The Academy of Medical Sciences

Team science: a discussion paper

November 2012

The Academy of Medical Sciences

The Academy of Medical Sciences is the independent body in the UK representing the diversity of medical science. Our mission is to promote medical science and its translation into benefits for society. The Academy's elected Fellows are the United Kingdom's leading medical scientists from hospitals, academia, industry and the public service. We work with them to promote excellence, influence policy to improve health and wealth, nurture the next generation of medical researchers, link academia, industry and the NHS, seize international opportunities and encourage dialogue about the medical sciences.

To submit comments about the proposals contained in the document, please contact Dr Rachel Quinn, Director of Medical Science Policy (rachel.quinn@acmedsci.ac.uk, 020 31762163).

Additional copies of the report can be downloaded from:
http://www.acmedsci.ac.uk/p47prid117.html

This report reflects the views of participants expressed at the roundtable and does not necessarily represent the views of all participants or of the Academy of Medical Sciences.

All web references were accessed in November 2012.

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Summary

- Trans-disciplinary teams bring together researchers with diverse skills and expertise to solve complex problems. They are essential to address major public health challenges and to translate research into health and wealth benefits.
- These teams are common in industry and healthcare, but less so in academia. They represent new ways of working that provide the opportunity for researchers to tackle a given problem more effectively without extra cost.
- Culture, reward and recognition currently focus primarily on the success of individuals, particularly in academia, and do not incentivise team approaches.
- The importance of trans-disciplinary teams needs to be communicated widely via the promotion of exemplars and the recognition of teams by the media. Prizes for teams, or institutions that explicitly facilitate team approaches, should be considered to encourage culture change and incentivise team working.
- Obtaining funding for trans-disciplinary team proposals is still a challenge, particularly in responsive mode. Including researchers with experience of team science projects on peer review panels could ensure they are properly assessed. Establishing productive trans-disciplinary teams requires a minimum of five years of funding, yet most project grants are for three.
- Appropriate team-related skills are essential, but often not as highly valued within academia as they are within industry and the NHS. It will be important to value these skills in promotion decisions. Team skills should be included in training programmes at all levels, with leadership training important at senior levels. Funders could consider mandating this training.
- Infrastructure (such as data platforms) will be essential in realising potential of many team science projects and will need to be adequately funded.
- Even within trans-disciplinary teams, it will be necessary to recognise and measure the contributions of individuals within teams. This should be possible under the new Research Excellence Framework and for scientific publications through the Open Researcher and Contributor ID.
- The Academy seeks views on this discussion paper, particularly on the proposals that arose from the roundtable that seek to encourage a culture that is more supportive of trans-disciplinary teams and to ensure that researchers have the skills and resources required to support functional team-working.

Overview

As part of the development of the Academy of Medical Sciences 2012-16 strategy, the Academy has been reflecting on the growing debate around the contribution of team science towards ensuring progress in the biomedical sciences and its translation into health and wealth benefits.

The implications of a more prevalent team science approach is relevant to how the Academy recognises excellence; its support for the next generation of biomedical scientists; its approach to linking academia, industry and the NHS; its desire to bridge the clinical/non-clinical divide; and its ability to interface more effectively with those disciplines that are increasingly important to medicine, such as engineering. Furthermore, it provides a means to increase the impact of research without necessarily increasing cost. These are all key objectives for the Academy in the next 5 years.[1]

In order to explore the opportunities and implications of team science, a small roundtable was convened at the Academy on 27 March 2012. Participants were drawn from academia, industry, the medical research charities, public research funders, and scientific publishing (please see Annex 1). This discussion paper combines the issues raised at that meeting, the background briefing paper that had been prepared for attendees in advance and the perspectives raised by the Academy's Fellows during our consultations with them about our new strategy. The Academy would welcome views from the biomedical community and representatives of other disciplines and sectors on the proposals that emerged from the discussions we have held.

[1] The Academy of Medical Sciences (2012). *Improving health through research: Academy strategy 2012-16*. http://www.acmedsci.ac.uk/p98puid239.html

Introduction to team science

Team science initiatives are designed to promote collaborative, cross-disciplinary approaches. Definitions of different types of teams can be found in Table 1. The phrase 'team science' originated in the US, where a growing trend within team science is trans-disciplinary science in which team members from different fields work together to combine or integrate their perspectives in a single research endeavour. In the UK the term 'interdisciplinary research' is more likely to be used and has been less likely to refer to major trans-disciplinary approaches.

Trans-disciplinary approaches enable studies to be undertaken that address a broad array of complex and interacting variables such as climate change, or major public health problems such as obesity. It is also seen as a promising approach to accelerating scientific innovation and the translation of scientific findings into effective policies and practices. It is considered that a diverse team brings a diversity of approaches to problem-solving, decision-making, communication, conflict resolution, and critical thinking. These teams are generally regarded as generating more creative ideas and, because the combined networks of the members are diverse, they have better traction in terms of disseminating ideas and outcomes.[2] While trans-disciplinary collaborations are seen as having the greatest potential to produce highly novel scientific outcomes, they are also the most challenging to sustain.[3]

Table 1 Definitions of different types of teams[4]

Scientific orientation	Definition	Example
Unidisciplinarity	**Unidisciplinarity** is a process in which researchers from a **single discipline** work together to address a common research problem.	A team of pharmacologists collaborate on a laboratory study of the relationships between nicotine consumption and insulin metabolism.
Multidisciplinarity	**Multidisciplinarity** is a **sequential** process whereby researchers in different disciplines work **independently,** each from his or her own discipline-specific perspective, with a goal of eventually combining efforts to address a common	A pharmacologist, health psychologist, and neuroscientist each contribute sections to a multi-authored manuscript that reviews research in their respective fields pertaining to the links between nicotine consumption, changes in

[2] Disis M & Slattery J (2010). *The road we must take: multidisciplinary team science*. Science of Translational Medicine **2** 22cm9.
[3] Stockls D, *et al*. (2008). *The science of team science*. American Journal of Preventative medicine **35(2S)** S77-89.
[4] Taken from: Rosenfield P (1992). The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. Social Science & Medicine **35**, 1343–57.

	research problem.	brain chemistry and caloric intake induced by nicotine, and physical activity levels.
Interdisciplinarity	**Interdisciplinarity** is an **interactive** process in which researchers work **jointly,** each drawing from his or her own discipline-specific perspective, to address a common research problem.	A pharmacologist, health psychologist, and neuroscientist conduct a collaborative study to examine the interrelations among patterns of nicotine consumption, brain chemistry, caloric intake, and physical activity levels. Their research design incorporates conceptual and methodologic approaches drawn from each of their respective fields.
Transdisciplinarity	**Transdisciplinarity** is an **integrative** process in which researchers work jointly to develop and use a shared conceptual framework that **synthesizes** and **extends** discipline-specific theories, concepts, methods, or all three to create **new** models and language to address a common research problem.	A pharmacologist, health psychologist, and neuroscientist conduct a collaborative study to examine the interrelations among nicotine consumption, brain chemistry, caloric intake, and physical activity levels. Based on their findings, they develop a neurobehavioral model of the links among tobacco consumption, brain chemistry, insulin metabolism, physical activity, and obesity that integrates and extends the concepts and methods drawn from their respective fields.

The discipline of the science of team science (SciTS) developed from a need to evaluate the value of the increasing investment in large-scale team science programmes. The field is concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of large-scale collaborative research, training, and translational initiatives through empirical analysis. There is a growing literature in SciTS. In August 2008 the

American Journal of Preventative Medicine dedicated a supplement to the topic and for the last two years an international conference on SciTS has been held in the US.[5,6]

At the roundtable, it was suggested that inter-disciplinary teams are easier to manage as each part (discipline) has a leader whereas in truly trans-disciplinary teams everyone is 'doing the same thing'. Participants heard that research on team performance suggested that, to be successful, teams need: shared objectives; clarity about outcomes; time to reflect on their performance as a team; and ideally to meet in person. There was some discussion about the optimum size of teams. In heterogeneous teams, it was proposed that eight to nine members was the optimum size, with larger groups needing to be divided into sub-teams. Homogenous teams that share a common culture (e.g. a team of particle physicists) might be successful with a larger team size.
clinical academics.

[5] Various authors (2008). *The Science of team science: assessing the value of transdisciplinary research*. American Journal of Preventative Medicine **35(2S)** S77-S252. http://dccps.cancer.gov/brp/scienceteam/ajpm.html
[6] http://www.scienceofteamscience.org/

The value of team approaches

Healthcare

Many health interventions require teams of health professionals from different disciplinary backgrounds (for example chronic depression, cancer care and accident and emergency). Many studies have demonstrated a positive relationship between team-work and clinical outcomes, with additional benefits of increased job satisfaction for staff.[7,8,9] The challenges are not only clinical, but organisational, with sustainable teams needing to span professional, hierarchical and organisational boundaries.[10]

Industry

There has also been research into developing effective teams in research and development in the private sector. For example, drug development teams in the pharmaceutical industry include representatives from clinical development, drug safety, regulatory affairs, statistics, and marketing. By background and training, all of these people approach the issue from a distinctly different perspective.

Academia

There has been recognition of the need for academia to adopt the team approaches seen in healthcare and industry.[11] Many UK institutions have established interdisciplinary research centres either proactively or in response to major funding awards (e.g. Centre for Cognitive Ageing and Cognitive Epidemiology in Edinburgh that was established as part of the joint research council initiative on ageing).[12] At the roundtable it was highlighted that the trans-disciplinary research efforts in genomics, stimulated by targeted funding, has been seen to generate a genuine culture change. In addition it was suggested that some evidence of the benefits of a team approach in research is emerging - for example collaborative papers are cited more often.

Cross-sector

It is increasingly recognised that for rapid translation of biomedical discoveries into health and wealth benefits and to address complex public health problems, it will not be sufficient for teams to simply cross disciplines that range from discovery and clinical research to public policy - they will also need to cross research sectors that include academia, industry, the NHS and government.[13] This cross-sector permeability is

[7] West MA & Borrill CS (2005). *The influence of team working*. In Cox J, *et al*. eds. Understanding Doctors Performance. Radcliffe Publishing, Oxford.
[8] Richardson J, *et* al. (2010). *Team working in intensive care*. Current Opinion in Critical Care. **16** 643-648.
[9] For example see: West MA, *et al*. (2002). *The link between the management of employees and patient mortality in acute hospitals.* International Journal of Human Resource Management **13(8)** 1299-1310 and West MA & Borrill CS (2005). *The influence of team working*. In Cox J, *et al*. eds. (2005). *Understanding doctors performance*. Radcliffe Publishing, Oxford.
[10] Ibid
[11] Meyers FJ & Pomeroy C (2011). *Creating the future biomedical research workforce.* Science of Translational Medicine **3** 102fs5
[12] http://www.ccace.ed.ac.uk/
[13] Jackson RD, *et al.* (2010). *Training the translational scientist*. Science of Translational Medicine **2** 63mr2.

embodied in the Government's recent Life Sciences strategy.[14] The UK Academic Health Science Centres and 'open innovation' partnerships between academia and industry are starting to bridge sectors. The Frances Crick Institute and the Academic Health Science Networks will continue with this approach. Academy Fellows who responded to our survey recognised that teamwork is particularly important in translational medicine, in teams spanning academia and industry.

Participants at the roundtable agreed that functional trans-disciplinary teams, bringing together diverse skills and knowledge, would be essential in addressing major public health challenges and more generally in translating scientific findings into effective policies and practices. Ultimately a successful team science approach is essential if we are to work more effectively to maximise the health and wealth benefits of biomedical research without additional funding. However, it was recognised that the focus is very much on individual success. For example, journal feature articles and more popular media coverage tends to focus on individuals rather than teams when reporting collaborative research. It was clear from the discussion that communicating the value of a team approach, including through the use of exemplars, would be essential in helping to ensure a shift towards a culture that supports team science. Increased permeability between academia, industry and the NHS could also help to promote better understanding of the importance of teams and how they can function most effectively.

[14] Department for Business Innovation and Skills (2011). *Strategy for UK life sciences.* http://www.bis.gov.uk/assets/biscore/innovation/docs/s/11-1429-strategy-for-uk-life-sciences.pdf

Determinants of a successful team science approach

Factors that have been implicated in determining the efficiency, productivity, and overall effectiveness of teams include:

- Funding trends
- Institutional infrastructure and resources for communication and data sharing
- Organisational policies—such as promotion and tenure policies
- Team processes, including the existence of agreements related to proprietary rights to data and discovery, as well as mechanisms for feedback and reflection
- Interpersonal dynamics among team members
- Team members' collaborative skills and experiences
- Genuine commitment and role models at all levels, including the most senior.

The implications of these are discussed in the sections below, particularly in academia where the team science approach is not yet established.

Reward and recognition

When recruiting and rewarding academics, universities face potentially conflicting pressures to recruit individuals who are good teachers; will be highly rated in any national research assessment process; and work well in teams. However, roundtable participants agreed that while there is a culture in academia that primarily celebrates the successes of individuals and individual institutions, it will be difficult to encourage functional teams. Given the growing importance of a team science approach, the participants discussed how this might be changed. It was recognised that there may be a difference between a team brought together to deliver a service, as in healthcare or industry, and a team brought together to solve a research problem. The latter may need more motivation (e.g. the prospect of an award).

Prizes and awards

Prizes have traditionally focused on either a single recipient or a very small group (for example the medals awarded by the national academies). The field of cancer has led the recognition of teams and Cancer Research UK's new Translational Cancer Research Prize is an example of this (see Box 1).[15] UK teams are clearly able to compete successfully internationally: the 2012 American Association for Cancer Research's Team Science Award was won by the Institute of Cancer Research (ICR) and Royal Marsden Hospital. The success of team prizes in the NHS, which are highly competitive, was highlighted. In healthcare delivery, the Health Service Journal prizes are awarded to organisations (e.g. hospital trusts) rather than individuals. In addition, National Institute for Health Research and the Association of the British Pharmaceutical Industry sponsor a national *Research Site of the Year* award that recognises a research team.

Our survey of Fellows during the development of our strategy focused primarily on the relevance of prizes and awards in a more team-based culture. Respondents agreed that awards for teams would redress the balance and encourage team working but noted that it might be difficult to define the boundaries of a team. It was also proposed that while the award should recognise the team, any prize should be directed to promoting the careers of junior members of the team, rather than the group leader.

It was agreed at the roundtable that prizes aimed at recognising successful teams, and/or institutions that have done the most to promote teams, should be explored further.

[15] http://science.cancerresearchuk.org/funding/find-grant/all-funding-schemes/translational-cancer-research-prize/

Box 1 Translational Cancer Research Prize

The Translational Cancer Research Prize (Cancer Research UK) recognises an outstanding translational research team that has done seminal work in cancer research. The work must have been at the cutting edge of scientific novelty, and have had significant impact on the continuing efforts to prevent, diagnose and cure cancer. The prize-winning team is expected to be multidisciplinary, and comprise both clinical and non-clinical members. The team may also include principal investigators and non-principal investigators. Team members do not necessarily have to come from the same country or belong to the same institution; but a significant proportion of the work that is being honoured must have been carried out in the UK. Institutions include those in academia, industry, or government. The team must be comprised of researchers providing complementary interdisciplinary expertise, each of whom has made separate substantive and quantifiable contributions to the research being recognised. The research to be recognised should reflect work towards a specific scientific goal that otherwise would not be realised by any single component of the team. The winning team receives a research grant of £25,000, a commemorative trophy, and free attendance at the NCRI Annual Conference for up to five members of the team, where the presentation ceremony takes place.

Career progression

At the roundtable it was agreed that academics are generally promoted due to their success as scientists rather than their abilities as team members or leaders. When applying for positions in the NHS, for example, it was suggested that there is more likely to be a focus on whether someone is a good team player. While the criteria for promotion remain those that simply reflect individual success then it will be difficult to change the culture within academia. The NIH National Cancer Institute has a developed a web-based team science toolkit that provides a forum for sharing knowledge and tools to maximise the efficiency and effectiveness of team science initiatives.[16] It includes templates for integrating team science into tenure offers and the ability to search for potential collaborators. In addition, the University of Southern California has recently amended its tenure and promotion guidelines, to provide departments with explicit instructions on how to weigh interdisciplinary research and collaborative scholarship when rewarding faculty.[17,18] UK universities could consider providing similar guidance to their staff.

Research outputs

With respect to scientific publications, the position as first or last author is currently used as a measure of success on multi-authored papers. At the roundtable it was suggested that developing the statements of author's contributions would be more appropriate than trying to recognise multiple 'first authors'. The author statements could be quite prescriptive in terms of allocating the level of contribution (e.g. give a percentage) or, if the statements were published online, they could be more descriptive. The development

[16] https://www.teamsciencetoolkit.cancer.gov/public/Home.aspx

[17] http://www.usc.edu/academe/faculty/private/1011/UCAPT_Manual_Jan_2011_for_posting.pdf

[18] http://www.insidehighered.com/news/2011/07/22/usc_rewards_collaborative_and_interdisciplinary_work_among_faculty#ixzz1p84vl1e4%20Inside%20Higher%20Ed

of an Open Researcher and Contributor ID (ORCID) gives researchers a unique identifier and will be linked to a database that could allow a description of each author's contribution to be outlined.[19] It was recognised that the development of author contribution statements that are more appropriate to a team science approach is an area where journal editors and the scientific community could helpfully work together.

The importance of databases to biomedical science was highlighted, and it was suggested that ORCID might also provide a mechanism for recognising individual contributions to their development.

In the case of patents it was noted that while the whole team of researchers can be listed when the patent is filed, the percentage contribution is determined for the purposes of allocating any associated income.

Recognising individuals versus teams

Participants at the roundtable noted that even in a team science culture there will always be a need to recognise individual successes and contributions. In industry, the entire team is rewarded at the end of a project, whilst individual contributions to the team are recognised during the project. The latter is important, as all individuals need to be motivated to contribute in order for a team to work. In industry, major milestones in the project (e.g. a drug going into development) are also recognised. It was agreed that this approach could be valuable in academia.

[19] http://about.orcid.org/about

Training and development

It was agreed at the roundtable that we should build on existing training schemes with regard to promoting team working and associated skills. In the context of clinicians, doctors have a duty to be able to work in teams despite little training provision at undergraduate level to equip them for this. This is something that might be considered by organisations such as the Medical Schools Council. In the UK, generic training courses (e.g. in presentation and grant writing skills) are provided by universities and funders. Some of these courses are being rolled out by universities to international partners in less developed countries. The possibility of including team leadership and collaboration skills in generic training should be explored by research institutions and funders. Subject to evidence that they are effective, tool kits such as the one developed in the US in the cancer field could be promoted in the UK.[20]

The NIH mandates that grant holders will have received training in certain core skills. UK funders could consider taking a similar approach with respect to team-related skills.

Generic team science development and training

Biomedical (and other) researchers will increasingly need to work in complex interdisciplinary and inter-institutional teams, often at the disciplinary interfaces. While some early-career researchers welcome the opportunities to explore new disciplines and sectors that are provided by team science initiatives, others view them as risky, possibly impacting the chances of career advancement.[21] Specifically there may also be concerns that individual contributions may be obscured and creativity blunted by excessive concentration on teamwork. One of the roundtable participants observed that some postdocs questioned whether experience in the management side of team projects will be valued in subsequent positions. Given that the number of trans-disciplinary teams is likely to increase, others felt that these concerns may be unfounded. Strong commitment to team sciences will be required at all levels within institutions to reassure researchers that participation in cross-disciplinary projects is valued.

Researchers will need to bring not only their scientific expertise but also the skills required to sustain functional teams. It is generally agreed that discipline-specific training is still required for researchers, but that curricula designed to promote teamwork and interdisciplinary training will promote innovation.[22] Coaching team members in conflict management and communication skills will be important and project management will be an increasingly essential competency.[23,24] In an effort to promote cross-sector translational research, a number of courses are being developed in the US to help

[20] https://www.teamsciencetoolkit.cancer.gov/public/Home.aspx
[21] Committee on Facilitating Interdisciplinary Research, National Academy of Sciences, National Academy of Engineering, Institute of Medicine (2004). *Facilitating interdisciplinary research*. The National Academies Press, Washington, DC.
[22] Meyers FJ & Pomeroy C (2011). *Creating the future biomedical research workforce.* Science of Translational Medicine **3** 102fs5
[23] Beckerle MC, *et al.* (2011). *Medical faculty development: a modern day odyssey.* Science of Translational Medicine **3** 104cm31.
[24] Jackson RD, *et al.* (2010). *Training the translational scientist*. Science of Translational Medicine **2** 63mr2.

academics to understand the mindset and priorities of industry in the drug discovery process.[25]

Leadership skills

It has been suggested that a successful leader of 'team science' projects, particularly in the initiation phase, will need to:

- Control dominant individuals
- Ensure that all members are acknowledged
- Connect disparate groups that don't yet have the trust and interdependence required to be self-sustaining
- Mentor other team members so that they can take a role as leader of the group as new projects are developed with shifting focus.
- Possibly share leadership over the course of the project as the focus of the project develops, for example in the flow of translational research, from the bench to bedside and back to the bench.[26]

Some of these characteristics differ from those that are developed, rewarded or required in less diverse teams.

At the roundtable, it was agreed that the best scientists do not always make the best leaders. In industry more junior scientists or those with lesser scientific credentials may be appointed as the project Chair. It was agreed that universities could do more to address poor team leaders. The NIHR research leadership-training course for trainees has been very successful and has recently received a very positive evaluation. [27,28] It was agreed that it would be helpful to explore whether elements of this course could be rolled out more widely.

[25] Jackson RD, *et al.* (2010). *Training the translational scientist*. Science of Translational Medicine **2** 63mr2.
[26] Disis M & Slattery J (2010). *The road we must take: multidisciplinary team science*. Science of Translational Medicine **2** 22cm9.
[27] http://www.nihr.ac.uk/faculty/Pages/Leadership_Programme.aspx
[28] RAND Europe (2012). The National Institute for Health Research Leadership Programme. An evaluation of programme progress and delivery. http://www.rand.org/pubs/technical_reports/TR1162.html

Funding and infrastructure

Funding aimed at promoting a team science approach - in the form of research grants, infrastructure and workshops - is growing. Examples in the US include the National Academies of Sciences Keck Futures Initiative and the National Institutes of Health (NIH) Clinical and Translational Science Awards.[29,30] In the UK, the Research Councils all fund interdisciplinary approaches, from small 'discipline-hopping' grants to major interdisciplinary research grants.[31]

The consideration of interdisciplinary research proposals by more than one funding committee or body presents challenges, particularly where the novelty of aspects of the proposal that fall within the remit of each funding body or committee are not regarded as equally high. Participants agreed that funders such as the Wellcome Trust and the NIHR, were able to evaluate and fund trans-disciplinary projects successfully in the responsive funding mode. However it was suggested that other funders appear to find it more difficult to deal with large, trans-disciplinary team projects that do not fall within a single, responsive mode subject board. These funders find it easier to support trans-disciplinary projects in the directed mode (e.g. top down 'grand challenges'). It was suggested that including those with experience of team science projects on grant awarding panels would be helpful.

The length of funding available is also important, with five years likely to be the minimum term required for team projects. Where only three years of funding is available, postdocs tend to look for new positions after two years. The new Research Excellence Framework (REF) will determine research infrastructure funding in UK universities. The fact that statements explaining why a researcher has been crucial to a collaborative project can be submitted to REF panel A (that covers the biological and clinical sciences), can be included was welcomed.

The number and value of grants held as lead PI is recognised as a measure of success and considered in the context of promotion, however generally only one lead PI is recognised. In 2007 the NIH launched a Multi-PI Policy for awards with the aim of '*encourag[ing] institutions to reward and recognize successful science teamwork through career advancement*'.[32] Currently however only PIs within a single institution can be recognised as equals, PIs at different institutions must establish a hierarchy such that only one institution receives an award.

Major biomedical projects - both now and in the future - require expensive technology platforms, informatics to manage large volumes of data, and shared facilities such as the Diamond Synchrotron. There was a discussion at the roundtable about whether the current funding model for universities promoted or hindered the development of this infrastructure. It was noted that universities could choose to spend their block grants from the Funding Councils on infrastructure and that capital grants for technology

[29] http://www.keckfutures.org/grants/index.html
[30] http://www.ncats.nih.gov/research/cts/ctsa/ctsa.html
[31] For cross-council initiatives see http://www.rcuk.ac.uk/RESEARCH/XRCPROGRAMMES/Pages/home.aspx
[32] http://grants.nih.gov/grants/multi_pi/

platforms are also available from the Funding Councils. The University of Dundee was cited as an example of an institution that had invested in infrastructure, which had contributed to its subsequent success.

Research integrity

The importance of ensuring that the team is accountable for its research integrity was emphasised. This becomes increasingly challenging in trans-disciplinary teams where team members will not easily be able to validate each other's work. Cross-institutional teams also present difficulties. Though regulatory requirements mean that laboratory paperwork is signed off on a daily basis in industry, an equivalent level of bureaucracy would not be appropriate in academia.[33]

[33] Following the roundtable, the Academy raised issues of integrity relating to team science with the organisations developing the new Research Integrity Concordat. http://www.universitiesuk.ac.uk/PolicyAndResearch/PolicyAreas/Research/Pages/Researchintegrity.aspx

Proposals for future action

Participants identified a number of areas where action and/or further discussion would be helpful in promoting the team science agenda, particularly within academia where team science approaches are not well established. These primarily focused on: encouraging a culture that is more supportive of trans-disciplinary teams and ensuring that researchers have the skills and resources to support functional team-working. Addressing the challenges and opportunities presented in this discussion paper is be essential if the UK is to develop and sustain the teams that will address major public health challenges and translate research into health and wealth benefits.

The Academy would welcome comments on how the issues outlined in the discussion paper might be addressed and, in particular, on the proposals outlined below:

- **Promoting the importance of interdisciplinary teams**, for example using exemplars. The Academy will be seeking opportunities to promote the importance of teams in its interactions with researchers of all levels of seniority, and the wider biomedical community.
- **Celebrating and rewarding success**.
    - Team prizes have been very successful in cancer research and in the NHS. Further consideration is needed about whether new prizes for teams, or institutions that support teams, would provide a significant incentive, and what form the prize should take.
    - Criteria for the promotion of academics must reflect their success in teams, not simply their individual successes.
- **Ensuring appropriate training and development**. Further discussion is needed about how best to include team leadership and collaboration skills for academic researchers and whether these should be formally regarded as part of the core skills set expected by funders.
- **Assessing trans-disciplinary research proposals effectively,** particularly in responsive mode. This might include ensuring that researchers with appropriate expertise are included on funding panels.
- **Recognising individual contributions to research publications**. Journal editors and the scientific community can helpfully work together to develop author contribution statements that are more appropriate to a team science approach.

Annex I Attendees at the team science roundtable

Sir John Tooke PMedSci (Chair) President	Academy of Medical Sciences
Professor Graham Burton FMedSci Professor of Reproductive Biology	University of Cambridge
Dr Philip Campbell Editor-in-Chief	Nature
Dame Sally Davies FMedSci Chief Medical Officer and Chief Scientific Adviser	Department of Health
Professor Raymond Hill FMedSci Visiting Professor of Pharmacology	Imperial College
Professor Nic Jones FMedSci Director of the Paterson Institute for Cancer Research & Chief Scientist	University of Manchester & Cancer Research UK
Sir Alan Langlands FRSE FMedSci Chief Executive	Higher Education Funding Council for England
Professor Anne Mills CBE FMedSci Vice Director & Professor of Health Economics and Policy	London School of Hygiene and Tropical Medicine
Professor Caroline Savage FMedSci Vice President and Head of Discovery Medicine	GlaxoSmithKline
Professor Karen Steel FRS FMedSci	Wellcome Trust Sanger Institute
Professor Paul Stewart FMedSci Dean of Medicine, Endocrinology, Diabetes and Metabolism & Chair of MRC Training and Career Development Board.	University of Birmingham
Professor Lionel Tarassenko CBE FREng Chair of Electrical Engineering & Chair, Royal Academy of Engineering's Biomedical Engineering Panel.	Oxford University
Dame Jean Thomas DBE FRS FMedSci Professor of Macromolecular Biochemistry & Biological Secretary of the Royal Society	University of Cambridge
Sir Mark Walport FRS FMedSci Director Wellcome Trust	Wellcome Trust
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