Institution:	University of Northumbria at Newcastle
Unit of Assessment:	3 - Allied Health Professions, Dentistry, Nursing and Pharmacy

a. Overview

This submission includes staff from the Faculty of Health and Life Sciences at Northumbria University and, reflecting the breadth of our activity, is organised into two major areas: Cellular and Molecular Sciences and Health and Lifestyle. Three research groups sit within each area, with significant cross-group and inter-disciplinary activity:

Cellular and Molecular Sciences

- *Applied Chemistry* Group (Lead: **Stanforth**; 6 FTE)
- *Mammalian Cell Biology and Immunology* Group (Lead: **Todryk**; 9 FTE)
- *Microbiology* Group (Lead: **Sutcliffe**; 11 FTE)

Health and Lifestyle

- *Clinical Biomechanics and Rehabilitation* Group (Lead: **Adams**; 3.9 FTE)
- *Health Interventions and Wellbeing Research* Group (Lead: **Kennedy**; 5 FTE)
- *Nursing and Public Health* Group (Lead: **Clarke**; 9.3 FTE)

Since 2008, the UoA has grown from 32.55 to 44.2 FTE. Notable successes include: new international income streams (e.g. Marie Curie); new charitable income streams (e.g. British Heart Foundation); a 40% increase in doctoral degrees awarded; improved business and community engagement (e.g. via TSB and the RCUK funded Fuse Centre for Translational Research in Public Health); and a significant rise in the number of high quality research publications, with more than 500 peer-reviewed publications in the assessment period, including papers in leading journals such as: *American Journal of Clinical Nutrition; Health Technology Assessment; Journal of Clinical Oncology; Movement Disorders; Nature Chemical Biology; PLOS Genetics; PLOS Medicine; PLOS Pathogens; PNAS;* and *Stroke*

b. Research strategy

Research aims and strategy for the assessment period

The strategic aims underpinning the sustained expansion of research in this UoA during the assessment period reflect both the University Corporate Strategy and specific strategic goals outlined at RAE2008. Key targets were to:

1. Increase the critical mass of research active staff by recruiting, developing and retaining high calibre academic staff, in turn sustaining a strong postdoctoral and postgraduate researcher (PGR) community with high completion rates.
2. Provide a physical environment and culture to support this growing research base.
3. Enhance the relevance of our research through strategic partnerships with industry, services, practitioners and service users, promoting knowledge transfer, business engagement and commercialisation, disseminating our research widely.

To achieve these aims, we have established supportive and inter-linked research groups with strong leadership and mentoring from experienced researchers. Our recruitment strategy has prioritised selection of staff with internationally excellent research profiles and strong strategic fits to the research groups.

Progress and summary of achievements in the assessment period

Evidence of achievement can be seen in the increase in staff numbers from 32.55 FTE category A staff submitted into RAE2008 (UoAs 11 and 12) to the current submission of 44.2 FTE staff. The 26 appointments made since 2008 include 15 Early Career Researchers (ECR) of which three are research fellows. As part of the wider University research strategy, an £18million Strategic Investment Fund was set up, with over £2.25million delivered to this UoA. This investment supported the appointment of **Adams**, **Cattan**, **Clarke**, **Evison** and **Sparagano** as Professors, **Dover** and **Todryk** as Readers and also provided University support for 20 PGRs (with a further 16 starting in 2013). The rise in the number of new doctoral students enrolled is accompanied by a significant increase in doctoral completions: 66 doctoral degrees have been awarded in the assessment period, an increase of >40% on 2008.

Work in both our main research areas addresses national and international priorities. For example,

Cellular and Molecular Sciences' work targets cardiovascular disease, the development of novel diagnostic methods and antimicrobials (primarily through business engagement and charity initiatives). Health and Lifestyle Research addresses priorities for healthy living, mental health, quality of care and the care of older people and people with long term conditions. Central to this work are our collaborations within academia, with business, local authorities, charities and partnerships with NHS organisations (encompassing many Foundation Trusts and Clinical Commissioning Groups, as well as Local Area Teams, Health Education England and Local Education and Training Boards). Work in this area benefits from our well established engagement in Fuse, the Centre for Translational Research in Public Health (one of five UKCRC Public Health Research Centres of Excellence).

Research Group activities and achievements

Cellular and Molecular Sciences researchers contribute applied science underpinning aspects of healthcare and extend understanding of disease processes.

The *Applied Chemistry* group carries out significant research in analytical, synthetic and computational chemistry. **Castagnolo** (ECR) has synthesised novel anti-infectives (including much needed anti-TB and HIV compounds; antifungal patent application submitted), whilst **Stanforth** synthesises novel diagnostic reagents, work which has been translated into microbial diagnostic kits through our long-term collaboration with Newcastle Freeman Hospital (Visiting Professor **Perry**) and bioMérieux (see Impact Case Study; over £1.5 million royalty income generated). **Dean**'s research is focused on bioaccessibility studies as a means to assess environmental health risk from toxic elements and organics and on the development of novel analytical methods. **Koutsidis** examines production of non-desirable process contaminants as dietary components that impact on human health and has TSB-funded work on valorisation of food industry waste products. Computational chemistry research (**Christov**, **Karabencheva-Christova**; both ECR with Marie Curie Fellowships for a collaboration with Stanford, USA) has given significant mechanistic insights into protein function for drug design and combatting antibiotic resistance through understanding ß-lactamase structures.

The *Mammalian Cell Biology and Immunology* group investigates the molecular basis of disease in order to discover novel targets for prophylaxis or therapy. **Bass** has performed important studies on maspin and its influence on cellular behaviour (with funding from British Heart Foundation and Breast Cancer Campaign) with the aim of identifying therapeutically useful bioactive peptides. **Finn**'s (ECR) work on cytochrome P450s aids understanding of drug metabolism and toxicity and **Padget** has generated insights into the roles of topoisomerases in therapy-related leukemia. **Todryk** has contributed significantly to the understanding of anti-malaria immunity and vaccine development through his studies on T cells, whilst **Falconer** (ECR) and **Walden** (ECR) have each contributed important insights into the roles of T cells in arthritis. **Padget** has discovered that increased levels of leptin may potentiate innate immunity and inflammation in conditions such as obesity and diabetes. Other work will inform the treatment and prevention of neurological diseases: **Schwalbe** (ECR) has published significant studies on DNA methylation as a prognostic biomarker for medulloblastoma, **Smulders-Srinivasan** (ECR) discovered a novel compensatory mechanism by which neurons with severe mitochondrial respiratory defects maintain a high membrane potential that increases neural death, whilst **Soundararajan**'s (ECR) studies of dual specificity kinase aid understanding of the mechanisms of onset and development of Alzheimer's disease and Down's syndrome.

In *Microbiology*, **Black** and **Sutcliffe** use varied strategies to identify novel virulence determinants in pathogenic streptococci, in collaboration with Visiting Professor **Waller**, and also use microbial enzymes as biocatalysts for the production of Advanced Pharmaceutical Ingredients and fine chemicals (see Impact Case Study). This latter work has received sustained funding from EPSRC and TSB. **Bridge** (ECR) has produced landmark work on the interaction between the hepatitis C virus and the hepatic lipid pathway, identifying this as a potential treatment target. **Brown**, **Dover** and **Sutcliffe** have carried out studies on bacterial cell envelope biosynthesis that identify novel drug targets and highlight fundamentally important pathways of bacterial biology, notably in pathogenic Actinobacteria, including *Mycobacterium tuberculosis*. **A Jones'** work on the systematics of pathogenic Actinobacteria has aided the identification of the previously unknown causal agent of reticulated papillomatosis and clarified the taxonomy of a significant pathogen of

horses and humans. **Cummings** has led a notable programme focused on changes in microbial community structure associated with chronic diseases such as COPD, cystic fibrosis and necrotising enterocolitis, which has further benefited from the expertise of newly appointed staff in molecular ecology and genomics (**Lanyon**, **Smith** (ECR)). This latter work is sustained by extensive collaboration with NHS clinical scientists, notably at Newcastle Freeman Hospital (Visiting Professor **Perry**). **Sangal**'s (ECR) work has applied genomic methods to understanding population structure and epidemiology of pathogens and his appointment as a Fellow strengthens our expertise in genomics. **Sparagano**'s work has identified vaccine candidates to control parasitic arthropods and developed novel diagnostic methods for bacterial pathogens.

Health and Lifestyle researchers examine areas of health and social care related to the management of ageing and long term conditions, as well as user involvement, the promotion of health and the reduction of inequality.

The *Clinical Biomechanics and Rehabilitation* research team addresses pain, recovery and functionality. **Adams**' work on chronic pain was used in formulating the first Guidance on the Management of Pain in Older People. **Caplan** investigates the structure and function of the knee joint in orthopaedic populations and has validated a novel method to map knee pain. **Debuse**'s work on the lumbopelvic region in people with low back pain has resulted in a three-year European Space Agency funded study with a view to using the exercise technology in astronaut rehabilitation. **Baker** has developed strategies to improve functional activity for people with Parkinson's disease, through movement analysis in the laboratory and home environments (see Impact Case Study). **D Jones'** work on quantifying the extent of swallowing problems in Parkinson's disease provides important data to support NHS evidence-based commissioning decisions about service provision.

In *Health Interventions and Wellbeing Research*, **Haskell** and **Kennedy** lead in nutritional neuroscience research, primarily in the form of human controlled trials by our internationally respected Brain, Performance and Nutrition Research Centre, which has a long history of successful collaboration with industry (more than £1.4million funding in the assessment period), working closely with global leaders including Bayer, GSK and Nestlé and Mars (see Impact Case Study). **George**'s research has demonstrated significant effects of dietary interventions on vascular functions, whilst **Wetherell**'s stress research found that caregivers of children with developmental disabilities have higher levels of C-reactive protein, a risk factor for cardiovascular events (supported by Research Autism). **Heffernan**'s work on the prospective memory deficits associated with second-hand smoking extends our understanding of cognitive consequences of second-hand smoke exposure in those who have never smoked themselves.

In *Nursing and Public Health*, **Clarke** leads the first phase of a major five-university MRC funded project 'Engaging with Older People and their Carers to Develop and Deliver Interventions for the Self-management of Chronic Pain'. The group contributes to delivering the Fuse Centre's objectives i.e. to improve health and wellbeing and to reduce inequalities by tackling major and emerging public health challenges (funded by ESRC and MRC with NIHR and others). **Carr** (Associate Director of Fuse) uses an innovative combination of realist evaluation and soft systems methodologies to provide a framework for evaluating complex public heath interventions. **Cattan** has led our development of public health research and has an international reputation in research on loneliness interventions in later life and healthy ageing research: in collaboration with Professor C Clarke (Edinburgh), she co-authored the Department of Health report into the use of dementia advisers and peer support networks (published 9 October 2013). **Gray** is an economist, expert in studies that allow rigorous, objective evaluation of policy initiatives to underpin the formulation of evidence-based policy. **Philipson** (ECR) has contributed statistical expertise to important studies on prognostic biomarkers for coronary disease. **Lhussier** has made significant contributions to understanding quality of life with enduring health needs, taking a user perspective. **Steven** has contributed significantly on nursing practice development, especially the delivery of quality and patient safety. **Cook**'s work in an international consortium (UK, Germany and Australia) has demonstrated that robotic animals can help to improve the quality of life for people with dementia and she leads a Work Package within the FP7 Marie Curie-People Actions-IRSES-2009 project "Models and Technological Solutions for Improving and Enhancing the Quality of Life". She has

also examined mechanisms to optimise involvement of older people in policy development, helping transform health and housing services (see Impact Case Study). Other staff linked to this group by their work on user involvement are being submitted to UoA 22. **Evison** has pioneered forensic facial analysis methods and leads a research team (mostly returned in UoA 22) that addresses practice and ethics in forensic science and medicine, whilst **Graham** (ECR) has developed methods for DNA profiling, including MRC-funded (Child PROTECTion Research Programme) work on the forensic detection of physical child abuse.

Future strategic aims and objectives

At the heart of our research strategy for sustaining and expanding the UoA's research base will be investment in and development of our people, estate and external engagement. This aligns with the University's 'Vision 2025', which is guiding the transformation of Northumbria into a research-rich, business-focused, professional university. Crucial to this Vision and accompanying implementation plan is an underpinning HR strategy to attract and retain research staff of the highest calibre. A further cornerstone of the strategy will be the introduction of a default workload allocation of 40% of academic staff time dedicated for research. Senior academic staff will continue to work with their groups to identify discipline specific challenges and opportunities for development, including targeting external funding bids, bidding for Faculty capital and other research investment support. We will aim to increase grant submission rates to one submission per FTE per year, supported by the Faculty Grant Working Group. We will capitalise on our expertise in attracting EU Marie Curie funding for international mobility (**Christov**, **Cook, Karabencheva-Christova** and **Sparagano**) and grow large scale EU collaborative ventures, in part through our engagement with Horizon 2020. ECRs will be supported in making New Investigator funding applications to RCUK.

Strategic initiatives have also been identified within each research group as follows:

In *Applied Chemistry*, analytical chemistry will support public health initiatives through continued analysis of environmental hazards and the development of methodologies to support our expanding capacity for metabolomics (lead by **Dean**). Collaborating with industry, synthetic chemistry will continue to expand medicinal chemistry and the development of novel diagnostic reagents (lead by **Stanforth**; collaboration with *Microbiology* e.g. Tétard's work with **Dover** on antimicrobial chelators). **Koutsidis** and **Black** will mentor others to build further on their success in business engagement through TSB funded research (e.g. in Industrial Biotechnology and Synthetic Biology), with an emphasis on biotechnological approaches to deriving value added molecules and improving food security.

The *Mammalian Cell Biology and Immunology* group will capitalise on the existing infrastructure to identify drug targets and expand the scope of disease models and diagnosis. We will use our metabolomics and proteomics capability to identify new targets; and drug discovery capacity to isolate novel compounds (in collaboration with *Applied Chemistry*). Led by **Bass**, we will identify *in vitro* functionality in established high throughput cell behaviour assays to determine which compounds to pursue as novel therapeutics for cardiovascular disease and cancers, including leukaemia and breast cancer (which will allow projects to be developed targeting the priorities identified in the impending Breast Cancer Campaign gap analysis). Led by **Todryk**, a priority will be to continue work on vaccines and immune responses to polymicrobial infections (e.g. cystic fibrosis; collaboration with *Microbiology*) and chronic inflammatory conditions such as atherosclerosis, arthritis and cirrhosis.

The *Microbiology* Group will prioritise three main areas of activity: 1) led by **Cummings,** we will continue to expand our work in microbial ecology, exploiting the new paradigms emerging from studies of the human microbiome, with collaborative support from Newcastle Hospitals Foundation Trust and engagement with relevant funders (e.g. on-going work with Tiny Lives). Technical expertise in this area will be further strengthened by formation of a cross-Faculty *Centre for Microbial Ecology* driven by the recent appointment of **Pearce** (submitting into UoA17) as Chair of *Environmental Microbiology*. 2) The second focus (led by **Sutcliffe**) will be to address priorities identified in the NIHR's Antimicrobial Resistance Themed Call i.e. by identifying novel antimicrobials and drug targets and by developing improved diagnostic methods, particularly for

drug resistant pathogens. 3) Led by **Black**, we will continue to use microbes for biotechnological applications in conjuction with our various external partners (notably through TSB).

The *Clinical Biomechanics and Rehabilitation Group* will prioritise two main areas of activity, musculoskeletal pain (led by **Adams**) and Parkinson's Disease (led by **Baker**), to address National Service Frameworks. We will continue on-going work on developing interventions for long term conditions using behavioural management approaches by targeting NIHR-Research for Patient Benefit and relevant charities (e.g., Parkinson's UK) in collaboration with our current local NHS, national and international HEI partners (e.g. movement analysis in Parkinson's disease, behavioural management of fibromyalgia). Further, we will continue apply work from lumbopelvic rehabilitation to exercise technology in astronaut rehabilitation in collaboration with the European Space Agency.

In the *Health Interventions and Wellbeing Research* Group, work on dietary and nutritional interventions (led by **Kennedy**) will be further developed, notably in collaboration with industry, to focus on peripheral and cerebral blood flow effects of nutritional interventions, including the effects of reduced blood flow in older age. Stress research (led by **Wetherell**) will be developed by securing funding (e.g. NIHR) to establish a multi-centre clinical trial for stress reduction in parent caregivers of children with autism, based on a self-completed emotional writing intervention undergoing development with the National Autistic Society. Further explorations of the psychobiological consequences and correlates of recreational drug use and substance abuse will be linked to Fuse. Collaboration with the Northumbria 'Health in Action' group (submitted in UoA4) will further facilitate the strategic development of this group.

The *Nursing and Public Health Group* (led by **Clarke**) will build on our well established work in the Fuse Centre to extend its contribution to health improvement and the development of health practice knowledge, policy and education. Engagement with the Academic Health Science Network for North East and Cumbria will enable us to improve quality of life for an ageing population, services and integration of care and examine workforce issues more broadly. Priority areas will include responses to the Francis, Keogh and Cavendish Reports, to examine the influence of organisational culture, and user involvement, in delivering safe effective compassionate care. We will seek to promote knowledge exchange by continuing to advance the boundaries of methodology and method. Strategic partnerships with health and social care providers, commissioners, practitioners and service users will enhance the relevance and use of our research in nursing and healthcare practice. Increasing our critical mass of staff in this group demands continued investment in doctoral study: 15% of academic staff in this area currently have doctorates and 15% are registered as PGR (comparing well with the 2006 Council of Deans' study): we aim to achieve 50% with doctorates by 2019.

c. People, including:

i. Staffing strategy and staff development

During the assessment period we have had a clear strategy of recruiting academics with internationally excellent research profiles, giving priority to those appointments that fit into extant or developing research groupings (e.g. Rehabilitation; Public Health). The success of this strategy is evidenced by the high proportion (>50%) of staff in this submission appointed post-2008. Maintaining the research momentum of these staff by providing them with dedicated research time and support remains a cornerstone of our strategy for growth. Academic staff appointments have been complemented by the appointment of three Anniversary Research Fellows in celebration of the University's 20th anniversary (**Bridge**, **Sangal**, **Smulders-Srinivasan**), selected as internationally excellent ECRs in a highly competitive process. We will provide these promising individuals with the opportunity to establish independent research groups and further strengthen our post-doctoral research culture (currently 14.6 FTE). Research aspirations of staff without PhDs (e.g. practitioners) are met by encouraging their collaboration with established researchers and enrolment on PhD programmes: currently 24 staff are registered on PhD programmes relevant to this UoA.

There are high expectations that all staff will develop the scope and depth of their research profiles. Research Group Leaders and the Professoriate: coordinate mentoring of staff, with an emphasis on ECR and less experienced researchers; facilitate internal peer review of grant applications and manuscripts; organise research seminar programmes and informal meetings (e.g. journal clubs); coordinate the operation and development of multiuser research spaces (e.g. tissue

culture; -Omics lab); and facilitate supervision, support and monitoring of PGR. Annual Personal Research and Innovation Plans (PRIP) have been introduced to support the planning and management of research and to nurture staff research aspirations. The PRIP process allows staff to document their research activity over the preceding 12 months and articulate their plans for the future. PRIPs are reviewed by senior research staff and used to inform mentoring and appraisal, as well as in decision making regarding allocation of internal research funds and workloads. All staff are given the opportunity to apply for sabbatical leave and 10 staff in this UoA have benefited from sabbaticals in the assessment period. Research is a key criterion of excellence in staff promotion and during the REF period, five staff in the UoA have been promoted to Reader (**Caplan, Dover, D Jones, Steven** and **Wetherell**) and ten staff have been appointed or promoted to Professor (**Adams, Carr, Cattan, Clarke, Cook, Cummings, Kennedy, Sparagano, Stanforth** and **Todryk**).

Expectations and commitments to ECRs are embodied in a Faculty ECR policy. ECRs are required to complete the University Postgraduate Certificate in Higher Education Practice, which includes training for research activities including ethics, seeking external research funding, publication of research and wider dissemination of research. All University workshops are mapped onto the Vitae Researcher Development Framework, with particular emphasis on relevance for ECRs. The University-wide ECR forum provides an informal mechanism for staff to express and discuss their training and development needs, feeding back to Faculty management to aid further development of the provision for ECRs. The Faculty also organises workshops and seminars to support staff in obtaining external research funding (e.g. NIHR, RCUK and EU funding workshops; Research Charities funding). University funding is available for collaborative visits (or to host visiting collaborators).

The University's support for the Vitae Concordat with respect to Support for the Development of Research Careers has been recognised by Vitae and an award for HR Excellence in Research. Training programmes are also available to encourage work on public engagement, with funding available to support events and public engagement activities (e.g. the 2013 British Science Festival in Newcastle, partnered by Northumbria). Northumbria is committed to providing an environment where diversity is valued and encouraged. Of the 46 individuals submitted to this UoA, 22 (48%) are female. Internationalisation of the UoA staff is clearly evident as nine staff (20%) are non-UK nationals.

Staff development in the UoA is further supported by our Faculty Research and Innovation Committee (chaired by **Sparagano**, Associate Dean Research) and its cross-Faculty working groups (which address strategy and support for ECR, grant income, innovation and publications). Future strategic goals for the six research groups are coordinated and championed by the Research Group Leaders and the UoA professoriate. Research Group Leaders are engaged in succession planning and coordinate the preparation and responses to the annual PRIP, which allows effective advocacy and targeting of resources to strategically important staff (e.g. prioritisation of staff for sabbatical and studentship support; matching applications from self-funding PGRs to relevant staff such as ECRs). Faculty management supports our on-going programme of capital investment to ensure that research facilities and available technologies (such as '-omics' capacity, analytical chemistry facilities, the biomechanics laboratory and the Clinical Skills Centre) remain internationally competitive.

University funding is also available for developing networks and partnerships, delivering events and public engagement activities, coordinated at University level by the Pro-Vice Chancellor for Business and Engagement, supported at Faculty level by Departmental Business and Engagement Champions. To encourage consultancy and collaborative relationships with external partners, a searchable comprehensive database of facilities and equipment (the 'Kit Catalogue') is available on the University website. Open Access publishing is encouraged and supported by the University and through external funding agencies.

ii. Research students

The University will continue to invest in PGR recruitment through various doctoral studentship and

scholarship schemes, including funding in collaboration with external partners. PGRs have a Principal Supervisor and at least one other academic supervisor. Supervisors meet regularly with their students (monthly documented meetings at the very least, as well as more frequent informal meetings) to provide research direction, support and guidance. The University Graduate School was established in 2008 to provide dedicated central support and administrative functions for research students. PGRs have access to a structured training programme including sessions on statistical analysis, bibliographic software, academic writing skills and ethics in research. In addition, all PGRs who participate in the delivery of teaching or laboratory demonstrating must attend sessions to ensure they are aware of participant expectations and their obligations. Training programmes are monitored and reviewed annually by the Graduate School, which highlights examples of good practice and opportunities for development. To disseminate best practice among supervisors, the Graduate School also provides a programme of training that all PGR supervisors have to undertake every three years.

In 2012, new University and Faculty regulations regarding student recruitment and progression were adopted, including an improved annual review process whereby progress is reviewed by an expert panel against clear and challenging criteria. All PGR complete an initial project approval template together with a PGR Development Portfolio (VITAE) template within three months of registering. Subsequent annual reviews allow for the PGR's progress and training needs to be formally reviewed. Two Faculty PGR Directors are responsible for monitoring PGR admissions and progression; to provide support for research students as well as supervisory teams; and report to the Faculty Research and Innovation Committee, which also has two PGR representatives. As a consequence of a strong and supportive framework for PGR supervision and training, Northumbria performs well in the Postgraduate Research Experience Survey (95% satisfaction in Question 17a) with a consistent upward trend, even in areas that were already high scoring, such as supervision and skills development.

Students are encouraged to contribute to Departmental research seminars and informal research group meetings (e.g. journal clubs). They are funded through the Graduate School to attend national and international conferences and encouraged also to present at the annual Northumbria Research Conference. Students are also encouraged to join relevant learned societies and to apply for external support for conference attendance.

d. Income, infrastructure and facilities

Income

Funding has been obtained from a wide range of sources, reflecting the breadth of our activities, including success with major UK and European funding agencies (DoH, Fulbright, Marie Curie, NIHR, RCUK), charities and business engagement (TSB/BBSRC).

Highlights for **Cellular and Molecular Sciences** include **Bass**: British Heart Foundation (£105,000), JGW Patterson Foundation (£49,000) and Breast Cancer Campaign (£19,000) and co-applicant on EACEA Erasmus Mundus Action 2 Partnership (€740,000); **Black**: TSB Feasibility Studies with Celbius Ltd (£83,000) and Chemoxy International Ltd and Biocatalysts Ltd (£73,000), three EPSRC Industrial CASE PhD studentships, with Prozomix Ltd (£89,000 and £85,000) and Nonlinear Dynamics Ltd (£87,000) and a KTP with Hycagen Ltd (£29,000); **Christov:** Marie Curie Outgoing International Fellowship for Career Development (€336,000) and Fulbright Senior Research Grant ($25,000); **Cummings:** Freeman Hospital Newcastle (£138,000) and Tiny Lives Trust (£36,000); **Dean:** two bioMérieux sponsored PGR (£53,000), a £2.9million One North East Large Company R and D Grant with Procter & Gamble (£160,000) and JISC Grant funding (£56,000); **Dover:** Hospital Infection Society grant (£56,000); **Karabencheva-Christova:** Marie Curie International Outgoing Fellowship for Career Development (€246,000); **Koutsidis:** TSB funded projects partnered with Frutarom, Prozomix Ltd and Marlow foods (£286,000), BBSRC/TSB funded project (£312,000) and a collaborative Newcastle Hospitals NHS Foundation Trust Grant (£100,000); **Stanforth:** annual bioMérieux grant (£140,000; eight patents generated); **Sparagano:** Incoming EU Marie Curie Fellowship (£232,000) for 'MosquitoBlock'; **Todryk:** Tyneside Leukaemia Research Fund (£42,000), industry funding with Immbio and PharmAthene (£20,000).

Highlights for **Health and Lifestyle** include **Caplan**: De Puy (£36,000) and Biomet UK Ltd (£93,000 industry sponsored studentship); **Carr:** Fuse funding from ESRC (£478,000) and MRC

(£338,000), NIHR Public Health programme (£265,000), North East Strategic Health Authority (£60,000); **Cattan:** NIHR (£16,000), Newcastle Primary Care Trust (£15,000) and DoH (£356,000); **Cook:** TSB, ESRC and DoH funded KTP (£129,000), ESRC and TSB funded KTP (£128,000); **Graham:** MRC (£62,000); **Gray:** NIHR HTA (£100,000); **Haskell and Kennedy**: 18 research projects funded by 14 commercial partners including Bayer, GlaxoSmithKline and Vitabiotics Ltd (total >£1.4million); **Lhussier:** North East SHA (£40,000, two projects).

Infrastructure and facilities

HEFCE RCIF and University funding have been used to extensively develop or refurbish research spaces. Researchers in **Cellular and Molecular Sciences** share three large multiuser laboratories (260 m^2 total) that provide facilities for biochemistry, microbiology and molecular biology, including a pilot scale fermentation suite allowing the production of significant quantities of recombinant proteins. These are complemented by a clean-room facility for high fidelity PCR and a 61 m^2 tissue culture suite for cell culture, the latter benefiting from a newly installed Xcelligence system for monitoring cultures; eight-colour flow cytometry and fluorescence microscopy platforms; MSD analytical equipment for biomarker analysis; ELIspot assays; and ELISA/advanced Western blotting capability (Syngene GBox Chemi XX6 ECL imaging). Facilities for Applied Chemistry Research include analytical chemistry facilities for High Performance Liquid Chromatography, Gas Chromatography and Liquid Chromatography Mass Spectrometry, complemented by a Jeol 400MHz Eclipse NMR Spectrometer, UV-Visible/fluorescence spectrometers and isothermal calorimetry. This equipment supports extensive research in synthetic chemistry located in recently refurbished containment facilities (118 m^2). To support our expertise in biomolecular sciences and analytical chemistry, we have a newly established -OMICs technology platform in dedicated laboratories (total 55 m^2). This includes an Ilumina MiSeq^{TM} high throughput DNA sequencing platform, which allows significant capacity for genomic and other DNA sequencing analyses; a Thermo QExactive high resolution, high performance quadropole-orbitrap mass spectrometer for metabolic analyses; and well established facilities for proteomics centred around a Dionex UltiMate 3000 nanoflow liquid chromatography/Bruker HCT Ultra mass spectrometry system. These 'wet' laboratory facilities are complemented by a recently installed dedicated High Performance Computing Cluster, which has significantly increased our capacity for work in computational chemistry, biochemistry and informatics.

Researchers in **Health and Lifestyle** use both wet laboratories and facilities for participatory research. *Clinical Biomechanics and Rehabilitation* researchers have new (ca. £1million) 134 m^2 research laboratories for human movement science, based in *Sport Central*, the University's £30 million state-of-the-art sports facility which was opened in 2010. These include a 3D gait laboratory equipped to measure whole body human movement, ground reaction forces and muscle activity during activities such as walking, stair ambulation and rising from a chair, as well as pressure mats and a 3D motion analysis system that can be used away from the laboratory environment; a biomechanics laboratory equipped with force platforms, a balance platform, an ultrasound system for musculoskeletal imaging, an isokinetic dynamometer, optoelectronic sensors and a range of biomechanical data acquisition systems; a performance analysis suite designed to allow the assessment of human movement using high speed video cameras and GPS technology; and access to a range of facilities for the clinical assessment of participants. The *Health Interventions and Wellbeing Research* group utilises the analytical chemistry facilities (see above e.g. for metabolomics work) and is further supported by a food pilot plant, kitchens and an organoleptic testing room (total 73 m^2). The Stress Testing laboratory has been refitted with continuous heart rate and blood pressure monitoring equipment (PortaPres) and in-house protocols developed for real life acute (e.g. Multitasking Framework) and ambulatory (e.g. diurnal cortisol) stress assessments. The Brain Performance and Nutrition Research Centre within this group utilises computer enabled and networked cognitive testing laboratories, Near Infrared Spectroscopy, Trans-cranial Doppler and EEG. Cognitive function and mood are measured with our own Computerised Mental Performance Assessment System (COMPASS), a flexible software framework specifically designed to deliver customised assessments of cognitive performance and mood. Facilities also include laboratories for taking and preparing samples and assessing in vitro parameters. *Nursing and Public Health* researchers use high quality accommodation for on-site research participants, international visitors and partner organisations, along with a state of the art

Clinical Skills Centre, simulating hospital and community environments. The University has also invested more than £20million in IT infrastructure and equipment, with computing laboratories and computational resources for high-level computing, storage and manipulation of very large data sets, valuable for public health research (e.g. **Cook** KTP). Forensics work is supported by dedicated 14m^2 laboratory for low-template DNA analysis, whilst large biometric databases support work on 3D craniofacial image analysis.

The University places considerable emphasis on the need to maintain high standards in research governance. The University Research Ethics Committee is responsible for overseeing research governance across the institution, developing cross-University policy (including producing an annually updated Research Ethics and Governance Handbook) and carrying out an annual Research Ethics Audit. The Faculty Research Ethics Committee and the Human Tissue Bank Governing Board report to this committee, which in turn reports to the University Research and Innovation Committee. An Online Research Ethics Approval System was launched in 2011 to improve the coherence of the approval process. In addition to ethics, the Faculty Research and Innovation Committee and its subcommittees provide a framework for operational matters.

Centralised research support is provided by the University Research and Business Services Department, which assists with external bidding activity, stakeholder engagement and with the commercialisation of research. To further aid dissemination of research, the University online repository, Northumbria Research Link, provides a user-friendly open access portal showcasing >10,000 research items including more than 900 from members of this UoA. Researchers are also increasingly using Open Access journals for research publications.

e. Collaboration and contribution to the discipline or research base

External collaboration is an important mechanism for extending the reach and significance of our research. Overall, staff in this UoA have more than 100 active collaborative links to other Universities, Research Institutes and businesses. These include more than 30 national collaborations, more than 40 international collaborations and collaborative links to more than 25 businesses, as evidenced by co-authored papers and collaborative grants. Significant examples include: **Adams** with Dr A Cuesta-Vargas (Malaga, Spain); **Bass** with Professor L Ruddock (Oulu, Finland); **Black** with Professor S van Pelt (Delft, Netherlands); **Caplan** and **Debuse** with Dr S Evetts (European Space Agency, Cologne); **Cattan** with Dr F Nyquist (National Institute for Health and Welfare, Finland) and Professor C Clarke (Edinburgh); **Christov** and **Karabencheva-Christova**'s with Professor E Solomon (Stanford USA); **Cook** with Professor W Moyle (Griffith University, Australia, where she is Adjunct Professor in the Centre for Health Practice Innovation); **Dean** and **Stanforth** with Dr S Orenga (bioMérieux, France); **Evison** is Visiting Professor of Forensic Science at Murdoch University, Australia; **Falconer** with Professor P Dyson (Imperial College); **Evison** with Professor M Guimarães (Sao Paulo, Brazil); **George** with Professor A Apichartsrangkoon (Chiang Mai, Thailand); **Gray** with Prof S Bryan (University of British Columbia, Canada); **Koutsidis**' extensive TSB funding in collaboration with multinational businesses such as Nestlé and PepsiCo; **Philipson** with Dr I Sousa (Minho, Portugal); **Schwalbe** with Professor E Molyneux (Blantyre, Malawi); **Soundararajan** with Professor S Knapp (Oxford); **Sparagano** with Professor A Giangaspero (Foggia, Italy); **Sutcliffe** with Dr J Nigou (CNRS, Toulouse); **Wetherell** with Professor A Scholey (Swinburne, Australia, where he is Visiting Fellow in the Centre for Human Psychopharmacology).

Members of the UoA have contributed invited oral presentations to more than 90 international symposia and delivered more than 50 invited research seminars at other institutions during the assessment period. In addition, our strong collaborations with health and social care providers, user groups and networks are essential in effective dissemination and translation into practice.

Members of the UoA are current Editors-in-Chief (**Black**, Advances in Biological Chemistry; **Christov**, Computational Molecular Bioscience; **Heffernan**, Open Addiction Journal; **Karabencheva-Christova**, Open Journal of Biophysics; **Sparagano**, Journal Veterinary Medicine and Animal Sciences; **Sutcliffe**, Antonie van Leeuwenhoek Journal of Microbiology), Associate Editors (**Cummings,** Environmental Biotechnology, Letters in Applied Microbiology and Journal of

Applied Microbiology; **Koutsidis**, Polish Journal of Food and Nutrition Sciences; **Todryk**, PloS ONE; **Wetherell**, The Psychologist) or have held these roles in the assessment period (**Cattan** and **Cook**, Ageing and Society; **Dover**, World Journal of Microbiology and Biotechnology; **D Jones**, International Journal of Therapy and Rehabilitation). In addition, more than twenty members of the submission are on the Editorial Boards of journals (e.g. **Adams**, Journal of Pain Management; **Bass:** Journal of Cell Adhesion; **Caplan**, Sports Engineering; **Carr**, Open Journal of Nursing; **Clarke**, International Journal of Older People Nursing; **Finn**, American Journal of Pharmacological Sciences; **Kennedy**, Nutritional Neuroscience; **Soundararajan**, American Medical Journal) and five have guest edited journal issues (**Christov**, **Dean**, **A Jones**, **Haskell**, **Karabencheva-Christova**). Staff in the UoA peer review manuscripts for a wide range of journals (more than 150 different journals in total).

Staff in the UoA routinely peer review for major funding agencies in (1) UK, such as BBSRC (**Black**, also Member of the BBSRC Research Committee's Pool of Experts; **Christov**, **Sutcliffe**, **Wetherell**); Chief Scientist Office, Scottish Government (**D Jones**, **Clarke**); EPSRC (**Christov**, also member of the EPSRC Chemistry Prioritisation Panel and College of Peer Reviewers; **Dover**, **Stanforth**); ESRC (**Cattan, Cook, Wetherell**); Health Technology Assessment Exercise (**D Jones**, **Steven**); MRC (**Clarke**, **Dover**, **A Jones, Sutcliffe, Todryk, Wetherell**); National Institute for Health Research (**Adams:** Research for Patient Benefit panel member), **Caplan**, **Carr**, **Cattan**, **Clarke** (Research Capacity Funding panel member), **Cook**, **D Jones**, **Lhussier**, **Steven**); NERC (**Cummings**); Royal Society (**Sutcliffe**); Scottish Health Board (**Carr**); and the Wellcome Trust (**Sutcliffe**) (2) Overseas funders, including Austrian Science Fund (**Black, Dean**); American Association for the Advancement of Science (**Dean**), Deutsche Forschungsgemeinschaft (**Dean**), European Social Fund, Heracleitus II (**Koutsidis**); EU Eurasia and Marie Curie schemes (**Sparagano**); Fondazione Capriole (**Cummings**); Health Research Board, Ireland (**Adams**); Natural Sciences and Engineering Research Council of Canada (**Evison, Sutcliffe**); National Science Foundation USA (**Black**); Netherlands Organisation for Scientific Research (**Black, Carr**); South African MRC (**Todryk**) (3) Major charities, including Age UK (**Cook**); Alzheimer's Society (**Haskell**); Cancer Research UK (**Todryk**); Genesis Oncology Trust NZ (**Clarke**); Horse Trust UK (**Black**); Leverhulme Trust (**Sutcliffe**); Multiple Sclerosis Society (**D Jones**); Parkinson's Disease Society (**D Jones**); and the Physiotherapy Research Foundation (**D Jones**). Members of the UoA have also externally examined more than 60 PGR candidates during the assessment period.

Members of the UoA contribute to the governance of learned societies and organisations. Examples include: **Adams,** Arthritis Research UK Musculoskeletal Pain Group member; **Caplan**, UK Space Biomedicine Consortium member; **Carr**, Community Practitioner and Health Visiting Association Research Advisory Group (to 2011); **Cattan**: Programme Advisory Group, Joseph Rowntree Foundation Neighbourhood Approaches to Loneliness, Campaign to End Loneliness Research hub co-chair; **Cummings**, Council of Association of Applied Biology; **Dean**, Royal Society of Chemistry Analytical Division Council; **A Jones** is Chair of the International Committee on Systematics of Prokaryotes 'Taxonomy of Nocardia and related genera sub-committee; **D Jones**, Honorary President of AGILE, Chartered Physiotherapists Working with Older People and was awarded a Chartered Society of Physiotherapy Honorary Membership (2012) in recognition of her "exceptional contribution to the advancement of physiotherapy with older people"; **Sparagano**, Society for General Microbiology, Eukaryotic Microbiology Committee; President, Society for Tropical Veterinary Medicine to 2011. Staff have also contributed by organising meetings and symposia of learned societies and other subject interest groups e.g. British Psychological Society Symposia (**Haskell**, 2009, 2011; **Wetherell**, 2008), Centre for Criminal Justice Studies (**Evison**, 2011), 2nd and 3rd European Workshop in Drug Synthesis (**Castagnolo**, 2008, 2010), 6th International Conference for Interprofessional education and collaborative practice (**Steven**, 2012), International Environmental Best Practices Conference (**Cummings**, 2009, 2013), 16th International Symposium on the Biology of the Actinomycetes (**A Jones, Sutcliffe**,2011), 10th International Symposium on Advances in Extraction Techniques (**Dean**, 2008), Society for General Microbiology symposium (**Sparagano**, 2013) and 1st UK Space Biomedicine Association Workshop (**Caplan**).