

IN CONFIDENCE

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## **APPENDIX 1**

### **PANEL MEMBERSHIP**

Professor Athene Donald (Chair)  
Cavendish Laboratory, University of Cambridge

Professor Steve Brocchini  
Department of Pharmaceutics, School of Pharmacy, London

Professor Aedin Cassidy  
Institute of Health, University of East Anglia  
(previously a member of the Agri-Food Committee evaluation panel)

Professor Alan Champneys  
Department of Engineering Mathematics, University of Bristol

Professor Patricia Connolly  
Department of Bioengineering, University of Strathclyde

Professor Peter Dobson  
Begbroke Science Park, University of Oxford

Dr Chris Dowle  
The Centre for Process Innovation, Redcar

Professor Walter Kolch  
Beatson Institute for Cancer Research, University of Glasgow

Dr Andrew Lewis  
Biocompatibles UK Ltd, Farnham

Professor Elaine Martin  
School of Chemical Engineering and Advanced Materials, Newcastle University

Dr Paul Martin\*  
Institute for the Study of Genetics, Biorisks and Society, University of Nottingham

Professor David Rand\*  
Mathematics Institute, University of Warwick

\* attended one meeting only

### **OBSERVER**

Dr Kedar Pandya  
EPSRC, Life Sciences Interface and Basic Technology Programme Manager

### **ACKNOWLEDGEMENTS**

The Panel would like to thank all the respondents who contributed to this evaluation. This includes Principal Investigators, current and former EBS committee members, and other funding organisations.

## **APPENDIX 2**

### **EVALUATION CONTEXT AND METHODOLOGY**

#### **Background**

1. BBSRC awards responsive mode research grants to unsolicited high quality research proposals from eligible applicants in any area relevant to the Council's mission. In the 2006/07 financial year, BBSRC spent £126 million on responsive mode grants, which was approximately 36% of BBSRC research funding. Of this, 11% (£13.4 million) was spent on responsive mode research funded through EBS.
2. It is important to note that BBSRC also funds significant amounts of research through Core Strategic Grants (CSG) made to seven Research Institutes. Some of this funding is for research that falls within the EBS remit. The Research Institutes, and the research funded by the CSG, are evaluated every four to five years in the BBSRC Institute Assessment Exercise. CSG-funded research is therefore not part of this evaluation.
3. All Principal Investigators (PIs) on grants are required to submit a final scientific report within three months of completion of the grant. They are asked to report on progress against scientific objectives and to list publications and other outputs arising directly from the research supported by the grant. Final reports are peer reviewed and graded by two current or former Committee members, or by other specialist advisers.

#### **Evaluation objectives and methodology**

4. The objectives of this evaluation were to:
  - assess the quality and international standing of research funded through EBS
  - identify the major outputs and, where possible, outcomes of the EBS responsive mode portfolio over the past 10 years: assess what difference it has made to the UK's scientific knowledge base and competitiveness
  - identify strengths, weaknesses and gaps in the programme, the way it is structured, the influence of initiatives and priority areas on the way the programme has developed, and the way in which it is administered
  - in consultation with the research community and other relevant funding bodies (other Research Councils, government and non-government funding agencies), assess whether EBS is currently funding the most appropriate areas of UK bioscience
  - assess the economic and social impact of EBS-supported research
  - identify ways to build on successes, and ways to address identified gaps and issues.
5. The evaluation comprised a number of surveys, followed by a review of findings. The work was coordinated by the BBSRC Evaluation and Policy Unit, in consultation with the Engineering and Biological Systems Branch. A logic chart was used to define the framework for the evaluation (see page 34). The chart represents the objectives and desired impacts of a project or scheme and places the scheme in its wider context, showing its links to the longer-term aims of the organisation.

## Surveys

6. Information was gathered from a range of sources:
  - **Completed grantholders:** 232 EBS responsive mode grants which started between July 1996 and September 2004 and were completed and graded by the time the survey was carried out. A structured sample of more than half of these was taken, comprising 137 grants drawn from all of the years covered, and encompassing a representative proportion of final report grades. A questionnaire (Appendix 3, page 35) covering topics including success of the grant, outputs, outcomes, views on the coverage of the portfolio, and views on the operation of the Committee was sent to the Principal Investigators (PIs) of the sample grants.
  - **Current grantholders:** A structured sample of half the current grants that had been active for more than a year, at the time of the survey, was taken, comprising 64 grants ranging from those at the end of their first year to almost completed grants. A questionnaire very similar to that sent to completed grantholders was sent to each PI.
  - **Committee members:** Current and past Committee members (those serving over the last five years) were sent a questionnaire (Appendix 3, page 44) covering topics such as coverage of the portfolio, EBS achievements, and views on the operation of the Committee, and BBSRC administration.
  - **Other relevant UK funding bodies:** A separate questionnaire (Appendix 3, page 47) was sent to other funding bodies with an interest in EBS research in the UK, namely: Department for Innovation, Universities and Skills (DIUS), Medical Research Council (MRC), Natural Environment Research Council (NERC), Engineering and Physical Sciences Research Council (EPSRC), and the National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs). The questionnaire covered potential overlap or gaps between remits, views on the appropriate niches for the organisations, management of the Committee, and interactions with UK industry and the Public.
  - **BBSRC data:** Relevant data were collated, including the final reports submitted by the sample PIs, and information from BBSRC grants databases.

## Review of findings

7. The role of the Panel was to provide an independent scientific evaluation of the data presented, focusing on the scientific aspects of the portfolio. The detailed process aspects covered in the surveys (i.e. issues that are common to all of the Research Committees) will be combined with the process-related responses from other responsive mode evaluations and reviewed by BBSRC Strategy Board. It should also be noted that financial and efficiency aspects are reviewed regularly as part of BBSRC internal audit procedures.
8. The Review Panel comprised independent experts who are not closely involved with BBSRC, but who are nevertheless familiar with the research in this area, and who between them have expertise across the EBS remit. The Panel included two members from industry.
9. The Panel met for two sessions. To facilitate the analysis, the three 'impact' lines of the logic chart were divided into five subject areas:

- a. research outputs and achievements
  - b. balance and coverage of the portfolio
  - c. interaction with industry
  - d. public engagement
  - e. ultimate impacts.
10. This report was presented to BBSRC Strategy Board, which is responsible for considering the report and acting on it as appropriate. The report will also be made public on the BBSRC website and circulated to all those who returned questionnaires.

## Constraints

11. The survey data used in this evaluation relate to the samples described above. The samples of completed and current grants represent a random cross-section of the science supported through the EBS Committee and cover 37% of completed grants and 39% of current grants. Nevertheless, it should be borne in mind that they are samples, a point which is especially pertinent to the analysis of portfolio coverage.

## INTRODUCTION TO EBS

12. The EBS Committee was established in 1996 and had its first responsive mode round in the same year.
13. The table below summarises BBSRC spend in the EBS area over the past five years. The focus of this evaluation is the research in responsive mode, but it should be noted that a significant amount of support in the EBS area is through research initiatives and Core Strategic Grants to BBSRC-sponsored institutes.

Financial Year	02/03	03/04	04/05	05/06	06/07
EBS spend – responsive mode (£ million)	9.0	10.4	11.4	12.1	13.4
EBS Spend Total <sup>1</sup> (£ million)	20.5	22.7	25.3	32.3	38.3
Number of EBS responsive mode grants started	37	67	56	55	45

<sup>1</sup>Including initiatives, studentships, Core Strategic Grants to Institutes, other types of grant.

14. The science funded by EBS under responsive mode is defined by its remit, which is the overarching definition of the scientific responsibility of the committee and is not generally subject to change or modification:

*The EBS Committee supports research in which the skills of biologists, engineers, mathematicians and physical scientists are employed in multidisciplinary and interdisciplinary work. Both theoretical and practical research is funded which furthers the understanding of biological systems; exploits that understanding to address user need in particular in the bioremediation, bioprocessing, chemical, diagnostics, healthcare, instrumentation and pharmaceutical industries; and develops tools and technologies for use in the life sciences.*

15. Proposals for basic and strategic research are invited on any topic within the remit. EBS covers both hypothesis-led and technology-driven approaches and recognises the need for longer, larger, collaborative grants in areas within its remit. Applicants

are also encouraged to work with industry, through LINK and other collaborative schemes.

## Themes

16. The role of the EBS Committee is to support high quality basic and strategic research across the breadth of its remit. That remit is very broad and the Committee has developed a themed description of its main activities to help the scientific and user communities to understand the major areas in which it operates. The themes are intended to be illustrative rather than exclusive:

- Bioengineering for Industry and the Environment
- Engineering Towards Medical Applications
- Systems Biology
- Theoretical Biology
- Tools and Technologies.

17. To show the distribution of the portfolio amongst the themes, the table below displays the value of EBS responsive mode grants live on 30 June 2006 (the last day of the evaluation period):

Theme	Spend (£M)
Bioengineering for Industry and the Environment	7.3
Engineering Towards Medical Applications	12.4
Systems Biology	1.9
Theoretical Biology	3.1
Tools and Technologies	10.0
Obsolete themes <sup>1</sup>	3.1
Not in theme	1.6
<b>Total</b>	<b>39.4</b>

<sup>1</sup>These themes (Metabolic Engineering, and Toolkits for Functional Genomics) were recognised at the time of application but are now incorporated into other themes.

18. The EBS themes were updated and reorganised in 2004 into the current structure. This structure reflects contemporary scientific development and explains the portfolio in a more coherent way.

## Priority Areas

19. Within the EBS remit there are specific areas of science called Priority Areas, in which the Committee particularly wishes to encourage applications, for example to address important gaps in the Committee's portfolio or to promote new/developing areas of science. If an application is within a priority area it will be funded preferentially to an application that is equal on all other accounts, but is not in a priority area. Priority areas are modified and/or removed over time as their objectives are achieved. Some of the current priority areas were designed to be responsive mode 'companions' to directed mode initiatives and to offer a route for further funding to initiative grant holders once their grants came to an end.

20. EBS currently has the following priority areas, which were put in place in 2004:

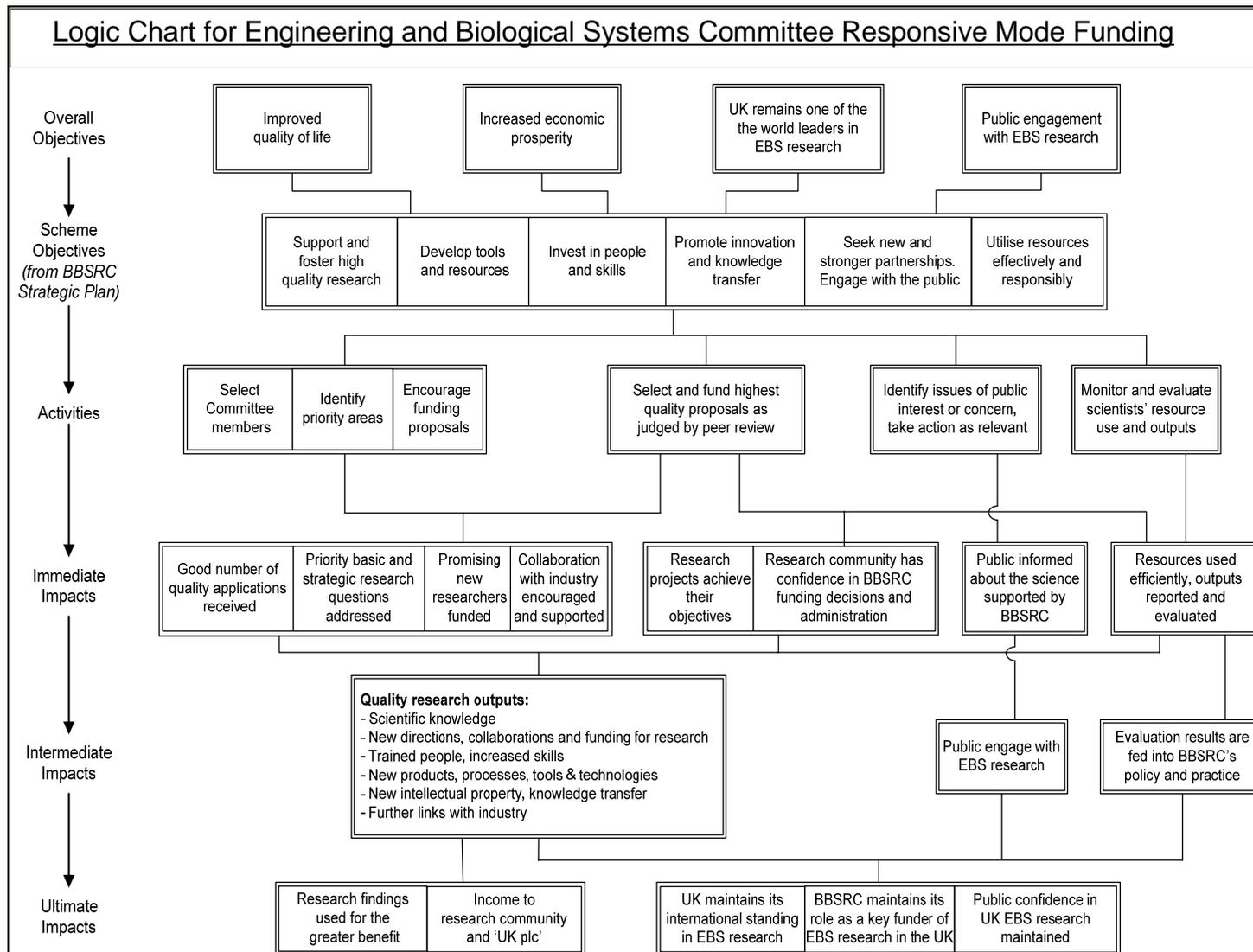
- Bio-artificial Interfaces & Aggregation Processes
- Bionanotechnology
- The 'Cell Supply-Chain'

- Joint wet/dry studies of cellular and sub-cellular networks
  - New Proteomic Technologies for Difficult to Analyse Proteins
  - Real-time, *In-Vivo* Functional Analysis
21. BBSRC recognises that research is becoming increasingly multi- and inter-disciplinary and that some research areas are important to all committees. As a result Cross-Committee Priority Areas were announced between 2001 and 2004. An application in a cross-committee priority area is given the same status as one in a committee priority area. Applications under any of the priority areas may potentially fall within the EBS remit, but in practise applications are generally only received in the priority areas shown below:
- Bioinformatics and e-Science
  - Biophysics
  - Bioscience Engineering
  - Technology Development
  - Theoretical Biology
22. The other Cross-Committee priority areas are: Biology of Transmissible Spongiform Encephalopathies; Cognitive systems; Developing Alternatives to Replace, Reduce or Refine Animal Experimentations; and Drug Resistance and Alternatives to Chemotherapeutics.

### **Research initiatives and programmes**

23. BBSRC also runs Research Initiatives and Programmes, which provide time-limited research funding in areas identified as strategically significant. These are evaluated separately by BBSRC, and hence do not form part of this evaluation. However, they comprise important background information, as the science supported in initiatives often becomes an important area in responsive mode after the initiative has ended. Moreover, they are important components of the overall balance of funding across the EBS remit.
24. The following initiatives were run through EBS or were relevant to its remit during or since the evaluation period:
- Bioinformatics
  - Bioinformatics and E-science Programme I&II
  - Centres for Integrative Systems Biology (CISB)
  - Collaborative Proposals in Systems Biology
  - e-Science Development Fund
  - Exploiting Genomics: Manufacturing and New Post Genomics Technology
  - Functional Genomics Toolkits
  - Innovative Manufacture
  - Interdisciplinary Research Collaboration in Bionanotechnology
  - Interdisciplinary Research Collaboration in Nanotechnology
  - Interdisciplinary Research Collaboration in Proteomic Technologies
  - Interdisciplinary Research Collaboration in Tissue Engineering
  - Mathematical Modelling Simulation & Prediction of Biological Systems
  - Proteomics and Cell Function
  - Proteomics and e-Science Training
  - Research Equipment Initiatives 2002-06
  - Stem Cell Science and Engineering
  - Systems Approaches to Biological Research
  - Technology Development Research
  - Tools & Resources Development Fund
  - Transnational Systems Biology in Micro-organisms

## Logic Chart for Engineering and Biological Systems Committee Responsive Mode Funding



## APPENDIX 3

### QUESTIONNAIRES

#### EBS Responsive Mode Portfolio Evaluation 2007 Survey of Completed Grants

Please complete as many questions as possible and return by e-mail to Lisa Holland by **2<sup>nd</sup> July**.  
Feel free to continue your answers on a separate sheet if necessary.

Dr Lisa Holland, Research Evaluation Manager  
lisa.holland@bbsrc.ac.uk

Name:  
Grant No:  
Grant Title:

### **RESEARCH**

1. **Did the project have any co-funding or in-kind support at the outset (excluding Industrial Partnership Awards or LINK funding)?**

Yes	
No	

If Yes, please give details:

2. **Was the project supported by this grant successful in meeting its objectives?** (please mark one box)

<b>4</b> (very successful)	<b>3</b>	<b>2</b>	<b>1</b> (not successful)

If you marked 1 or 2, were the reasons for this related to:-

Staff e.g. shortages, staff leaving	
Experimental/methodological/technical reasons	
Lack of resources, e.g. funding, equipment	
Unrealistic objectives	
Incorrect/inappropriate hypothesis	

Comments:

3. **How did this grant support your wider research aims?** (please mark all appropriate boxes and comment if you wish)

Enabled extension of research into new areas	
Provided funding for activities that other bodies would not fund (e.g. 'blue skies' research)	
Strengthened the skill base of the group (e.g. techniques, cross-disciplinary skills)	
Generated income from patents, spin out companies, etc to support further research	
Helped to publicise the importance of your field of research	
Strengthened the standing of your research group in the field	
Contributed to the development of tools and technologies	
Supported new/stronger collaboration with industry	
Other – please specify:	
Did not support my wider research aims	

Comments:

### Staff recruitment

4. **Do any of these statements describe your experience with recruitment for this grant?** (please mark the most appropriate box for each member of staff employed on the grant)

The grant had a named researcher from the outset	
I found it easy to recruit well qualified and experienced staff	
I had to accept someone with significantly less experience than was needed	
I had to delay the start of the grant (e.g. I needed to re-advertise, I was waiting for visa clearance for an overseas candidate)	
It was difficult to find someone with the necessary qualifications and experience	
Staff left or temporarily stopped work during the grant, so I had to re-recruit	
There were no suitable UK candidates	
I was lucky this time, recruitment is usually difficult	

Comments:

5. **How closely did the skills of your Research Assistant match the needs of the project?** (please mark one box and comment if you wish)

<b>4</b> (close match)	<b>3</b>	<b>2</b>	<b>1</b> (significant training needed)

Comments:

6. **Did you have major staffing difficulties during the grant?**

Yes	
No	

Comments:

## **ECONOMIC AND SOCIAL IMPACTS**

The economic and social impacts of science funded by BBSRC is of increasing importance. Please answer as many questions as you can and provide comments where possible.

### **People**

#### **7. Please provide details of all staff employed on the grant:**

Grade/Position ( e.g. PDRA, Technician)	% Time spent on grant	Dates of apptmt: from - to (month/Yr)	First destination after this grant*		Second destination after this grant*		For RAs only:	
			UK	Over seas	UK	Over seas	was this the RAs first postdoctoral position?	was the RA named on the application?

\*Please indicate category in appropriate column: **a** – remained in my lab; **b** - permanent academic elsewhere; **c** - fixed-term academic elsewhere; **d** - further training (excl. teaching); **e** - teaching or teacher training; **f** - private sector, industry or commerce; **g** - government or other public sector; **h** - other employment; **i** - not employed.

#### **8. If any student projects were running at the same time and on a similar topic to this grant please indicate:**

	Number	First destination/s after training (if known)*
Doctoral		
Masters		
Other – please specify:		

\*Please indicate category: **a** – remained in my lab; **b** - permanent RA elsewhere; **c** - fixed-term RA elsewhere; **d** - further training (excl. teaching); **e** - teaching or teacher training; **f** - private sector, industry or commerce; **g** - government or other public sector; **h** - other employment; **i** - not employed.

### **Publications and other outputs**

#### **9. What publishing strategy have you adopted for your research? (Please mark one or more box/es and comment if you wish).**

Target high profile, general journals	
Target the most appropriate journals for my area of science	
Target journals where I can get my results published quickly	
Target conference proceedings	
All of the above when/if appropriate	
Other - please specify:	

Comments:

#### **10. Is your publishing strategy influenced by having to produce a final scientific report for BBSRC within 3 months of completion?**

Yes	
No	

Comments:

11. **Please list all further publications arising from the grant since the final report was produced, including those that are 'in press' or accepted for publication, in the spaces below or on a separate sheet.** Please identify (underline or in bold) authors employed on the grant (i.e. research assistants or technicians funded by the grant).

Please list publications in the following two categories, and ensure that the full reference is included (Author(s), Year, Title, Journal, Volume, Page):

- a. original work reported in refereed journals
- b. others: review articles, edited conference papers, book chapters and articles in popular magazines.

12. **How many of these publications had co-authors based in industry and/or overseas?**

Industry	
Overseas	

13. **Did any new products, processes, tools or technologies result from this grant?** (e.g. reagents, tools, software or methodology)

Yes	
No	

If yes, please provide details where relevant:

Description	
Who are the (potential) users? For what purpose do (or will) they use it?	
How was/will it be made accessible to others?	
Does it have the potential to be commercially exploitable?	
What impact has it had on researchers and on the community as a whole?	
Is the resource still accessible and relevant, or has it been superseded by new technologies?	

14. **Please give details, including accession numbers, of DNA and protein sequences that you have submitted to online databases as a result of this grant:**

## Further funding

15. Have you received a further grant from EBS to continue or develop the work funded by this grant?

Yes	
No	

If no, please tell us why? (please mark one or more box/es and comment if you wish)

My research priorities have changed	
Applied to EBS but proposal was not funded	
Funding is more accessible from other sources (other BBSRC Committees, other Research Councils, other funding bodies) – please specify:	
Other - please specify:	

Comments:

16. Have you received further funding related to this EBS grant from another funding body, including another BBSRC committee?

Yes	
No	

If yes, please provide details:

Funder (BBSRC Committee/ other funding body)	Grant reference (BBSRC grants only)	Value (£) and Duration (months) (non-BBSRC grants)

## Exploitation

17. Have you or your colleagues applied, or are you likely to apply, for any patents, licences or other form of intellectual property rights as a result of the research supported by this grant?

Yes	
No	
Likely to apply	

If yes, please give details:

Type of IP	Has it been licensed to companies?	If so, has the licence yielded any income? (please give details with dates)

**18. Have you or your colleagues established any spin-out companies from the research supported by this grant?**

Yes	
No	

If yes, please provide details:

Company name	Area of activity	Date established	Trading/dormant	Turnover		No. staff
				FY	Value	

**19. If you secured further funding to continue this work (from BBSRC or alternative source) did that funding yield any new products, processes, tools or technologies?**

Yes	
No	

If yes, please give details, including the funding body and any patents/licences/other intellectual property:

**20. If, in the future, your work led to the possibility of interactions with the user community, such as collaborative research with industry, would you consider applying to BBSRC to fund this work?**

Yes	
No	

If yes, what type of grant would you apply for?

IPA	
LINK	
Other - please specify:	

If no, please tell us why, and where you would look for funding?

**Other economic and social outcomes**

**21. Did any other economic or social outcomes arise from the research supported by this grant?** (please mark one or more box/es and provide details where appropriate)

Outcome		✓	Details
New or improved <b>academic</b> <sup>1</sup> contacts	UK		
	Overseas		
New formal <b>academic</b> <sup>1</sup> research collaboration (e.g. joint publication, joint funding application)	UK		
	Overseas		
New or improved <b>industrial</b> <sup>2</sup> contacts	UK		
	Overseas		
New formal <b>industrial</b> <sup>2</sup> research collaboration (e.g. joint publication, joint funding application)	UK		
	Overseas		
Contribution to the reduction, refinement and replacement of animals in experiments			
Contributions to public engagement or science in society activities	Publicity in the general non-scientific media		
	Schools activities		
	Public dialogue events		
	Other		
Other			

<sup>1</sup>if cross-disciplinary, please specify which discipline;

<sup>2</sup>please specify type of industry

Comments:

**22. Did the research supported by this grant result in outcomes of benefit to the public good?** (please give details where appropriate)

Human health	
Animal health and welfare	
Environment	
Contribution to the formulation of government policy	
Other – please specify:	

23. **To what extent did regulatory procedures and ethical issues impact on the progress of the research?** (please mark one box)

<b>4</b> (significantly)	<b>3</b>	<b>2</b>	<b>1</b> (not at all)

If you marked 3 or 4 please give details:

### **THE EBS COMMITTEE**

24. **What is your area of expertise?** (mark one or more classification)

Analytical Biotechnology		Environmental Biotechnology	
Biocatalysis		Metabolic Engineering	
Biochemical Engineering		Theoretical Biology	
Bioinformatics		Tissue Engineering	
Biomaterials Science		Toolkits for Functional Genomics	
Bionanotechnology		Systems Biology: Modelling, Simulation and Experimental Validation	
Drug Delivery		Other – please specify:	

25. **Do you think your area of research has been well supported by the EBS Committee?** (please mark one box and comment if you wish)

<b>4</b> (very well)	<b>3</b>	<b>2</b>	<b>1</b> (not at all well)

Comments:

26. **Are there any exciting areas in the EBS remit that the Committee should be covering but is not?** (for details of current EBS remit: <http://www.bbsrc.ac.uk/science/areas/ebs.html>)

27. **The EBS Committee has focused to a significant extent on the needs of the user. Do you feel this is appropriate?** (please mark one box and comment if you wish)

<b>4</b> (very appropriate)	<b>3</b>	<b>2</b>	<b>1</b> (not at all)

Comments:

28. **Do you have any comments on the operation of the EBS Committee?** (e.g. remit, themes, Priority Areas)

29. **What is your opinion of the EBS grants application/administration processes?** (please mark one box and comment if you wish)

4 (very effective)	3	2	1 (not effective)

Comments:

30. **To what extent was the scope and format of your application affected by your perception of any of the following:** (please mark one box in each row)

	4 (significantly)	3	2	1 (not at all)
EBS funding schemes and policies				
EBS remit				
The user-need focus of the committee				
Application form				

Comments:

31. **Do you have any comments on the refereeing process?** (e.g. quality, helpfulness of referees' comments)

32. **How could BBSRC increase the number and quality of referees' comments?**

**GENERAL**

33. **Do you have any other comments relevant to this evaluation?**

**Thank you, your contribution is much appreciated.**

# Engineering and Biological Systems Committee Responsive Mode Portfolio Evaluation 2007

## Survey of Current and Past Committee Members

Please return by e-mail to Lisa Holland by **11 July**. If completing by hand, please feel free to continue your answers on a separate sheet.

Dr Lisa Holland, Research Evaluation Manager  
[lisa.holland@bbsrc.ac.uk](mailto:lisa.holland@bbsrc.ac.uk)

Name:  
Organisation:

### **REMIT**

1. To what extent do you think the EBS remit is covered by the portfolio? (please mark one box and comment if you wish)

4 (well covered)	3	2	1 (poorly covered)

Comments:

2. Are there gaps or areas of inappropriate overlap between:
- EBS and other BBSRC Committees?
  - EBS and other UK funders in this area?
3. Have any scientific areas/opportunities been missed in recent years? If so which ones, and why do you think they were missed?
4. During your period of service how well do you feel the expertise of the Committee matched the remit of EBS? (please mark one box and comment if you wish)

4 (well matched)	3	2	1 (poorly matched)

Comments:

5. What have the Committee's key achievements in terms of the supporting the engineering and biological systems community been? (In other words, what difference has the Committee made?)

### **ECONOMIC AND SOCIAL IMPACT**

6. Who are the end users of the EBS-supported research, tools and resources (including databases), and what are the long-term outcomes?
7. What do you think is the most significant economic or social impact made by EBS-supported research over the past decade?
8. What comments, if any, do you have on the training, and number of skilled scientists in areas relevant to the engineering and biological systems community in the UK?
9. Has the research supported by EBS contributed to the reduction, refinement and replacement of animals in experiments? If so, to what extent (please give examples)

10. Do you think there is sufficient engagement between the engineering and biological systems research community and the public?

Yes	
No	

If yes, please describe any particularly memorable examples

If no, how could this be improved in the future?

11. What is your opinion of the current level of interaction between BBSRC and government departments, such as DTI, in terms of policy making?

**Process and Management**

12. How well do you think the Committee meetings are structured? (please mark one box and comment if you wish)

4 (well structured)	3	2	1 (poorly structured)

Comments:

13. How effective is the current refereeing process? (please mark one box and comment if you wish)

4 (well effective)	3	2	1 (not effective)

Comments:

14. Do you have any other comments on the BBSRC grant appraisal process (including its management and the rank ordering process)?

15. Do you feel that the EBS Committee works well as a team in reaching conclusions (please refer to your period of service)?

Yes	
No	

Comments:

16. What do you think of the final report grading process? What alterations, if any would you like to see?

17. What are your views on the BBSRC management of the grant system as a whole?

**Other**

18. What do you think are the most important functions of the BBSRC Committees? Do you have any comments on their role within BBSRC?

19. Do you have any other comments relevant to this evaluation?

Thank you, your contribution is much appreciated.

## **Annex 1: Interaction with Industry**

Additional questions for industrial committee members. Information about BBSRC's interactions with industry can be found on the website ([www.bbsrc.ac.uk/funding/innovation/Welcome.html](http://www.bbsrc.ac.uk/funding/innovation/Welcome.html)) should you require it.

20. What is your perception of engineering and biological systems research in the UK? e.g. Is it internationally competitive? Is it a growing sector? Is it appropriate to the needs of the end user?

21. What is your view of the way BBSRC funds engineering and biological systems research in the UK?

22. Does your company currently invest in bioscience research?

Yes	
No	

If yes, is research carried out internally or by an outside organisation/s (please give details)?

If no, is there a specific reason/s for this?

23. What changes have you seen in industrial-academic interactions over the past decade and what are your opinions of these changes?

24. Are you aware of the ways in which BBSRC funds collaborative projects between academia and industry?

Yes	
No	

If yes, with which schemes are you familiar?

25. What is your opinion of the current level of interaction between BBSRC supported-engineering and biological systems researchers, and industry?

26. Has your company considered collaborating with BBSRC-funded researchers?

Yes	
No	

If yes, please give a brief description of the experience

If no, is there a specific reason/s for this?

27. How do you think BBSRC could encourage further interactions between industry and academia in the future?

28. Please indicate what proportion of the scientists you recruit are from the following sectors:

UK Academia:

Overseas Academia:

UK Industry:

Overseas Industry:

UK Public Sector:

Overseas Public Sector:

Other (please state)

**Thank you for completing this section. Your comments and information will be very useful.**

# Engineering and Biological Systems Committee Responsive Mode Portfolio Evaluation 2007

## Views of UK Funders

Please provide as much detail as you can, and return by email to Lisa Holland by **13 August**.

Dr Lisa Holland, Research Evaluation Manager  
**Lisa.Holland@bbsrc.ac.uk**  
Tel 01793 414678

Name:  
Job title:  
Organisation:

**Please set out your views on BBSRC's Engineering and Biological Systems Committee.**

**You may wish to comment on the following:**

- content and coverage of the EBS remit, including any specific strengths or gaps in funding (please refer to enclosed background information)
- Interface between EBS and your funding body in terms of: scientific coverage, and joint application/administration processes (where such processes exist).
- management and operation of the EBS Committee
- flexibility of EBS responsive mode funding in terms of length and size of awards
- interaction of EBS-supported researchers with Industry and the Public

## APPENDIX 4

### LIST OF SAMPLE COMPLETED GRANTS

Grant No.	Title	PI
E17303	Characterisation of a specific articular cartilage progenitor cell	Archer C
E11450	Synthesis and characterisation of novel betaine - based copolymers for high performance biocompatible coatings	Armes S P
E15526	The use of bacterial chemotaxis and engineered chemoreceptors to detect pollutants	Armitage J
E15841	Development of novel methods for protein surface representation and comparison	Artymiuk P
E15832	Quantitative visualisation of biodegradation during natural attenuation of organic pollutants in groundwater	Banwart S
E15512	The carrier erythrocyte as an antigen delivery vehicle for the enhancement of the immune response	Bax BE
E17993	Hyperluminescence of biomolecules on multiphoton excitation	Bisby R
E08293	The development of techniques for the direct quantification of cell-surface adhesion using a force microscope	Bowen WR
E06058	Auto-assembly for engineering using biological recognition - a pilot project	Bowyer A
E11507	Dioxygenase-catalysed oxidation of organosulphur compounds to yield thiosulphinates and thiophene oxides	Boyd D
E12509	Synthesis and applications of porphocyanine-oligodeoxynucleotide conjugates as photoactive antisense agents	Boyle RW
E15462	Solid phase dendrimer synthesis; multiple valency and assay amplification	Bradley M
E11895	A novel fluorescence technique for studying proteins <i>in vivo</i>	Brindle K
E06656	Developing integrated methods for the design and analysis of sightings surveys	Buckland S
E09803	Development of an enzyme-catalysed desymmetrisation of prochiral ketones	Carnell A
E07916	A combined mathematical and experimental study of the consequences of heterogeneity in soil structure and moisture for microbial dynamics	Chaplain MAJ
E08527	Multi-strain species modelling and control via differential algebra reduction	Chappell MJ
E10441	Cell separations in expanded beds	Chase H
E16594	Responsiveness of cells to mechanical force; implications for the choice of cells for tissue engineering heart valves	Chester AH
E11436	Rapid bioassay for water-insoluble toxicants using water-in-oil microemulsions as solvent media	Christofi N
E13750	Targeting long DNA sequences using DNaseI-PNA conjugates	Connolly BA
E15580	Macromolecular assemblies and interactions at the air-water interface of biomolecular foams	Cooper A
E16354	North West Centre for Bioarray Innovation	Cossins AR
E07665	Multiplex cloning - generic technology for rapid identification of novel biocatalysts	Cowan DA
E13044	Exploitation of Bayesian design in steady-state enzyme-ligand binding and catalysis	Crabbe MJC
E15766	Chemo-enzymatic synthesis of the thylakoid lipids	Crout D
E05547	Applications of <i>Bacillus megaterium</i> cytochrome P450 in synthetic chemistry	Cullis PM
E15365	Biotinylation of enveloped viral gene therapy vectors and development of a scaleable purification process for such vectors	Darling D
E11767	The motility of diatoms under mechanical vibration	Davies S

Grant No.	Title	PI
E11765	Enzyme-catalysed acylation as a new strategy for oligosaccharide synthesis with minimal protection	Davis BG
E05946	Development of new <i>in situ</i> procedures for quantitatively measuring available elements in soils	Davison W
E13177	A population model of low level eye-movement control	Dean P
E06476	Protein-protein interactions within the apoptosis regulating Bcl-2 family by fluorescence resonance energy transfer and flow cytometry	Dive C
E09788	Coalescent-based estimation of demographic parameters, selection, and genealogical structure in multilocus genetic data sets	Donnelly P
E08273	Targeted-directed in situ assembly of novel latent detectors	Douglas KT
E08580	Theoretical investigation of novel electrophoretic techniques for the separation and analysis of DNA molecules	Duke T A
E12524	Intracellular trafficking of polymeric viral mimetics designed for intracytoplasmic delivery of gene and oligonucleotide therapeutics	Duncan R
E11939	A novel strategy for bioanalytical and biocatalytic devices: biomolecule immobilisation on nanoporous TiO <sub>2</sub> electrodes	Durrant J
E17100	A universally-applicable approach for the generation of protein-specific antibodies: applications in proteomics	Edwards R
E14022	Development of micromechanical devices for application as sensors in molecular probe chemistry	Evans A
E16515	A simple and economic process for viral vaccines: process synthesis and modelling of in vitro self-assembly	Falconer R
E08546	An investigation into the application of periodic feeding strategies in continuous bioreactors	Faraday D B
E09625	Isolation, identification, modification and exploitation of sugar mimics which occur in plants	Fleet G
E10135	Preparation and properties of a DNA mismatch- cleavage fusion protein	Fox KR
E06786	Development of a microchannel plate (MCP) detector for beta- autoradiography	Fraser G
E14090	Application of stochastic geometry to understanding transport of microorganisms in soil	Friel N
E13897	Assembly of nanoparticle drug delivery systems using novel functional biodegradable block copolymers	Garnett MC
E15784	Modelling T cell activation	George A
E09651	Engineering haem binding sites in monomeric rop	Gilardi G
E11970	Development of a novel method for trace interpretation for DNA sequencing	Gillies D
E11139	Development of an acoustic wave system for studying biological interactions occurring at the cell membrane	Gizeli E
E15014	Methods for monitoring, control and optimisation of animal cell cultures	Glasse J
E11126	Integrated miniaturised macromolecule separation and detection systems using fourier transform and correlation techniques	Goddard NJ
E10136	Isothermal titration calorimetric analysis of the formation of complexes between immunoglobulins and mutated immunoglobulin-binding domains from protein L of <i>Peptostreptococcus magnus</i>	Gore MG
E15769	Creation of a nanoparticle biosensor for multiplex single nucleotide polymorphism analysis	Graham D
E14651	Realising a qualitative increase in the capacity of proteomics by statistical image analysis of 2D electrophoresis gels	Graham J
E14966	Using the <i>Salmonella typhimurium</i> FNR protein to target therapeutic gene expression in hypoxic sites in diseased tissues	Green JG
E12683	Development of screening systems for novel Hsp90 antagonists	Greenhalf W
E07298	Enzyme action under very low water conditions: hydration hysteresis and sulphatase reversal	Halling P
E11659	Bioremediation and microbial population dynamics	Head I

Grant No.	Title	PI
E17305	Regulation of stem cell differentiation for the tissue engineering of cartilage	Hollander A
E09266	Computer modelling of the molecular motors in cilia	Holwill MEJ
E15128	Synthesis, hybridisation and patterning of DNA at silicon surfaces	Houlton A
E18018	Supercritical fluid mixing of cells and polymers: a novel method of instant scaffold formation	Howdle S
E16046	Regeneration of bone revision total hip arthroplasty using tissue engineering techniques	Hua J
E17771	Continuation support for the development of 'smart' membranes for solute delivery	Hubble J
E15611	Templated <i>in situ</i> assembly for the delivery of multi-site ligands	Hunter CA
E18534	Light-harvesting complexes as nanoscale reporters of inter membrane protein association forces and as optical circuit components	Hunter CN
E15109	Mucoadhesive, colon-specific drug delivery systems	Jackson CW
E08102	Modification of therapeutic protein products during viral- inactivation processes	James D
E14658	Feasibility study: stable isotope effects during MTBE biodegradation; a marker for biochemistry of natural attenuation	Kalin R
E13530	Evolution in spatial systems: long-term changes in disease behaviour	Keeling MJ
E13805	Metabolic control analysis and engineering of the yeast sterol pathway	Kelly D E
E10309	Directed evolution of cytochrome p450 from <i>Streptomyces griseus</i> for enhanced biocatalysis and bioremediation	Kelly S
E10985	A combined heat/oxygen flux metabolite probe to detect initiation and control suppression of apoptosis in cell culture	Kemp RD
LKE13546	The functional competence of animal cells in culture: analysis of the cellular proteome	Klappa P
E12967	Direct, sensitive and quantitative detection of viruses using rupture force spectroscopy	Klenerman D
E09879	Cyanide biodegradation: a model for the development of molecular probes for optimisation of bioremediation	Knowles C
E18561	Experimental (micro-fluids) and theoretical (modelling) engineering of electro-mechanically active cardiac cell cultures	Kohl P
E18541	Development of high resolution, rapid scanning ion conductance microscopy for liver cell studies	Korchev Y
E11930	Immunosensor based on the direct enzymatic degradation of thin films	Krause S
E10129	Lipid bilayer biosensors: development of cell surface display to produce porins with novel affinities	Lakey JH
E15100	Functional genomics of cytochromes P450 via substrate-trapping technology	Lamb DC
E18262	Interaction of the cationic polymer, chitosan, with plasmid DNA and artificial membranes	Lawrence MJ
E07300	Heterologous expression and generation of molecular hybrids of alkene mono-oxygenases	Leak D
E08265	Serine protease inhibitor libraries based on natural inhibitor proteins	Leatherbarrow RJ
E16689	Novel application of the <i>Pseudomonas fluorescens</i> biofilm cellulose-matrix as scaffold material in tissue engineering	Leaver C J
E08816	Characterisation of bacterial biofilms using the quartz crystal shear wave sensor	Lewis TJ
E17405	Microbial strain dynamics and bioreactor stability in an intensive absorber-bioscrubbers process	Livingston A
E10337	An integrative approach to the development of a novel biomimetic keratoprosthesis	Lloyd AW
E15770	Construction of biofilm consortia with defined internal architecture	Markx GH
E19366	Making artificial receptors accessible - molecular imprinting at surfaces and interfaces	Mayes AG

Grant No.	Title	PI
E13746	The development of genetic systems to facilitate the exploitation of clostridium genome information	Minton N
E10224	Application of solid-state acid-base buffers to enzyme catalysed reactions in synthetic chemistry	Moore B
E15209	An enhancer trap that drives inducible mis- expression in ARABIDOPSIS	Moore I
E12914	Smarter assays: a `brighter luciferase'	Murray JAH
E13497	Multigene engineering of mRNA translation initiation in eukaryotic cells for enhanced recombinant protein production	Naylor LH
E17610	Origin and spread of cardiac excitation: an anatomico- physiological computer model of rabbit SAN	Noble D
E13156	The development of a biotransformation system for the synthesis of carbon-fluorine bonds	O'Hagan D
E14029	Protein coated microcrystals: novel biocatalyst preparations	Parker M
E09606	Development and optimisation of an immunological and cellular tool-kit for pollutant biosensing	Paton G
E07395	Synthesis, characterisation and evaluation of novel ion exchange displacers for protein separation: a systematic structure-property relationship study	Patrickios CS
E12952	Cryopreservation of mammalian tissues: injury caused by freezing and its prevention by control of ice crystal growth	Pegg D
E16608	Molecular evolution approach for the affinity maturation of anti-microcystin antibodies from phage display libraries	Porter A
E11123	Active transport of gene expression plasmids to the cell nucleus by way of peptide nuclear localisation signals	Pouton C
E11490	Biological phosphorus removal from wastewaters: a novel approach	Quinn JP
E08524	Scanning near field optical microscopy to probe biological structure and organisation	Rayment T
E14976	Smart hyperbranched polymers for protein purification	Rimmer S
E12956	Cryogenic force microscopy of biomolecular structure	Roberts C
E14064	Nonlinear dynamics and variability of postsynaptic integration in cortical neurons during natural patterns of input	Robinson H
E07351	Development of a homogeneous DNA assay	Sammes P
E11940	Biosynthesis of nanophase hydroxyapatite by a species of citrobacter	Sammons RL
E09216	Strategic engineering of morphinone reductase and PETN reductase for biotransformation and biosensor applications	Scrutton N
E11714	Design and implementation of aqueous two-phase partition for recovery of adenovirus gene therapy vectors	Seville JPK
E13913	Targeted delivery of DNA into the cytoplasm of epithelial cells for the treatment of prostate cancer	Seymour L W
E14784	Mechanisms, kinetics of membrane transport and structure - activity relationships of membrane translocating peptides	Smith AW
E16849	An ultra-violet resonance Raman probe of sub-millisecond protein folding	Smith DAM
E15847	Controlled lysis of yeast in the gut for the delivery of vaccines, probiotics and therapeutic agents	Stateva L
E14660	Structure of DNA-copolymer colloidal complexes	Stolnik-Trenkic
E13948	<i>In vitro</i> synthesis of bone tissue: bioreactor and scaffold design	Triffitt JT
E16779	Rapid screening of heparan sulphate-protein interactions	Turnbull JE
E08711	On line monitoring of bubble size distribution and gas liquid dispersion in biological processes using an acoustic technique	Varley J
E11649	Integrated planar silicon technologies for high density screening of antibiotics	Walmsley AR
E11056	Monitoring of mutagenic and toxic chemicals by fluorescence induction and detection. Phase 2.	Walmsley RM
E07436	Electro-optical modulation of biologically active patterns	Wharton C

<b>Grant No.</b>	<b>Title</b>	<b>PI</b>
E14767	Biomembrane force probe for mapping energy landscapes in protein interactions and folding	Williams P
E08537	Wavefront correction in confocal microscopy	Wilson T
E15073	Combinatorial optimisation in directed evolution experiments: a systematic approach	Winson MK
E12155	Enhancing the degradative activity of bacteria by genetic augmentation with P450cam to provide novel catabolic pathways	Wong LL
E13753	Nanofabrication of protein fibres and matrices using self - assembly peptides of <i>de novo</i> design	Woolfson DN
E11124	Hyperthermophilic microorganisms: applications to hot waste gas biofiltration	Wright PC
E06813	Generic methods of statistical modelling for biological systems and their application in plant physiology research	Young P

## CURRENT GRANTS FOR WHICH QUESTIONNAIRES WERE RETURNED

Grant No.	Title	PI
BBC5158551	Dual degradable polycation/DNA polyplexes for gene delivery	Alexander C
BBC0067711	Field gradient focusing for proteomic analyses	Ansell RJ
BBD52222X1	Rapid electrocatalytic hydrogen cycling by enzymes: establishing the basis for future energy technology	Armstrong FA
BBC5125101	Confocal Raman microscopy to investigate bone formation, disease and repair	Aspden RM
BBD0036361	Disulfide bridging protein conjugation	Brocchini SJ
BBD5229891	Protein interactions in ionic media	Bruce N
BBC5058401	Osteogenic differentiation of human embryonic stem cells in 3-D culture	Buttery LDK
BBSB0319X	Tunable biomaterials for soft tissue engineering	Cameron N
BBC5163791	Defining nanoscale high through-put screening of stem cell-biomaterial interactions	Davies M
BBD5230941	Field effect sensing for protein microarrays	Davis J
BBC5061721	Use of nanoparticles and macrophages to target two novel therapies to hypoxic areas of tumours: a combined biological and mathematical study	Dobson J
BBC0036831	Optical biosensors in human and animal health	Eckersall PD
BBC0072631	Experimental design for stochastic dynamical models in the life sciences	Gibson G
BBC50466X1	Combinatorial bioformulation of epidermal growth factors	Gonzalez AM
BBD01638X1	The application of time domain processes for the improvement of data quality and enhanced pattern recognition in NMR based metabolomics	Griffin JL
BBD0013071	Nanospheres in the cytosphere: interrogating the intracellular milieu with ion-dot ANSors	Hall EAH
BBD01364X1	Constructing stable chitosan and pectin peptide-delivery systems for nose and gut	Harding SE
BBC5095661	Practical statistical alignment	Hein J
BBD0081311	Supported Cell Membranes: The next level in model membrane systems	Jeuken LJC
BBC5072531	Biological information extraction for genome and superfamily annotation	Jones D
BBD0044031	Baeyer-Villiger enzymes and application in biotransformations	Littlechild JA
BBD0113291	Improving the delivery of 5-aminolaevulinic acid in photodynamic therapy (PDT): synthesis and biological studies of novel peptide prodrugs	MacRobert A
BBSB01219	Linking ecological and evolutionary dynamics	Morgan B
BBC0068792	Construction of a biotechnologically versatile and stable oxygenase biocatalyst	Munro AW
BBC0073601	Mining term associations from literature to support knowledge discovery in biology	Nenadic G
BBD0016681	Using theoretical simulation to direct bone tissue engineering	Oreffo R
BBC5138931	Fibronectin-based biosynthetic devices for spinal repair	Priestley J
BBD0183581	EMBOSS: European Molecular Biology Open Software Suite	Rice PM
BBC5154121	Analysis and enhanced representation of protein interaction networks: towards understanding the evolution of complex intracellular systems	Robertson DL
BBC50446X1	The development of novel caged beta-lactam antibiotics: tools for the study of bacterial resistance by time-resolved IR spectroscopy	Snaith J
BBD00151X1	Open image informatics software for biological microscopy	Swedlow JR
BBSB03645	Non-viral gene delivery: optimising in vivo stability and cell targeting	Tabor A

<b>Grant No.</b>	<b>Title</b>	<b>PI</b>
BBD5224971	Polyvalent protein-ligand displays for human endometrial stromal cell and embryonic stem cell adhesion differentiation and proliferation	van der Walle C
BBD0129101	The iBAC genomic DNA expression library	Wade-Martins R
BBD5214651	Bioprocessing of genetically engineered filamentous phages to underpin new therapeutic and industrial applications	Ward JM
BBD5227111	Tightening the barrier: developing techniques for obtaining physiological mass transfer properties of endothelium in vitro	Weinberg PD
BBD0107481	Coupled oscillators - detecting the functional consequences of signalling pathway interactions.	White MRH
BBSB02525	Development of adenovirus type 4 vector systems	Wilkinson GWG
BBD5225381	Molecular breeding for the improvement of biocatalytic activity - directed evolution of a chimeric glucanase with enhanced ability to disrupt oral biofilms	Wilson M
E20372	Characterisation of a novel N-linked general glycosylation pathway as a tool for glycoengineering	Wren B

## APPENDIX 5

### OTHER NOTABLE GRANTS IDENTIFIED BY PANEL

#### *A simple and economic process for viral vaccines: process synthesis and modelling of in vitro self-assembly*

In this project, a scalable process for the manufacture of human papillomavirus type 16 virus-like particles (VLPs) was developed and each process step characterised and used to generate quantities of capsomers for subsequent self-assembly trials. This work advanced understanding of the VLP self-assembly process and provides an alternative manufacturing process to those based on yeast and insect cell expression systems used commercially. The work led to one refereed paper and one of the RAs employed on the grant has set up their own company.

#### *Application of solid-state acid-base buffers to enzyme catalysed reactions in synthetic chemistry*

The aim of this project was to develop and exploit methods of controlling and measuring the ionisation state of enzymes in low water media. It involved close collaboration between groups at Strathclyde and Edinburgh and resulted in the development of a number of practically and commercially useful tools for promoting enzyme catalysed synthesis in organic solvents. Four refereed papers were published and some of the know-how from this project has been taken forward by the spin-out company, XstalBio.

#### *Computer modelling of the molecular motors in cilia*

This grant used computer modelling to establish the molecular mechanisms involved in the generation of bends during ciliary movement. It resulted in the modelling of a microtubule by a longitudinal assembly of solid cylindrical elements with appropriate elastic properties, which emphasised the importance of the links between microtubules and suggested that a weak, as well as strong, interaction between the outer dynein arms and the neighbouring microtubule is of significance in generating axonemal bending. Six refereed papers and three book chapters resulted from the grant.

#### *Construction of biofilm consortia with defined internal architecture*

This project studied the use of artificial biofilms with man-made, rather than natural, architectures. The research resulted in the simplification and improvement of existing approaches, leading to significant time reductions in making microelectrodes and the production of more robust and applicable microelectrodes. The technology developed has potential in the instrumentation/biosensors area. New collaborations were established in the UK and overseas, six refereed publications published, and a number of public engagement activities organised.

#### *Design and implementation of aqueous two-phase partition for recovery of adenovirus gene therapy vectors*

This project concentrated on the development of an aqueous based bioprocess to separate/isolate adenovirus for possible gene therapy. It led to the establishment of cell culture systems for the production of host animal cells, their infection with adenoviral vectors and the subsequent recovery of vectors from lysates of harvested cells. Seven refereed papers and several new collaborations resulted from the grant.

#### *Development of a microchannel plate (MCP) detector for beta autoradiography*

This research focused on the design and manufacture of a pre-commercial prototype of a highly sensitive, large area electronic detector for use in the direct digital autoradiography of whole-body tissue slices and electrophoresis gels. The detector developed was, at the time, the only means of obtaining high spatial resolution images within a reasonable amount of time. The research received wide media coverage and was presented to the Minister of Science and HRH The Duke of Edinburgh.

#### *Integrated miniaturised macromolecule separation and detection systems using fourier transform and correlation techniques*

Two key approaches to this project were the use of direct CNC machining in polymers and photolithographic channel fabrication, and the direct fabrication in light curable polymers using a maskless photolithography system. These methodologies have subsequently been applied to 2D capillary electrophoretic separation devices for proteomics. One refereed paper was published, two patent applications made and the fabrication methods developed contributed towards the establishment of a spin-out company.

#### *Modelling T-cell activation*

The aim of this grant was to gain a fuller understanding of how engagement of the T cell receptor activates the T cell. Results showed that specificity and sensitivity of the T cell can be found at three levels: the

receptor, the cell and the population of cells. This finding could eventually feed into improved strategies for treatment or prevention of disease, and could be an important tool for scientists studying cell division in a range of systems. This work resulted in four refereed papers.

*Synthesis, hybridisation and patterning of DNA at silicon surfaces*

This grant developed an approach for attaching DNA oligonucleotides to oxide-free silicon wafers to which complementary DNA strands could be attached. The capability of these non-native silicon surfaces to remain conductive and used as electrodes was demonstrated. Use of photolithography permitted patterning of the DNA-coated substrate, and the potential use of the substrates for enzyme activity was also shown. Eight refereed papers were published.

*Targeted delivery of DNA into the cytoplasm of epithelial cells for the treatment of prostate cancer*

This project was part of a larger effort to develop non-viral vectors for intracellular localisation of polynucleotides. These are complex formulations of heterogeneous mixtures of macromolecules, and progress was made on several fronts. The grant resulted in 14 refereed papers and several new collaborations both in the UK and overseas. The PI is the co-founder of a spin-out company in the field covered by the grant.

*The development of techniques for the direct quantification of cell-surface adhesion using a force microscope*

The aim of this project was to develop methodologies for the direct quantification of the adhesion of biological cells to surfaces using an atomic force microscope. Experiments were carried out using a variety of cell types such as *Saccharomyces cerevisiae* and *Candida albicans* interacting with different surface types, resulting in the development and exploitation of a unique means of quantifying the adhesion forces. Six refereed publications were published and a large number of interdisciplinary interactions established.

*Theoretical investigation of novel electrophoretic techniques for the separation and analysis of DNA molecules*

This grant looked at one of the technologies for extracting pieces of DNA and resulted in the invention of a novel method of electrophoretic separation which permits the continuous sorting of molecules. The method relies on rectified diffusion in a 2-dimensional microfabricated sieve of asymmetric obstacles. The work was carried out in collaboration with a group in the US and resulted in six refereed papers.

*Using the Salmonella typhimurium FNR protein to target therapeutic gene expression in hypoxic sites in diseased tissues*

The aim of this grant was to use a modified strain of *Salmonella* as a delivery vehicle for targeting therapeutic gene expression to hypoxic regions of tumours. A system was developed with two independent levels of tumour targeting, providing a new strategy for delivering gene therapy to inaccessible areas of solid tumours. This could also be used in the treatment of various inflammatory conditions and cardiovascular diseases. A new collaboration was established with cancer researchers and one review paper was published.