Appendices

APPENDIX 1: SCOPE OF THIS STUDY

A question of definition

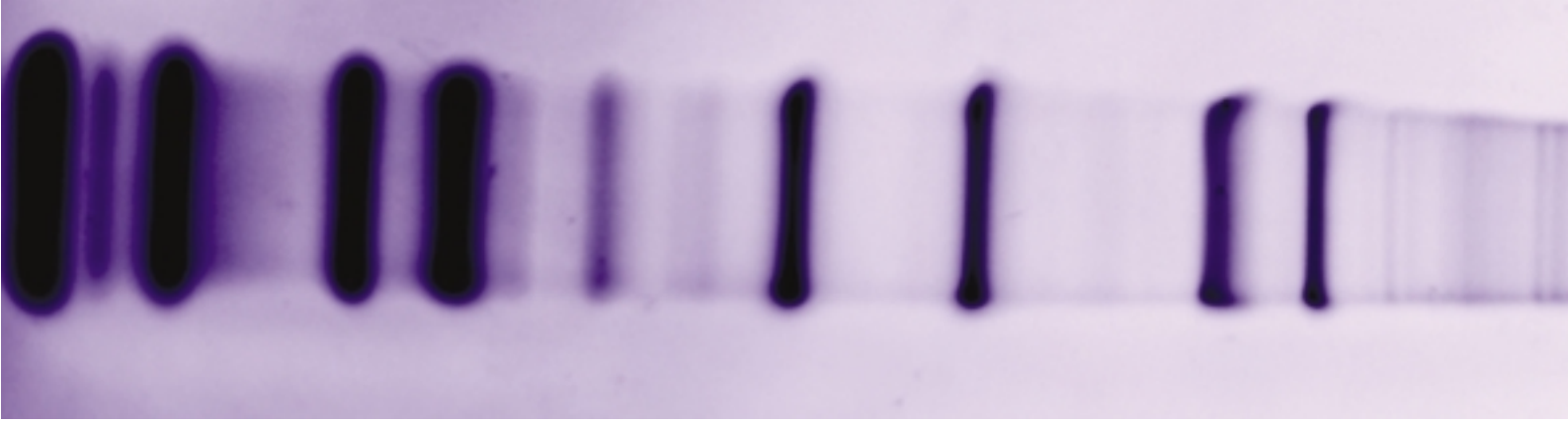
The BIGT was deliberately called the *Bioscience* Innovation and Growth Team rather than the *Biotechnology* Innovation and Growth Team in order to offer a wider perspective. However, in many areas, clear focus and prioritisation of issues was required. The BIGT has focused on companies based in the UK, though not exclusively of UK origin, using the modern biosciences to develop innovative drugs.

The Ernst & Young definition of bioscience includes three categories[1]:

- **Biotechnology companies:** encompassing entrepreneurial biotechnology companies using modern biological techniques to develop products and services, including:
  - Producers of biotech drugs (e.g. CAT, Xenova) and vaccines (e.g. Acambis, Powderject), and UK subsidiaries of US companies (e.g. Amgen, Genzyme).
  - Speciality pharmaceutical manufacturers (e.g. Galen, Shire).
  - Platform technology companies (e.g. Inpharmatica Bio-informatics).
  - Contract manufacturers (e.g. Lonza, Avecia).
- **Suppliers and service companies:** including suppliers of chemicals, glassware and related plastic disposables, research products, imaging, analytical and automated equipment, contract research organisations, companies who provide a niche R&D function (e.g. Amersham, MDS, Covance and Automation Partnership).
- **Diagnostic and device companies:** including companies producing bioanalysis, test kits, medical diagnostic kits relating to biotechnology, medical devices and surgical implant developers and manufacturers (e.g. Smith & Nephew, Celsis, and MWG Laboratories).

While BIGT has focused on bioscience companies involved in drug development, the forthcoming Healthcare Industries Task Force (HITF), to be led on the Government side by the Department of Health (DH) and on the industry side by the Association of Healthcare Industries (ABHI), will investigate the medical devices and diagnostics industry, including those sub-sectors with a bioscience element.

1 www.ey.com



APPENDIX 2: TECHNOLOGY DRIVERS OF THE BIOSCIENCE REVOLUTION

Five major breakthroughs for bioscience

1. **Gene sequencing**, and in particular the sequencing of entire genomes, has greatly expanded knowledge of how organisms work. The sequencing of the genomes of viruses and bacteria has provided an invaluable tool in the fight against infection. The publication of the human genome sequence is helping researchers to understand every aspect of physiology. The area of genomics – the study of an organism's entire genome – is helping understanding of the complex interplay of genes in us and other organisms. From that understanding come clues to potential ways to treat particular medical conditions.

2. **The development of molecular techniques** has provided researchers with the tools they require to apply an increasing knowledge of biology to the treatment and prevention of disease. Techniques such as Polymerase Chain Reaction (PCR), and RNA interface are enabling the manipulation of genes in order to study their function or for industrial or therapeutic purposes. Advances in ways of looking at proteins are helping the correlation of protein expression with states of health, and study of ways in which proteins interact. Using gene chip arrays etc. researchers can 'see' which genes are 'switched on' at any moment and which proteins (the principal 'movers and shakers' of the body's condition) are being produced. New areas of knowledge, such as metabolomics and glycomics, are increasing understanding of the molecular basis of disease.

3. **Advances in imaging techniques**, particularly those based on fluorescence are enabling scientists to see molecular reactions take place in real time and in vivo. They can now see which parts of the body are accumulating particular molecules as a person or animal performs certain tasks or suffers from a particular disease or malfunction.

4. **The IT revolution** is having a significant impact on the way bioscience is done and how the research community operates. It relies increasingly on IT for data capture, analysis, modelling and sharing. Bioscience often involves very large, international teams collaborating and sharing fundamental knowledge (about protein/enzyme structures and function, etc).

5. **Nanotechnology** is having an ever-increasing impact on bioscience. This exciting area is already being utilised in the development of biosensors and drug delivery methods, and looks set to play a role in many areas of healthcare.

APPENDIX 3: UK PHARMACEUTICAL INDUSTRY STATISTICS AS A POINTER TO FUTURE BIOSCIENCE INDUSTRY

The UK Pharmaceutical Industry in 2002:

- 0.6% of UK GDP.
- 3% of UK manufacturing GDP (i.e. almost £4.5 billion).
- Third largest trade surplus for the UK (exports £10.33 billion in 2002, surplus of £2.6 billion in 2002).
- Direct UK employment in pharmaceuticals 60,000 of which 20,000 are engaged in R&D.
- 250,000 jobs associated with pharmaceuticals.
- In 2002 UK pharmaceutical industry accounted for 3% of world sales (£8.5 billion) (joint fifth largest).
- In 2002 the UK had 10% of world pharmaceutical R&D expenditure.

The economic benefits of today's pharmaceutical industry can serve as an indicator of the bioscience industry's future potential. Pharmaceuticals is a high productivity sector in terms of labour productivity (over £65,000 per employee). GlaxoSmithKline was fifth in the DTI's 2003 index of top companies by value added. Pharmaceuticals came second to banking in terms of value added as a percentage of sales, and second only to telecommunications in terms of investment (R&D plus depreciation) as a percentage of value added by the sector.

APPENDIX 4: UK BIOSCIENCE INDUSTRY STATISTICS

Table A.1: UK bioscience industry vs main international competitors

Country	Total number of companies 2002	Public companies only					
		Number of public companies	Industry market cap (€ millions)	Revenues (€ millions)	Employees	Number of biotech marketed products	Number of pipeline products
USA	1,457	307	205,000	26,986	191,000	74	872
UK	331	46	9,377	2,933	22,104	10	194
Switzerland	129	5	7,285	1,748	8,158	8	79
France	239	6	536	250	9,655	6	31
Germany	369	13	488	513	13,386	1	15

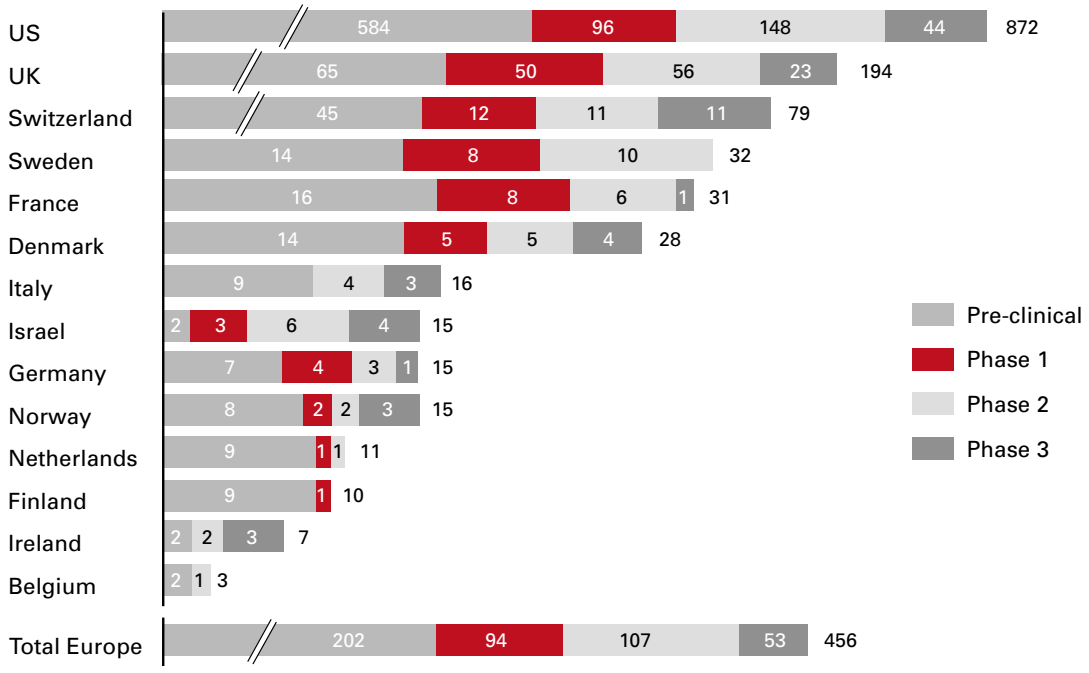
Source: Ernst & Young for European company data (2003); BIO, 2003 for US except for number and revenues of public companies re: BioCentury; Pharma Projects March 2003 for pipeline and BioCentury, for number of marketed biotech products. Marketed products (including small molecule drugs) for UK bioscience companies number 38.

Table A.2: UK bioscience industry by sub-sector

Key data	Bioscience			
	Diagnostics and devices	Suppliers and service companies	Biotech companies	INDUSTRY TOTAL
Number of companies	393	342	422	**1,157**
Number of employees	34,300	40,997	25,885	**101,182**
Revenues (£)	3,632,734,913	4,515,301,349	3,168,831,790	**11,316,868.052**
Retained profit (£)	-108,253,531	260,586,550	-178,185,545	**-25,852,526**
Corporate tax payable (£)	57,104,575	200,190,857	12,306,401	**269,601,833**
Employee remuneration	913,728,243	1,048,228,468	867,445,324	**2,829,402,036**
Average wage per employee (£)	26,639	25,568	33,511	**28,573**

Source: Ernst & Young. Biotech companies in *Table A2* includes ~100 companies not typically included in the standard E&Y definition (such as UK subsidiaries of US biotech companies) and accounts for the difference in numbers with *Table A2*

Figure A.1 Product pipeline of public bioscience companies worldwide



Source: Pharma Projects for US.; Ernst & Young for Europe

APPENDIX 5: BIOSCIENCE SUCCESS INDICATORS

Indicators of success

Success for the UK industry must be both scientific and commercial. The BIGT aspiration is to build a set of sustainably profitable companies – companies that develop major products, and retain a significant portion of the value created by those products. Key indicators of success will be:

- Number of self-sustaining profitable companies
- Number and value of products (drugs, diagnostics, instruments, etc.) – both launched and in the pipeline
- Growth in output
- Revenue growth
- Increased profitability
- Employee growth
- Total R&D spend
- Inward investment

The UK bioscience sector may never be as large as that in the US. But the UK should aspire to create a sector on a par with a major US cluster, e.g. Southern California. A sub-sector of the UK bioscience – public biotech companies – is roughly equal in size to what the public biotech sector was in San Francisco in 1996. If the San Francisco growth rates between 1996 and 2002 are applied to the UK potential, our sub-sector of 46 public companies, $3.4 billion in revenues, and 22,000 employees in 2002 could quadruple revenue to $14 billion and triple the number of employees to 65,000 by 2015.[2] This would mean our public biotech sector would be the same size in 2015 as the Southern California public biotech sector was in 2001.

APPENDIX 6: CHALLENGES FACING THE UK BIOSCIENCE INDUSTRY

Table A.3: Survival index of UK public bioscience companies

Number of years of cash remaining	% of companies	
	Year	
	2001	2002
>5	44	30
3 to 5	18	22
2 to 3	15	13
1 to 2	11	15
<1	12	20
Total	100	100

Source: Ernst & Young

APPENDIX 7 : REGULATIONS OF RELEVANCE TO BIOTECH COMPANIES COVERED BY BIGRAG (BIOTECHNOLOGY INDUSTRY/GOVERNMENT REGULATORY ADVISORY GROUP)

Bioscience regulatory activity

Area of activity	Key issues	Lead Dept
Regulation on the transboundarymovement of LMOs	Definition of pharmaceuticals and the impact to the transport of clinical trials materials and vaccines.	DEFRA
Clinical Trials Directive	Gold plating UK regulations and the impact to academia and experimental medicine.	MHRA
GM Food and Feed	Practicalities and enforcement.	FSA
Cells & Tissues Directive	MEPs seeking to restrict stem cell research.	DH
Contained Use Regulations	GM animals, level of inspections, disclosure of information, use of pathogens and toxins in research.	HSE
Traceability and Labelling	Unworkable as regards products derived from but not containing detectable GM material.	DEFRA
Deliberate Release Regulations	ACRE involvement in clinical trials for GM Vaccines.	DEFRA
Environmental Liability	Concern re. definitions and strict liability regime.	DEFRA
Adventitious GM Presence in Conventional Seed	Implications for zoning of GM crops and impact on co-existence.	DEFRA
Aarhus Convention	Push to include Classes 1 and 2 Contained Use in public register.	DEFRA
Cartagena Protocol	Level of ratification.	DEFRA
HFEA	Watching brief on guidelines, stem cell research.	DH
Human Fertilisation and Embryology Regulations 2000	Watching brief on judicial reviews/ challenges, stem cell research.	DH
Human Fertilisation and Embryology Act 1990.	Watching brief on judicial reviews/ challenges, stem cell research.	DH
Legal protection of biotech inventions (98/44)	Implementation in Europe.	Patent Office

Community Patent	Benefits to SMEs.	Patent Office
Anti-Terrorism Legislation – Biological Weapons and the Chemical Weapons Acts	Concerns over research premises.	Home Office
UN treaty on Pollution Information Disclosure	Use of this information by animal rights extremists to target individuals and companies.	DEFRA
Review of Animal Testing Directive	Impact to UK research if more restrictions/regulatory hurdles put in place.	Home Office
Criminal Justice and Police Act	Animal rights extremists.	Home Office
Biological Weapons Convention	Watching brief on future action.	FCO
Animals (Scientific Procedures) Act	Watching brief.	Home Office
Directive on Human Tissue Products	Awaiting proposals from Cion.	DH
EU Chemical Strategy	Impact to number of animals used in research.	DTI
UN Resolution on cloning	Ban on therapeutic cloning.	DH / FCO
Proposal from the Council of Europe to change the cage sizes for animals involved in research	Implications the production/ testing of vaccines.	Home Office
Codex	Watching brief only.	DEFRA
HGC	Current work, genetics and reproduction.	DH
AEBC	Current work, GM debate, liability, co-existence.	OST
GTAC	Current work, guidelines on gene therapy research.	DH
GAIC	Current work, use of genetic tests in insurance.	DH
ACGM	Current work, guidance on contained use, reconstitution.	HSE
ACRE	Current work, GM vaccines.	DEFRA
Parliamentary Select Committees	– Scientific Response to Terrorism (Commons Science and Technology Committee) – Inquiry into Biotechnology (Commons Trade and Industry Select Committee).	OST DTI

Glossary of Acronyms and Terms

Acronyms

ABI – Association of British Insurers

ABHI – Association of British Healthcare Industries

ABPI – Association of the British Pharmaceutical Industry

AFSSAPS – Agence Francaise de Securite Sanitaire des Produits de Sante

ATU – Autorisations Temporaires d'Utilisation (Temporary Authorisations for Use)

BBSRC – Biotechnology and Biological Sciences Research Council

BELS – British Expats in Life Sciences

BFAO – Bioscience Framework Access Office

BIA – BioIndustry Association

BIGRAG – Biotechnology Industry Government Regulatory Advisory Group

BIGT – Bioscience Innovation and Growth Team

BioNow – Bioscience arm of the Northwest Development Agency

BLC – Bioscience Leadership Council

BMJ – British Medical Journal

BRAF – Bioscience Risk Assessment Forum

BYES – Biotechnology Young Entrepreneurs Scheme

CAGR – Compound Annual Growth Rate

CEO – Chief Executive Officer

CMP – Coalition for Medical Progress

CMR – Centre for Medicines Research

CNS – Central Nervous System

CPD – Continuing Professional Development

CRO – Clinical Research Organisation

CVS – Corporate Venturing Scheme

DEFRA – Department for Environment, Food and Rural Affarirs

DfES – Department for Education and Skills

DH – Department of Health

DTA – Doctoral Training Account

DTC – Doctoral Training Centre

DTI – Department of Trade and Industry

EASDAQ – European Association of Securities Dealers Automatic Quotation System

EBIT – Earnings before Interest and Taxes

EES – Engineering Education Scheme

EIR – Entrepreneur in Residence

EMEA – European Medicinal Evaluation Agency

EMI – Enterprise Management Incentives

EORTC – European Organisation for Research and Treatment of Cancer

EPSRC – Engineering and Physical Sciences Research Council

FDA – Food and Drug Administration

FP – Framework Programme

GMP – Good Manufacturing Practice

GSK – GlaxoSmithKline

HEBE – Higher Education Business Enterprises

HEFCE – Higher Education Funding Council for England

HEI – Higher Education Institution

HEIF – Higher Education Innovation Fund

IoB – Institute of Biology

IMP – Investigative Medicinal Product

IP – Intellectual Property

IPD – Initial Professional Development

IPEM – Institute of Physics and Engineering in Medicine

IPO – Initial Public Offering

IRCoI – Interdisciplinary Research Collaboration Scheme

LSE – London Stock Exchange

MAB – Monoclonal Antibody

MBA – Master of Business Administration

MEP – Member of the European Parliament

MfB – Manufacturing for Biotechnology

MHRA – Medicines and Healthcare products Regulatory Agency

MRC – Medical Research Council

NAPF – National Association of Pension Funds

NASDAQ -- National Association of Securities Dealers Automated Quotation System

NCP – National Contact Point

NCRI – National Cancer Research Institute

NCRN – National Cancer Research Network

NCTA – National Clinical Trials Agency

NEAT – New and Emerging Applications of Technology Programme

NHS – National Health Service

NICE – National Institute of Clinical Excellence

NIH – National Institute of Health

NIMR – National Institute for Medical Research

NTO – National Training Organisation

NTRAC – National Translational Cancer Research Network

NVQ – National Vocational Qualification

OST – Office of Science and Technology

PhD – Doctor of Philosophy

PIPEs – Private Investments in Public Equities

RDA – Regional Development Agency

SEMTA – Science, Engineering and Mathematics Training Alliance

SME – Small and Medium sized Enterprises

SSC – Sector Skills Council

STREPS – Specific Targeted Research Projects

SVQ – Scottish Vocational Qualifications

TTO – Technology Transfer Offices

UCSF – University Challenge Seed Fund

Scientific Terms

Biogeneric – a biologic drug whose patent has expired, which can be manufactured and sold by a company other than the original patent holder.

Bioinformatics – the process of managing and analysing large amounts of biological information, most commonly used in reference to the analysis of results of drug discovery research and genomics.

Biologic – a biological molecule used as a drug, usually a protein.

Gene Array – a high throughput method for investigating the effect of agents (proteins, chemicals) on gene expression.

Gene Therapy – a procedure whereby a gene is introduced into a cell such that there is a beneficial effect to the patient as a result of the genes action within the cell.

Genetics – the study of the hereditary material.

Genome – the entire inherited genetic makeup of an individual or species.

Genomics – the analysis of the genomes of various species, often for the identification and understanding of the function genes useful in therapy and diagnosis of human disease.

High Throughput – the use of automated technologies to conduct biological screening and processing development to increase speed.

Imaging – visualisation of biological structures at the macro and micro levels.

Mammalian Cell Culture – growth of mammalian cells in an artificial environment usually for the production of complex biologics.

Metabolomics – a technology that explores the metabolites (small molecular weight compounds) in a cell.

Microbial Fermentation – growth of micoorganisms often on large scale often for the production of small or complex molecules.

Molecular Biology – the study of biological systems and structures at the molecular level.

Monoclonal Antibody – highly specific antibodies derived from a single cell, that recognise only one specific feature of an antigen.

Pharamacogenomics – development of personal drugs through the use of individual patients genomes.

Pharmacogenetics – the study of how people respond differently to drugs due to their genetic makeup, in terms of both how well the drug will work and what side effects the person might suffer.

Proteomics – the study and comparison of the full protein complement of cells and their interactions, using large scale methods for the simultaneous analysis of many proteins.

Tissue Engineering – manipulation of tissue and cells under artificial conditions with the aim if conducting regenerative medicine.

Transcript Profiling – study of the RNA complement of a particular cell under defined conditions.

Transgenic – an organism that has foreign DNA inserted within its genome. In this report it refers to genetically modified plants or animals that produce novel biologics.