified medicine will allow for a range of targeted and cost effective treatment across the different health demand markets.

Stratified medicine will enable major development in, for example, dementia. Today, there are no drugs that can cure dementia; only slow the disease progression. The first tranche of biomarker diagnostics are on their way, although several years from market entry. This will result in earlier identification of the illness and better intervention and approaches to treatment.

### Precision Medicine

Precision medicine is in effect the ultimate destination for stratified medicine enabling a very high level of tailoring of therapeutic intervention to the unique genetic make-up of the patient. It will use many of the techniques and processes developed at a group level in stratified medicine. One of the defining medium term features of personalised medicine will be the availability of full genome sequence data of the individual patient.



Precision medicine anticipates a future where a much greater amount of information is available, in particular patient specific whole genome data, to inform and personally tailor and target therapies to the specific needs of the patient. The advent of stratified medicine, which uses only a small fraction the potential available genomic and other “omic” biomarkers has already been profound. It has produced a very rapid convergence of diagnostics and therapeutics companies facilitating major pharma and in vitro diagnostics collaborations. There has been hugely increased emphasis on new biomarker discovery and validation in both research and commercial sectors.

The very process of drug discovery itself is now significantly dependent upon response monitoring biomarkers which may evolve into marketed companion diagnostics. These changes have created major new challenges and opportunities for CRO service companies and hugely increased demand for effective IT and bioinformatics services.

### **Diagnostics**

Another key enabler in terms of taking advantage of the market opportunities in the LHS sector is that of diagnostics. Over 70% of NHS clinical decisions are based on diagnostic tests. In all of the sectors outlined in the demands and market opportunities section above there is a need for earlier, more effective and more easy to use diagnostic tests.

#### **In Vitro Diagnostics (IVD)**

- 2m pathology tests are carried out every day in the NHS
- 70% of clinical decisions in the NHS are based on diagnostics test
- UK IVD market valued at £1.09bn in 2011
- UK IVD market has over 200 companies employing 4,000 full time staff.

The UK IVD market was worth US\$1.09b in 2011 and is one of the fastest-growing IVD markets in Europe, with growth forecast to average 7.1% from 2011 to 2018 - outpacing both France and Germany. The development of diagnostics will result in earlier diagnoses and the tailoring of earlier and better interventions across subsectors.

### **Point of care testing**

Point of care testing comprises of the performance of a test in the immediate vicinity to a patient to provide a rapid result outside the conventional laboratory environment. Laboratory medicine comprises services which provide knowledge and diagnostic information for the care of individual patients through the scientific analysis of specimens of blood, fluids, tissue and other samples.

Point of care diagnostics will also facilitate a shift towards more personalised care and more self-care, both of which will help to capture the opportunities across health sectors. Clinical commission groups will be seeking to improve prevention, reduce the costs of unnecessary testing and make better clinical decisions going forward. The use of point of care diagnostics and point of care platforms is expected to be a key enabler in the delivery of this.

The use of diagnostics, and especially companion diagnostics will fundamentally change the way in which care is delivered over the next ten years.

The evolution of companion diagnostics will represent a shift from single to multiplex analyses to guide treatment decisions and monitor treatment effect and the occurrence of acquired drug resistance .

### **Connected health**

Another key enabler in order to capitalise on the sectoral opportunities going forward will be the use of connected health and sensory technologies to alter the way in which healthcare is delivered. The global mobile health market for connected health will grow 32% CAGR to reach £35.7bn by 2020 and £35.7b by 2020<sup>65</sup>.

Market research firm IDTechEx predicts that the whole wearable electronics business, including glasses, jewellery, headgear, belts, armwear and wristwear, legwear and footwear, skin patches, exoskeletons and e-textiles will grow from US\$14b this year to US\$70b by 2024, with healthcare forming the main part. Connected health technologies will allow for increasing self-management of conditions and help to deliver point of care diagnostics.

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<sup>65</sup> UKTI Proposition – The UK Digital Healthcare Opportunity'



## Medical sensors market in healthcare

The medical sensors market was worth US\$2.7b in 2012 and is expected to reach US\$8.3b in 2018, growing at an estimated CAGR of 17.71% from 2013 to 2018. The global market's volume is expected to reach 134.27m units by 2018, growing at a CAGR of 30.36% from 2013 to 2018. Bio sensors alone contribute more than 60% of the total wearable health technology revenue<sup>66</sup>.

## Connected health will help to meet demands across sectors

Connected health and sensory technologies will allow Northern Ireland to meet demands across health sectors going forward. Dementia provides a good example. The economic and social burden of dementia is primarily on the patient and the immediate caregiver's. Technology will be crucial then in assisting with the care of the patient and to support the caregiver's needs.

Across all sectors drug adherence is frequently cited as an unmet need by clinicians but patients don't see the benefit, the drugs aren't efficacious enough. Technology such as smart pills and drug use sensors can provide adherence data and also detect overdosing, providing information to support prescribing.

## Wearable point of care diagnostics

Lab-on-a-chip (LOC) devices integrate and scale down biomedical and other analytical laboratory functions to a miniaturised chip format. Their small size and low power requirements, and the speed at which they provide results, offer possibilities for moving many diagnostic and analytical activities out of fixed, centralised, facilities and provide real-time information to, for example, health staff at surgeries and other remote locations. LOCs are therefore an important component of 'e-health', as well as having many non-health applications, such as pollution and contamination monitoring.

Applications of LOC devices include rapid in-situ detection, clinical diagnosis, forensic science, electrophoresis, flow cytometry, blood chemistry analysis and protein and DNA analysis.

The advantages of LOCs include the miniaturisation of testing devices, efficient use of chemical reagents, improved bio-assay, and improved portability of detection and assay systems.

LOCs promise the potential for new point of care diagnostics and wearable diagnostic capabilities that will fundamentally change the way in which healthcare practice is carried out. IBM, for example, has developed a capillary-based chip that will allow a drop of blood to be screened for different disease markers in within minutes<sup>67</sup>.

## Smart Pill Technology

The current poor compliance with drug delivery regimes are widely understood to cause around 3% of global healthcare expenditure approximately US\$5.5 trillion to be wasted, i.e. US\$165bn pa wasted each year, which is money society can no longer afford to 'flush down the global toilet'.

Smart pills containing RFID technology and skin patches equipped with microcircuits, are powering a wearable and digestible healthcare revolution in which constant monitoring and advanced data analysis are key. The technology offers patients the ability to better track and manage their diseases, while helping healthcare companies to monitor patient progress. Crucially, pharmaceutical companies are in on the act as they attempt to find new ways to treat disease and grow their revenues.

Smart pill technology, with the associated wearable sensor which acts as a communication hub between the ingested product and a mobile phone, is on the cusp of becoming a day to day actuality. Companies are entering the market with ingestible sensors, which run on the electrical charge found naturally in the human body, giving a new dimension to the compliance challenge. Although day to day user numbers are still low, the reality of being able to know when a specific pill, tablet or other product has been ingested is upon us. Patients, carers and clinicians are now able to use real time information about medication taking, combined with activity and rest data, to make informed, collaborative treatment decisions as well as giving carers a level of comfort via remote monitoring for when they aren't able to be present.

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<sup>66</sup> <http://www.whatech.com/market-research-reports/press-release/consumer/28316-jsb-market-research-wearable-electronics-market-and-technology-analysis-2013-2018-by-components-sensors-battery-display-networking-applications-consumer-healthcare-enterprise-products-smart-textiles-glasses-watches-e-materials-geography>

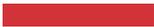
<sup>67</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/288571/10-1252an-technology-and-innovation-futures-annex.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288571/10-1252an-technology-and-innovation-futures-annex.pdf)

## Leveraging Northern Ireland sectoral strengths

In meeting future market opportunities Northern Ireland can rely on a number of areas of strength with LHS. These are illustrated in table 14 below.

### KEY NORTHERN IRELAND SECTORAL STRENGTHS/CAPABILITIES OF LHS DEVELOPMENT

<b>Drugs, devices and diagnostic development</b>	Northern Ireland has a strong reputation in oncology and cardiology diagnostics and is home to two of the UK's largest diagnostics companies. Northern Ireland has also developed new diagnostics for accurate diagnosis (multiplex testing), prevention and risk assessment.
<b>Clinical trials</b>	Northern Ireland particular strengths lie in oncology, vision science, cardiology, opthalmology and respiratory conditions. The NICTC demonstrates key infrastructural strengths in this area.  Northern Ireland Ireland has also has well developed relationships key bodies such as the Wellcome Trust-Woolfson Foundation Clinical Research Facility and CROs such as Celerion, Biokinetic Europe and O4 Research.
<b>Connected health</b>	Northern Ireland's strength in connected health is in the management of long term, chronic conditions. One of the responses highlighted that the largest volume of jobs was driven by 'hands-on' care. The TF3 telemonitoring service, for the remote monitoring of chronic conditions and the elderly, was also specifically mentioned and long standing strengths at both universities were recognised. The area has seen encouraging spin-outs from NIBEC, smart homes within SERG and the development of successful ecosystems and industry led alliances.
<b>Health analytics</b>	Northern Ireland has key infrastructural capability through bodies like the Administrative Data Research Centre, the HSC Safe Haven, iHAC and companies such as Exploristics and Kainos.  Data analytics was a recurring theme in discussion between the LHS Panel and ICT MATRIX chairs. The potential around the new Honest Broker – Safe Haven which the HSC has recently established was identified.  The use of key data sets could lead to improve data mining. More more robust algorithms, greater evidence based discovery, predictive modelling and trending systems etc. are all of strong interest and there is a desire to increase skills, training and an understanding of this powerful asset in Northern Ireland.
<b>Precision medicine</b>	Northern Ireland has particular strengths around the development of diagnostics to determine the response of colorectal cancer patients to anti-EGFR therapy and in the treatment of breast cancer.  There are important infrastructural elements in the Northern Ireland Biobank and Centre for precision medicine.  Biomarker discovery and development are pillars of research at QUB across many disease areas (mainly oncology and respiratory disease) and the basis for the two main companies in this field - Almac Diagnostics and Randox Laboratories Ltd.  The Northern Ireland Biobank is able to access NHS tissue archives and enhance the biobank resources through the selective creation of unique tissue microarrays (TMAs) and DNA libraries for particular cancer types. All of these samples are linked anonymously, with robust clinical outcome data which has been gathered through partnerships with clinical care teams in the trust.  The Northern Ireland Centre for Stratified Medicine at C-TRIC aims to translate advances in personalised medicine into enhancements in the delivery of care for key degenerative diseases of ageing, through research and the connection of key stakeholders. Areas of research focus include head and neck and prostate cancer.



**HSC –  
Integrated  
Social &  
Healthcare  
Record**

Northern Ireland is also unique within the UK in that its health and social services are integrated, so providing a unified approach to patient engagement. The five HSC trusts form a 'manageable' region where the main actors form a closed loop healthcare system.

This closed loop healthcare systems create unique advantages for Northern Ireland in the UK and EU regional context around patient data analytics and forecasting, which leverages established IT and data mining capabilities.

Northern Ireland has a unique position on structural integration of HSC. Health and care integration is now a key policy driver for health & wellbeing improvement globally, and in particular in the US, UK and by the European Commission.

This presents opportunities for Northern Ireland to take a leadership position, and thus create economic opportunity by the development of products and skills for international markets.

The task of the strategy group will be to wed the capabilities identified (both in chapter 2 and in the above table) with the market opportunities identified throughout this chapter. The strategy group will then have to establish areas of overlap between the capabilities and strengths and the trends and market opportunities going forward in order to formulate a series of recommendations.

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5 BRIDGING THE GAP – CREATING THE  
RIGHT FRAMEWORK CONDITIONS

5



## 5 BRIDGING THE GAP – CREATING THE RIGHT FRAMEWORK CONDITIONS

This chapter provides an overview of the requirements and interventions required in order to capitalise on the future trends in the Northern Ireland LHS ecosystem. There are a number of key initiatives that have to take place to build up critical mass in areas like skills and funding. Additionally, there is a need for infrastructural developments and changes to the way in which regulatory and procurement processes are managed.

This chapter provides a thematic overview of the issues and requirements that need to be addressed in designing Northern Ireland's LHS interventions going forward. It first looks at the key thematic enablers that need to be addressed in future interventions in the Northern Ireland LHS sector.

These include:

- human capital – skills (quantity and quality)
- funding
- FDI
- entrepreneurship
- leadership
- legal framework
- networks and collaboration
- procurement (as a way to drive innovation)
- regulatory framework
- infrastructures

The chapter then provides an overview of the coordinated approach and the issues to be addressed in scoping the HILS Hub and supporting physical infrastructure in Northern Ireland.

In order to build the right framework conditions for the LHS in Northern Ireland going forward there will be a need to deliver upon areas such as skills, funding, FDI and the other enablers detailed in the table below. In order to design the right interventions to ensure that Northern Ireland can take full advantage of future LHS opportunities all of the areas below will have to be addressed.

## ILLUSTRATION OF LHS ENABLERS REQUIRED TO ALLOW FOR THE DEVELOPMENT OF THE NORTHERN IRELAND ECOSYSTEM

<b>Human capital – skills (quantity and quality)</b>	<ul style="list-style-type: none"> <li>▪ Health economics and predictive analysis as well as a range of attendant skill sets are required, including:             <ul style="list-style-type: none"> <li>» statistical, analytics skills and bioinformatics skills (specialisation within these skillsets)</li> <li>» skills around software development, data analysis, programming, computational thinking and embedded systems (incorporated into degree courses)</li> <li>» chemistry, analytical and medicinal analytical skillsets especially at the undergraduate level</li> <li>» LHS specific legal and regulatory skills (especially skills developed inhouse)</li> <li>» business and strategic skills for clinicians and scientists</li> <li>» research skills. (especially the development of a mixture of clinical and research skills).</li> </ul> </li> <li>▪ Continued emphasis on STEM at all levels needs to be reinforced (examples of good practise with STEM Ambassadors).</li> <li>▪ An approach to build cross-disciplinary capabilities at all levels of education needs to be put in places, which could include:             <ul style="list-style-type: none"> <li>» examples of good practise CPD and short courses</li> <li>» adequate interfaces between disciplines (Chemistry, Biology, Physics, Analytics, etc).</li> </ul> </li> <li>▪ More effective promotion of LHS including the development of a co-ordinated voice of skills needs from a commercial perspective.</li> </ul>
<b>Funding</b>	<ul style="list-style-type: none"> <li>▪ An easily accessible single repository explaining sources of funding (EU/ UK/ NI) available to LHS companies.</li> <li>▪ Specialised funding and more coherent funding approach including:             <ul style="list-style-type: none"> <li>» more coherent and phased LHS funding</li> <li>» sufficient funding focus on specific areas to achieve critical mass</li> <li>» more private equity involvement.</li> </ul> </li> <li>▪ There is a need for ring-fenced LHS funding.</li> </ul>
<b>FDI</b>	<ul style="list-style-type: none"> <li>▪ More leadership within FDI policy is required (this should be considered as part of the establishment of a Chief Scientific Officer).</li> <li>▪ Stronger, coherent messages and political backing for the development of LHS FDI are required.</li> <li>▪ LHS sector champions could promote Northern Ireland's global stars.</li> <li>▪ FDI by acquisition should be put on the agenda as an acceptable economic development option</li> </ul>
<b>Entrepreneurship</b>	<ul style="list-style-type: none"> <li>▪ LHS should be made as attractive as other sectors like IT.</li> <li>▪ The cost of starting up a company in the traditional LHS space is high compared to other sectors (due to regulatory costs etc.).</li> </ul>



<b>Leadership</b>	<ul style="list-style-type: none"><li>▪ It is important to build a committed visible leadership and co-ordination capability for the sector. A facility whereby decision makers within industry, academia and government could meet to make decisions for Northern Ireland would dramatically progress this issue.</li><li>▪ Development and implementation of a more coherent LHS strategy, including:<ul style="list-style-type: none"><li>» developing and implementing a more coherent and targeted LHS strategy (across all stakeholders) to attract more and higher quality FDI</li><li>» developing liaison teams to link all stakeholders and, separately, sectoral investment leads within the UK Office for Life Sciences.</li></ul></li></ul>
<b>Legal framework</b>	<ul style="list-style-type: none"><li>▪ Current IP arrangements should be reviewed to leverage internationally proven IP models that will enable companies to operate more freely and bring better balance on IP issues between industry, academia and HSC.</li><li>▪ Standard R&amp;D contracts should better meet the needs of both academia and industry.</li></ul>
<b>Networks and collaboration</b>	<ul style="list-style-type: none"><li>▪ There is insufficient dedicated and protected time for R&amp;D within HSC. A better understanding of the R&amp;D process is required to bring innovation to market.</li><li>▪ Adoption of new technology must be visibly demonstrated. Only through evidence of adoption of new technologies can we promote Northern Ireland as an innovative healthcare system and so attract innovative companies.</li><li>▪ There is a disconnect between the pace of the market and the pace of academic research.</li><li>▪ More market insight and better identification and understanding of the commercial drivers of activity in LHS is needed. In England, for example, clinicians have time allotted to research in their weekly schedules and this could be repeated here.</li><li>▪ More incentives to collaborate are needed. The Health Service should develop more effective systems to work with entrepreneurs.</li><li>▪ Clinical research and development capability needs to accelerate, convert value and validate innovation.</li><li>▪ Creative thinking in the LHS sector must be harnessed - Northern Ireland has one of the lowest uptakes of innovative practices and medicines in Europe.</li><li>▪ Clinicians and innovators must understand one another's needs.</li></ul>
<b>Procurement (as a way to drive innovation)</b>	<ul style="list-style-type: none"><li>▪ Interfaces between clinicians and procurement functions should be streamlined to ensure that industry fully understands the user's needs as part of the procurement process. This will mean creating the right incentives for clinicians to free up time for innovation and procurement activities.</li><li>▪ Ways to improve leverage of funds from the Small Business Research Initiative (SBRI) should be developed.</li><li>▪ Procurement guidelines are often followed to the letter at the expense of the underpinning objectives</li></ul>
<b>Regulatory Framework</b>	<ul style="list-style-type: none"><li>▪ Access to data, including patient data, needs to be streamlined to better support innovation and emerging big data, data analytics and health economics capabilities.</li><li>▪ Better support for indigenous companies through regulatory approval process (CE, FDA etc.) is needed.</li><li>▪ Clinical trials need to have a more joined up governance process which includes:<ul style="list-style-type: none"><li>» points of accountability</li><li>» reduced time for approval process.</li></ul></li></ul>
<b>Infrastructure</b>	<ul style="list-style-type: none"><li>▪ Northern Ireland needs a physical infrastructure which includes:<ul style="list-style-type: none"><li>» a bio-incubator that provides clean labs, wet labs, administrative space and funding advisors</li><li>» more lab space that is GMP ready - there is a debate over whether Northern Ireland is currently in a position to offer this</li><li>» support for the need for more spin outs</li></ul></li></ul>



## **Supporting physical infrastructure**

The HSC R&D Strategy, recognises the importance of cohesion between the MATRIX Foresight Report for LHS and the strategy itself. The biggest commitment laid out in the HSC R&D strategy is the establishment of a biomedical research facility.

Most of the UK LHS sector benefits from a biomedical research facility – in England in particular, the Department of Health has recognised the importance of a joined up approach and shared priorities with regard to research and innovation between healthcare trusts and academia. Thus translational research – harnessing academic insight, leveraging commercial collaborators, and focussing on patient need has become the norm rather than the exception.

Significant funding has been placed into Biomedical Research Units (BRUs), Biomedical Research Centres (BRCs) and more recently Academic Health Science Centres (AHSCs). These have aligned research and innovation activities between academia and health trusts, created integrated governance frameworks with greater efficiency and driven significant government and private investment in infrastructure and research programmes.

The centres, modelled from early such structures in the US and Scandinavia, have created world-leading facilities with a huge critical mass of research expertise which is globally competitive. Recent Innovate UK (TSB), EC and Research Council funding through life and health science-related programmes (including catapults) has added to the investment as these large, integrated centres facilitate more and more success. Areas without such forward thinking infrastructure (physical, governance, expertise etc.) will lag behind. Whilst patient need and patient outcomes are at the heart of these models, the attractiveness to industry cannot be underestimated. Those companies involved in precision medicine, drug discovery etc. are keen to access clinical research facilities, to draw on academic insight into clinical research (trials) and accelerate the time to market through smooth, integrated structures.

Northern Ireland, unlike the rest of the UK, does not benefit from a biomedical research facility. The development of such a facility - if delivered with sufficient scale and ambition - could offer the opportunity to realise a step change in the development of the LHS sector in Northern Ireland.



A coordinated approach to addressing the following issues should be considered in scoping infrastructure requirements:

- **Leadership and co-ordination**

Panel members highlighted the importance of building a committed, visible leadership and co-ordination capability for the sector. A facility whereby decision makers within industry, academia and government meet to make decisions for Northern Ireland would dramatically progress this issue.

- **Collaboration**

Panel members reiterated the importance of collaborative infrastructure in the LHS. One response specifically suggests that the provision of a new infrastructure for stakeholder collaboration would allow the HSC and private industry to learn from each other and develop a shared vision. There are similar themes emerging that are shared across other companies, such as issues surrounding regulatory compliance, clinical evaluations, funding, developing, retaining or attracting the right talent and also working with or within the HSC.

- **Training and development**

The need for training and development capability is highlighted. This covers establishing a knowledge centre to accelerate innovation through collaboration and the development of open innovation platforms. The new HILS Hub could have a key role in leading programmes that enable skills development and education of stakeholders across disciplines.

- **Dedicated bid and grant application.**

It is suggested funding streams be mapped to areas of excellence and that funding partners are proactively sought. Additionally services that are currently available to help companies complete funding applications should be “marketed” more effectively and could potentially be delivered centrally.

- **Incubation and start-up space**

Provision of space at reduced costs for new start-ups along with the provision of mentoring and assistance should be considered.

- **Development and implementation of a more coherent LHS strategy**

A recurring issue is the need to develop and implement a more coherent and targeted LHS strategy (across all stakeholders) to attract more and higher quality FDI. It is suggested that liaison teams linking all stakeholders and sector specific investment leads be created within the UK Office for Life Sciences.



APPENDIX 1



# APPENDIX 1A: UNIVERSITY AND RESEARCH CENTRE PROFILES

## The Centre for Cancer Research and Cell Biology (QUB)

### About:

The Centre for Cancer Research and Cell Biology (CCRCB) at QUB is a cross-faculty, interdisciplinary research centre with over 300 clinical and basic researchers from across the world and is committed to the highest quality of research excellence. Specific focus groups are:

- advanced radiotherapy
- breast
- gastrointestinal
- haematological malignancies
- ovarian
- prostate and bladder

The CCRCB research programme has been underpinned by the construction of a 5,000m<sup>2</sup> purpose built facility<sup>68</sup>. The building, which opened in July 2007, has five floors comprising new research laboratories, write-up areas for post-doctoral research staff and postgraduate students, meeting/seminar rooms and modern administrative office space.

CCRCB is structured across two research divisions. The principal programme within the centre addresses cell biological aspects of cancer cell and molecular biology. The programme of the Clinical Research Division has a strong clinical translational and clinical trial focus.

The research infrastructure is supported by expertise in core technologies including the biological resource unit, bio-imaging, tissue processing and bio-banking facilities. The CCRCB provides an environment in which clinical scientists can work alongside and interact with basic research colleagues in a variety of laboratory programmes.

### Impact:

Core 'measures of impact/esteem'

- First class research facility which was designated as a Cancer Research UK Centre of Excellence in 2009.
- Prostate Cancer Movember Centre of Excellence.
- CCRCB secured approximately 25% of the competitive income generated by the university as a whole (approximately £15m last year).
- Levers additional funding: e.g. from research councils, The Wellcome Trust, NIHR, CRUK and other charities.
- Centre works in partnership with biotech and pharmaceutical companies to deliver applied research in personalised medicine.
- Spin out companies achieved - Almac Diagnostics and PathXL.
- £13m CCRCB Almac Discovery Joint Programme in Cancer Discovery, launched in September 2013.
- Collaboration with Almac has developed the DDRD Assay (now licensed) and ALM201.

<sup>68</sup> <http://www.qub.ac.uk/research-centres/CentreforCancerResearchCellBiology/Research/EnablingTechnologies/MolecularPathologyandBiobanking/>



## Molecular Pathology and Bio banking

### About:

The Molecular Pathology Programme at CCRCB includes the Northern Ireland Molecular Pathology Laboratory (NI-MPL), the Northern Ireland Biobank (NIB), the Digital Pathology Programme and an incipient Comparative Pathology Group. The Molecular Pathology Diagnostic Unit is a partnership between CCRCB and the Belfast Trust. NI-MPL is a self-contained, purpose-designed, nationally accredited hybrid operation, capable of performing molecular pathology translational research and molecular diagnostics of solid tumours.

Molecular pathology research in Belfast involves academics at QUB and clinicians within the Belfast Trust tissue pathology laboratories and is underpinned by the new Northern Ireland Biobank. The vision of the biobank is to host and distribute a collection of well defined, quality assured biological samples to support translational research programmes in Northern Ireland and beyond.

### Impact:

Within the first 15 months, the programme has attracted research funding and diagnostic structural funds in excess of £1m, has validated some of the core molecular diagnostic tests and has taken part in some of the published work of CCRCB<sup>73</sup>.

## Centre for Infection and Immunity

### About:

This interdisciplinary research centre which opened in 2010 is committed to the highest quality of research excellence and has over 50 clinical and basic researchers. The centre houses clinical and basic science researchers leading international programmes investigating the role innate and adaptive immune responses to infection and tissue injury and how these might be targeted to develop effective new treatments.

The centre's research is primarily focused on lung diseases, with major programmes in asthma, cystic fibrosis (CF), lung infection and acute lung injury. The centre supports a highly interactive and collaborative, multidisciplinary environment between molecular immunologists, microbiologists and clinical researchers.

The centre has a strong translational research emphasis, developing novel therapeutic strategies, using in vivo models of disease and conducting clinical trials including early phase programmes. This is supported by NICRN and international collaborations in asthma, CF and early drug development. It also has strong links with industry partners in biotech and Pharma.

### Impact:

The centre collaborates with Randox in the development of diagnostic assays and with Celerion, a local CRO, in the design and execution of clinical trials.

The centre is one of the nine centres of research excellence within the Inflammatory Respiratory Disease Translational Research Partnership.

Prof Stuart Elborn, an internationally recognised CF expert, led the original trial for Ivacaftor, the first ever drug that targets the underlying cause of CF and, which has been approved for patients with the G551D genetic mutation, also known as the 'Celtic Gene'.

Staff at the centre and in the School of Pharmacy are lead partners in new €6 million global research programme, known as CF Matters.

## Centre for Experimental Medicine

### About:

The Centre for Experimental Medicine (formerly known as the Centre for Vision and Vascular Science) is a multidisciplinary research centre focussed on eye disease and vascular dysfunction, particularly relating to diabetic complications. The centre has over 60 basic and clinical scientists working in areas of retinal angiogenesis, diabetic retinopathy, age-related macular degeneration (AMD), genetics and microvascular biology.

The centre will move to a new building, in 2015, representing a £32m investment supported by the Wellcome-Wolfson Capital Awards Initiative and philanthropic funding from Queen's Beyond campaign.

It will bring together on the same site, in state-of-the art research facilities, over 1,000 leading scientists and clinicians engaging in fundamental and translational research in cancer, cystic fibrosis, asthma, multiple sclerosis, infectious diseases, genomics, diabetes and vision related conditions.

### Impact:

Regenerative medicine is an emerging research theme within the centre and could lead to linkages with the Cell Therapy Catapult in the future. Professor Alan Stitt is a partner in the novel €6 million EU-FP7 funded REDDSTAR.

£32m award received from the HEFCE and £4.8m from Wellcome-Wolfson for a research facility to help find cures for eye disease.

External funding has been levered from wide ranging sources including Age UK, the EU, BBSRC and others.



## The Centre for Public Health

### About:

The Centre for Public Health (CPH) is focused on advancing the health of the public at a regional, national and international level, by increasing knowledge and influencing clinical and public health practice and policy. The centre is committed to high quality research aimed at improving public health, and comprises thirty academic researchers under the direction of Professor Ian Young.

It also houses the MRC Methodology Hub for the island of Ireland (led by Professor Mike Clarke) and is allied with the Northern Ireland Cancer Registry.

Scientists and clinicians in the centre are working to identify the epidemiological and genetic risk factors that are important for the health of the individual and of the population, and to develop screening and interventions to reduce the burden of chronic disease in the future.

CPH is developing high quality research programmes involving close collaboration between clinical experts and scientists with skills in biochemistry, epidemiology, nutrition, genetics and statistics. There is a strong emphasis on maintaining international research collaborations, facilitated through formal links with a number of other institutions. In addition, the centre actively participates in research networks throughout the UK and Europe.

### Impact:

One of the six centres of excellence for public and population health in the UK, the CPH has secured £9m in funding from UKCRC until 2018

Professor Mike Clarke is among 400 scientists named on the worldwide list of the most 'Highly Influential Biomedical Researchers'.

CPH launched Northern Ireland's largest ever public health research project. NICOLA – the Northern Ireland Cohort for the Longitudinal Study of Ageing – is hoping to provide the basis for future Government policy by following the lives of 8,500 over 50s as they grow older.

## Queens School of Pharmacy

### About:

The School of Pharmacy at QUB one of the leading centres in the UK for pharmacy education, is also a leading UK academic centre for pharmaceutical research which is focused on projects that ultimately have the potential to meet unmet clinical needs. The school has two research clusters:

**Pharmaceutical Science and Practice (PSP):** Research in this cluster ranges from basic and applied pharmaceutical sciences to the development of new health care models that can be implemented in a variety of settings. Principal investigators within the cluster bring together a broad expertise in bioactive biomaterials, advanced drug delivery systems, clinical pharmacy and applied clinical microbiology, and health services research pertinent to pharmacy and primary care. This provides the basis for four key themes of research within the cluster:

- Bioactive biomaterials and infection control
- Clinical pharmacy
- Drug delivery
- Primary care

The cluster has a strong track record in the commercialisation of its work and working closely with health policy and clinical colleagues to produce research that has direct applications to clinical care.

**Molecular Therapeutics (MT):** Research focuses on the validation of drug targets and the development of experimental therapeutic agents. Principal investigator groups within the cluster bring together a broad expertise in molecular and cellular biology, chemical biology, medicinal chemistry and peptide proteomics. This provides the basis for four key themes of research within the cluster:

- Chemical biology and medicinal chemistry
- Experimental therapeutics
- Natural drug discovery
- Proteases and inhibitors

### Impact:

Funding is attracted from the UK Research Councils - MRC, EPSRC and BBSRC as well as major charities.

Dr. Ryan Donnelly was winner of the 2013 BBSRC 'Innovator of the Year' award for his research on transdermal drug delivery using microneedles.

A number of substantial research relationships with industry, including GSK Stevenage, Warner Chilcott Ltd and Merck KGaA. In this later case, the phosphorus-based chemistry enabled by the use of ionic liquids and collaboratively developed within QUB, resulted in the generation of commercialised products which employ the QUB-developed technology for their manufacture.

In collaborative partnerships with companies such as Almac Discovery and Fusion Antibodies Ltd., the school have developed novel therapeutics to inhibit tumour angiogenesis and metastasis.

Key highlights include the pharmaceutical development of a microbicide-release vaginal ring product now in Phase 3 trials, the out-licensing of drug delivery technologies and the development of products, including Ametop™ and Femring™.



## QUB School of Biological Sciences

### About:

The primary focus of the Molecular Biosciences Research Cluster is fundamental biological processes in cells, microbes and parasites as well as applied processes in environmental microbiology, parasitology and disease control. The group provides a broad platform of fundamental and applied expertise in the biosciences, including: molecular biology, cell biology and cell signalling, microbial biochemistry and genomics, stress metabolism, bioremediation, parasite biology, physiology and therapeutics, protein biochemistry, expression and engineering, peptide/protein modelling and synthesis, nucleic acid structure and function, bioimaging.

The food safety and nutritional research elements are linked within the Institute for Global Food Security (IGFS), which aims to exploit cutting edge technologies to drive a competitive and sustainable agricultural sector.

The IGFS houses a suite of state-of-the-art laboratories, conducting cutting edge research into various topics ranging from soil & plant health through to food security. Acknowledging the impact of the work of the institute, QUB has committed more than £33m to support, nurture and promote its growth. The research conducted at the institute is globally driven. Of particular relevance to this study are three research themes, animal Welfare, human nutrition and food safety.

The human nutrition and health theme is multi-disciplinary, with research spanning a range of applied and basic research activities encompassing: analytical chemistry, clinical chemistry, epidemiology, protein structure and function, molecular biology, transcriptomics, microbiology, enzymology, psychology, consumer behaviour, human intervention studies, metabolomics, mitochondrial biochemistry, cellular biochemistry, bioenergetics, exposure biomarkers, bioinformatics.

The early detection of natural and manmade chemical contaminants and harmful bacteria in fresh water and marine environments, farm animals, animal feed materials, many types of foods and environmental samples is one of the primary drivers of the food safety research group.

Scientists within the IGFS work with local and international partners to conduct fundamental and applied research in targeted areas of animal and fish health, and in animal behaviour and welfare.

### Impact:

The school conducted research which isolated and characterised the causative virus of post-weaning multisystemic wasting syndrome in pigs and was involved in the development of vaccines that are used worldwide to control this major disease.

Professor Chris Elliott is at the forefront of a programme of research of benefit locally but also of significant importance on a global scale. He spearheads a major initiative to develop techniques to safeguard the food supply. With colleagues at QUB, and partners across the globe, he is undertaking cutting edge research to develop early warning techniques to detect food contamination issues.

Working together with local industry in the application of his research, Professor Elliott hopes to reinforce the integrity of the food produced locally, ensuring our place on the world market for many years to come.

## UU: Biomedical Sciences Research Institute

### About:

The BMSRI undertakes research in stratified medicine, biomedical science, nutrition and dietetics, optometry, and pharmaceutical science. It researches the key degenerative diseases, including those with a nutritional aspect that affect an increasing ageing population. It works from the basic molecular level to human clinical trials, with translation to clinical and commercial benefits.

The BMSRI is also exploiting the remarkable opportunities made possible by recent molecular advances; revolutionary changes in biomedicine and biotechnology that will soon transform whole industries and economies, but which offer particular advantages in its field. The proper application of the results of its research is expected, over the next decade, to transform our understanding of human biology and pathology by giving a real understanding of their very complex molecular aspects. The BMSRI is actively pursuing these goals by applying a range of rapidly developing techniques: bioimaging, systems biology, genomics, proteomics, transgenics etc., to a variety of problems in human health.

Within the BMSRI, there are five centres of excellence:

The Clinical Translational Research and Innovation Centre (C-TRIC) is a partnership company between the BMSRI, the Western Trust and Derry City Council, strategically sited at Altnagelvin Hospital, the second largest acute teaching hospital in Northern Ireland. C-TRIC is a multi-use flexible facility of approximately 1,000 sq metres (9,000 sq ft).

The Centre for Functional Genomics aims to augment the existing world-class biotechnology and biomedical facilities at Coleraine by focusing on research projects that may have commercial impact on biotechnology, biomedicine or high-added-value food production.

Centre for Molecular Biosciences and the facilities, equipment and technologies it provides, has further established UU as one of the world's leading biomedical research centres concentrating on degenerative diseases, especially its interaction with nutritional factors.

Centre for Nutrition and Bone Health is based in the state-of-the-art Centre for Molecular Biosciences at UU Coleraine Campus, and is aimed at building additional and sustainable research capacity in nutrition and bone health, with a particular focus on identifying strategies to prevent osteoporosis, a crippling bone disease that strikes people as they grow older and a serious public health issue with major health, economic and social consequences.

Wellcome Trust-Wolfson Northern Ireland Clinical Research Facility (NICRF) was established in 2013 with funding from the Wellcome Trust and the Wolfson Foundation to provide state-of-the-art facilities to support clinical research. The NICRF is a joint venture with HSC, QUB and UU.

### Impact:

In 2008 BMSRI was enhanced by the new 4,000m<sup>2</sup> SAAD Centre for Pharmacy & Diabetes (with £1.84m from the SAAD Group, £3.2m from the SRIF3 Programme and £1.3m university funding).

Also in 2008, the £2m 1,000m<sup>2</sup> Clinical Translational Research and Innovation Centre (C-TRIC) was opened at Altnagelvin Hospital.

Continued commitment to clinical impact has resulted in the opening of two additional major clinical research centres as partnerships: the Northern Ireland Functional Brain Mapping Facility (£5.5m), 50% funded by Invest NI; and the £11.5m Northern Ireland Centre for Stratified Medicine with 22 new posts.

Substantial research collaborations with local and global companies in the biotech, pharmaceutical and nutrition industries including Radox Laboratories, Norbrook, Nestle, Sanofi Aventis, and DSM.

Received £1m from Norbrook Laboratories for the establishment of the Norbrook Chair in Pharmaceutical Formulation.

The BMSRI has been successful in the exploitation and commercialisation of its IP and has seen numerous spin out companies formed over the years, including Gendel Ltd, EFMB, Diabetica Ltd and more recently Jenarron Ltd.



## UU: Centre for Stratified Medicine

### About:

The new Northern Ireland Centre for Stratified Medicine – the only one of its kind in the island of Ireland – will put UU at the frontier of pioneering medical research into chronic degenerative diseases.

Funding for the £11.5m facility is a collaborative project between UU's Biomedical Sciences Research Institute, C-TRIC and the Western Trust. The funding for the Northern Ireland Centre for Stratified Medicine is made up of £5.6m from Invest NI, £1.5m from HSC R&D and £4.4m from UU.

The Centre for Stratified Medicine will undertake research in areas such as heart disease and stroke, diabetes, bone disorders, inflammatory diseases, mental health, dementia and cancer. The centre will facilitate research that can better identify drugs or treatments that meet the specific needs of individual patients and marks a significant advancement in this strategic research area.

### Impact:

The centre supports 22 high end jobs, including 15 lecturers in stratified medicine.

There is a clear economic argument for the development of stratified medicine. Of the £595b global spend on pharmaceuticals in 2011 an estimated £393b was used for therapies which did not produce the desired effect.

## UU: NIBEC - the Nanotechnology and Integrated Bio Engineering Centre

### About:

NIBEC represents a consolidation of research groups, associated with advanced material types used in medical devices, electronics, photonics, tissue engineering, nanotechnology, microfluidics, sensors, MEMS, optical and environmental devices.

The multi-million pound purpose-built facilities house some of the most sophisticated nano-fabrication, biological and characterisation equipment in the world. NIBEC is staffed by an internationally recognised and well experienced team of over 60 researchers and academics working predominantly at the interface of bioengineering and nanotechnology.

### Key Relevant Clusters at NIBEC are:

Sensors and connected health: Sensors, point of care monitoring and integrated intelligence based platforms.

Tissue engineering and regenerative medicine: The surface science of biomaterials and their biological interface, focusing on the surface modification of substrates to act as bio-active scaffolds.

Nanomaterials: The growth and characterisation of nanostructures to enhance devices.

NIBEC currently hosts two affiliated centres:

The Multidisciplinary Assessment of Technology Centre for Healthcare (MATCH) is a well-established research collaboration between four leading UK universities (Birmingham, Brunel, Nottingham & UU) and a cohort of industrial partners, also supported by stakeholders from the NHS and other public sector organisations. MATCH, funded since 2003 by the Engineering and Physical Sciences Research Council (EPSRC) and partner subscriptions, provides a critical research mass in the field of health technology assessment (HTA) in its widest sense, bringing together expertise in health economics, engineering and social sciences. Key roles played by MATCH in development of point of care systems include the economic assessment of devices and pathways to NICE approval.

The Centre for Advanced Cardiovascular Research supports the development of leading edge research in the field of medical devices, nanotechnology and bio-molecular science applied to critical cardiac care. The centre facilitates research and the development of new technology platforms thus accommodating the evolution of optimal therapeutic and diagnostic devices and systems.

### Impact:

Over thirty patents filed and four new spin-out companies (over 100 employees). NIBEC have developed and licensed numerous devices such as PRIME ECG, Vital Signs Wireless Patch, 12-lead holter-telemonitoring, AED defibrillators, telemonitoring platforms, the world's biggest selling ECG electrode and a range of licensed algorithms to companies such as Samsung, Tyco and Meridian Medical.

Successful spin-out companies have emerged from NIBEC in recent years, the most successful of these being Heartscap, HeartSine Technology, Intelesens (formerly Sensors Technology and Devices Ltd.) and spin-in SiSaf

## UU: The Intelligent Systems Centre

### About:

The Intelligent Systems Research Centre (ISRC) is a major research unit within the UU Faculty of Computing and Engineering.

The ISRC is dedicated to the creation of intelligent computational systems, taking inspiration from, and learning from, biology and neuroscience. The work of the centre is directed at achieving a greater understanding of biological signal processing and the translation of critical aspects of that knowledge into computational systems that can perform in a way that humans would consider "intelligent".

A key element of the ISRC is the functional brain mapping research and it is the first functional brain mapping facility on the island of Ireland.

Enterprise Minister Arlene Foster announced a £5.5m investment package for the advanced research project at the Intelligent Systems Summit 2013 in June.

The facility is one of only a few in the UK to use the recently developed brain imaging modality, magneto encephalography (MEG), to measure brain activity.

### Impact:

There is huge interest in MEG among the big pharmaceutical companies in the US and Europe. Merck want to involve functional neuroimaging in major trials in Alzheimer's disease (AD). The companies Biogen and Orasi plan to use MEG as part of multi-modality pathway to study AD and make sure drugs have an effect. It is also possible to use MEG for stratification of the AD patient. Specifically, Biogen is currently looking to find 10 groups that could be involved with an AD protocol for them. The potential for MEG in terms of analysis and understanding of deep brain stimulation for the alleviation of Parkinson's disease and major depressive disorder is also of interest to these companies.

## UU: Institute of Nursing and Health Research

### About:

The Institute of Nursing and Health Research (INHR), aims to be world-leading in research and development that enhances the knowledge, expertise and engaged scholarship of nursing, midwifery, public health and allied health professions research.

The INHR's work is structured and delivered through five research centres with each one being led by an internationally recognised expert in the field:

- Centre for Intellectual and Developmental Disabilities
- Centre for Health and Rehabilitation Technologies (CHaRT)
- Managing Chronic Illness Research Centre
- The Centre for Maternal, Foetal and Infant Research
- Person-centred Practice Research Centre

### Impact:

The success of the INHR to date is evidenced by its publication record in international journals, and external grant support from a variety of sources including Government (Research and Development Office, DHSSPS, DEL), charities (e.g. Wellcome Trust, Multiple Sclerosis Society, and the National MS Society,) and industry.

Centre for Intellectual and Developmental Disabilities has had around 150 articles published in peer reviewed journals and has received £1.5m in research income.

CHaRT is the largest multidisciplinary grouping of allied health professionals, clinical scientists, and PhD students in the UK and Ireland.

The Centre for Maternal, Foetal and Infant Research is the European co-ordinating centre of EUROCAT - European Surveillance of Congenital Anomalies, funded by European Commission DG Sanco Public Health Programme and a WHO Collaborating Centre for the Surveillance of Congenital Anomalies.

## UU: Smart Environments Research Group

### About:

Situated within the School of Computing and Mathematics on the Jordanstown campus, the Smart Environments Research Group (SERG) undertakes a range of research in the areas of pervasive computing and ambient assisted living.

SERG's current research objectives include the following:

- To stimulate and promote multidisciplinary research in areas of connected health related to computing science, biomedical engineering, networks and embedded systems.
- To increase/align joint theoretical and applied research.
- To provide an improved environment for the training of early stage researchers and PhD students.
- To provide the necessary environment and equipment to support the undertaking of research in all areas of the CSRI in order to maintain an equivalent rating as achieved in the 2008 RAE in the 2014 REF.

### Impact:

One of the main impacts of SERG is in research supporting the utility of smart environment to support remote health and wellness monitoring, management, and assistive solutions.

Smart phone technology plays a key role in the delivery of such solutions. SERG has, for example, recently launched an app for self-management of daily activities, targeted towards older children and teenagers with autism.

## UU: Connected Health Innovation Centre

### About:

The Connected Health Innovation Centre (CHIC) is focused on business led research in the area of connected health. CHIC seeks to lead transformational research which aligns care needs with technology providers, researchers and clinical experience. CHIC targets research in areas such as e-health, digital health, tele-health, tele-monitoring, disease management, and home based care. Key focuses for the research are vital signs sensing development, integrated care, assisted living and point of care diagnostics. Its membership of approximately 25 fee paying companies covers a broad section of Northern Ireland's connected health sector. Companies include:

- Accenture: A global management consulting, technology services and outsourcing company, with approximately 261,000 people serving clients in more than 120 countries.
- I+: An SME working in e-health and ambient assisted living systems. It has specific expertise in distributed architecture for data sharing and integration of heterogeneous data sources, modelling and development of system intelligence.
- Radox: Home grown, international clinical diagnostic company. Radox develops, manufactures and markets diagnostic reagents and equipment for laboratory medicine, with a distribution network of 130 countries

### Impact:

The products associated with CHIC's research have already impacted in the following ways:

- Created over 120 jobs across all 3 connected health spin-outs (Heartsine, Intelesens and Heartscape).
- Saved lives, improved the quality of life and cut costs.
- Technologies are used by the Wellcome Trust, CIMIT and various companies as exemplars of the future of healthcare.
- The concept of connected health in Northern Ireland was derived from much of CHIC's early work. This has inspired many initiatives such as the BEST Centre, ECHCampus (2009-2012) and now the European Connected Health Alliance (2011-); NICH-ECO; culminating with NIMAC which will see a joint agreement between USA, Finland, RoI, Northern Ireland, the Manchester Eco System and Catalonia as well as the DHSSPS & DETI signing a strategic and joint connected health MoU.



## APPENDIX 1B: LIFE AND HEALTH SCIENCE PANEL MEMBERS

- Jim McLaughlin, Intelesens (Co-Chair)
- Robert Grundy, Almac (Co-Chair)
- Irwin Armstrong CIGA Healthcare
- Janice Bailie, HSC R&D Division, Public Health Agency
- Tony Bjourson UU
- Sean Donaghy, HSC Board
- Rebecca Di Maio, Heartsine
- Tom Gray, Kainos
- Stephen Kennedy, GSK
- Mary Jo Kurth, Radox
- Karen McCann, Colleges NI
- David McEaney, Clinician
- Graham McGeown, QUB
- Noel McQuaid, James Leckey Design
- Neil Morgan, Innovate UK
- Chris Nugent, UU
- Margaret Patterson, AFBI
- Frances Weldon, QUB





# MATRIX

**NORTHERN IRELAND  
SCIENCE INDUSTRY PANEL**

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