Introduction
Ireland has a long tradition of excellence in food production through agriculture and food processing. That base remains strong and Ireland is still a net exporter of food. However, in a changing global environment, this output and the jobs that produce it may have little buffer against market pressures. To help build security and value in the Irish food industry, the focus in recent years has been on food research and innovation to allow Ireland to develop a niche within an international context. In particular, there has been a drive towards improving the understanding of our relationship with food and health, and an industry-recognised need to develop scientific methods that reliably increase the nutritional and specific beneficial health impacts of individual foodstuffs, which can then be marketed as “functional foods”. Maintaining Ireland’s international reputation as a “Food Island” also includes paying cognisance to the sustainability of Irish food production through novel approaches and methods within the sector. Such understanding and innovation is seen as central to Ireland’s ability to compete in a global market.

Against this backdrop, the UCD Institute of Food and Health was established in 2008 to bring together academic and research staff from across UCD in health-related aspects of food research, and to align research efforts with national and European research agendas.

The Institute allows UCD to achieve critical mass in food and health and to exploit the unique repertoire it has across Agriculture, Veterinary Medicine, Food Safety, Nutrition, Food Law, Consumer Research, Food Science, Food Biosystems, and Food Production.

The Institute is comprised of 30 faculty members, 55 post doctoral research staff and 167 graduate students (134 PhD and 33 MSc students) funded through a significant competitive research income from national and international funding agencies. The Institute has a €1.53 million operational research income per researcher. To support the Institute in its work, and to benchmark it against other international institutes, an External Advisory Board has been appointed (Annex I).

The Institute represents the breadth of research from farm to fork at UCD; Food Production, Food Science, Food and the Consumer, Biosystems Engineering, Food Law, Nutrition and Food Safety. The expertise, competencies and capabilities in these areas are described in Table 1.

UCD ranks in the top 10 of European universities and top 25 of International universities in Food Science and Technology research output:

<table>
<thead>
<tr>
<th>University</th>
<th>EU Ranking</th>
<th>Global Ranking</th>
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<tbody>
<tr>
<td>University of Ghent</td>
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<tr>
<td>University of Helsinki</td>
<td>2</td>
<td>13</td>
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<tr>
<td>Technical University of Denmark</td>
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<td>14</td>
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<td>University of Hohenheim</td>
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<td>University of Milan</td>
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<td>20</td>
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<td>University Santiago de Compostela</td>
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<td>22</td>
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<td>Catholic University of Louvain</td>
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<td>Wageningen University</td>
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<td>24</td>
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<tr>
<td><strong>University College Dublin</strong></td>
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<td><strong>25</strong></td>
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<tr>
<td>University of Bologna</td>
<td>10</td>
<td>27</td>
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* Based on a search of Web of Science for volume of publications for the term “Food Science and Technology” for 2005 -2009

* March 2010 figures
<table>
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<th>Table 1 Expertise within the UCD Institute of Food and Health</th>
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<tr>
<td><strong>Discipline</strong></td>
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| **Food Science** | Research areas of major interest include food preservation, novel food processing and food traceability. There are also significant competencies in food analysis and characterisation; food product manufacture; food ingredient interaction; food formulation and the development of functional foods. | • Predictive monitoring tools for safety management systems  
• Traditional processing equipment for the meat and dairy industries for the testing of novel products  
• Novel processing technologies for improving stability and shelf life  
• Molecular and stable isotope technologies for food traceability and authentication purposes  
• Analysis of the chemical and physical properties of food  
• Sensory analysis facilities and expertise  
• Strengths in protection and delivery of bioactives and their functions for improved bioavailability and processing including encapsulation |
| **Food Law** | The team has expertise in international trade and agricultural law, food regulation and governance and environmental law. | • International research expertise and networking in this area |
| **Food Production** | Research in this area is focused on novel oligosaccharides for gut health; sustainable food production; and enhancement of nutritional composition in primary food production. | • Novel feeding strategies to reduce methane and odour emissions in food animals  
• Animal models for food and health research |
| **Food and Consumer** | The team is active in understanding consumer attitudes, beliefs and perceptions of food and health. This includes modelling behaviour and risk perception; and evidence-based interventions for behavioural change. | • Expertise in the development of novel quantitative methodologies such as internet based surveys, and qualitative studies to address consumer behaviour |
| **Food and Nutrition** | Research is centered on cellular and molecular nutrition, nutrigenomics, public health nutrition, and modelling human exposure to food chemical intake. | • Internationally recognised strengths in genomic, transcriptomic and metabolomic platforms in assessing the relationship between nutrients and health  
• Suite of tools and facilities to support human dietary and lifestyle intervention trials  
• Protocols and management systems for conducting national nutrition surveys  
• Unique searchable databases on food ingredients and food packaging usage, coupled with advanced probabilistic software and expertise for the prediction of food chemical exposure risk |
| **Biosystems Engineering** | Expertise in food chain integrity, food process engineering, sustainable food production, computerised food technology, process optimisation, sustainable energy, and environmental engineering. | • Probabilistic models to quantitatively assess risks along the food chain  
• Analysis and design of quality control systems  
• Design of novel refrigeration systems  
• Sensor design to optimise process control  
• Sustainability analysis of food chains |
| **Food Safety** | Encompassing the UCD Centre for Food Safety, research activities include the development of reliable identification and detection protocols for a range of food-borne pathogens including the neonatal pathogen Cronobacter; understanding the genetic basis for the emergence of multi-drug resistance (MDR) food-borne zoonotic bacteria, including Salmonella and Campylobacter. | • Designated WHO Collaborating Centre for Research, Reference and Training on Cronobacter  
• Identification of microbes recovered from food manufacturing sites  
• Molecular sub-typing expertise to track important food-borne pathogens  
• Genomic and proteomic tools to explore bacterial resistance mechanisms contributing to antimicrobial and food processing stresses |
By interacting across these disciplines and by linking in with campus, national and international initiatives, UCD Institute of Food and Health researchers ensure that their contributions are relevant to a broad spectrum of scientific, health, legal and social arenas.
## Vision

To become a leading global force in food and health with an output centred on the 4 Ps: People, Papers, Patents, and Policy.

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<tr>
<th>People</th>
<th>Papers</th>
<th>Patents</th>
<th>Policy</th>
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<tr>
<td>People are the core of successful research teams, and our vision sees the best and brightest from around the world working with us in a dynamic and multi-disciplinary environment.</td>
<td>The traditional output from scientific research is the scientific paper, and we envisage an output of high-impact publications as a key metric by which the performance of the members of the Institute are judged.</td>
<td>The Institute will foster within its community an awareness of innovation as a stimulus for the development of intellectual property and of knowledge protection. The Institute will be recognised by industry as an academic grouping comfortable with the joint output of papers and patents.</td>
<td>Food is one of the most regulated parts of our daily lives, and such regulations emanate from, and lead to, policy documents on all aspects of food and health. The Institute will place a high priority on the publication of multi-disciplinary position papers specifically intended to contribute to policy making on the basis of excellent scholarship.</td>
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Mission

To realise an internationally recognised multi-disciplinary consortium in food and health, engaged in leading edge research and meeting the national objective of economic development through the acquisition and protection of knowledge, the education of highly skilled graduates, and the application of knowledge to the development of national and international policy.
Goals 2010-2013

To achieve its mission, the Institute identified the following goals

1. To grow and develop the Institute through increased funding, attracting the best students and developing internal systems to deliver on its mission.

2. To grow and develop an innovation and entrepreneurial culture within the Institute, producing graduates with entrepreneurial skills and mindsets and developing facilities and capabilities for the provision of additional services for industry.

3. To develop and communicate the Institute’s brand to support and underpin the Institute in its work.

The following outlines the objectives and activities, which the Institute will undertake to realise these goals.
1. **To grow and develop the Institute through increased funding, attracting the best students and developing internal systems to deliver on its mission**

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Activities</th>
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<tr>
<td>The Institute will target non-exchequer sources as a major source of funding over the next 3 years.</td>
<td>The Institute has initiated a series of seminars with the National Contact Point for the EU Framework Programme 7 and has put in place an internal mentoring programme to help newcomers to the EU research agenda. In addition to targeting EU funding, the Institute will also foster applications from other non-exchequer sources.</td>
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<tr>
<td>Integration of research across the Institute and with other UCD research institutes is a priority.</td>
<td>The Institute will promote the concept of “Food and Wellness” across the campus, building links with other research groups toward the development of new products, new processes and new consumer solutions.</td>
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<td>The Institute will seek funding to make key academic appointments and to help grow our research portfolio.</td>
<td>We will prepare a proposal with a leading Irish development NGO to create a joint post in international nutrition. We will develop a case for the establishment of posts in food biotechnology and in gut microbiome studies.</td>
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<td>To develop a significant e-learning platform to market existing and future modules within the Institute, while helping to develop the overall UCD capacity to deliver distant learning courses.</td>
<td>Look at best practices within the University and elsewhere and produce a business plan for consideration by UCD Senior Management.</td>
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2. **To grow and develop an innovation and entrepreneurial culture within the Institute, producing graduates with entrepreneurial skills and mindsets and developing facilities and capabilities for the provision of additional services for industry**

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<td>The Institute will develop a graduate training programme in food entrepreneurship.</td>
<td>Working through the UCD-TCD Innovation Alliance, we will develop an e-learning module on entrepreneurship, and will take the lead in developing an EU Food Entrepreneurship Network.</td>
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<td>To provide a professional interface with national and international industry in the provision of both advice and services.</td>
<td>We will explore a number of management options to increase our interface with industry toward a more coherent and professional approach. A plan for the development of an appropriate facility through the potential appointment of a Business Development Manager, or the creation of a campus company to provide consultancy and to provide research and development expertise, will be drafted.</td>
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3. **To develop and communicate the Institute’s brand to support and underpin the Institute in its work.**

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<tr>
<td>To develop a comprehensive communications programme aimed at profiling the Institute nationally and internationally, amongst our peers, consumers, policy makers and potential future students.</td>
<td>We will host a number of policy workshops aimed at connecting UCD research to policy making process nationally and internationally. We will promote UCD as a centre of excellence in Food and Health through various activities including the development of short videos and PowerPoint podcasts.</td>
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Research

The mission and objectives of the Institute are closely aligned with UCD’s strategy to be a leading international research-intensive university with a direct influence on shaping national and international policy while contributing to the Irish economy.

We see three key aspects to this research:

- We will have a strong focus on multi-disciplinary research, integrating our efforts within our research areas and, in particular, integrating our research across the campus with a wide range of disciplines. Thus, our work on milk protein bioactives brings us into collaboration with the bioinformatics group in the UCD Complex Adaptive Systems Laboratory. We have integrated our research on primary food production into the UCD Earth Systems Institute. Our research on nutrition and exercise in older persons is in close collaboration with the UCD Institute of Sport and Health. Our work on personalised nutrition will bring us into contact with electronic engineering in the development of phenotype feedback devices and with computer sciences in social networking.

- Our research involves close collaboration with industry at national and international level and with large corporate and SME companies. Within this Roadmap we have set ourselves the task of deepening these relationships and we will ensure that our proposals for entrepreneurship development will involve the local food sector.

- We recognise the added value of collaborative research and thus most of our large projects are multi-centre at national or EU level. Collaboration at national level is particularly important to maximise national research investment and we have a strong presence in key national collaborative groups such as the Irish Food and Health Research Alliance5 and the Irish Universities Nutrition Alliance6.

Our research performance is reviewed annually by our External Advisory Board (Annex 1) and is benchmarked against the European Technology Platform (ETP) Food for Life Programme7.

Research infrastructure and benchmarking

The ETP Food for Life is an industry-led initiative with considerable influence over the make-up of the EU Framework research programmes. Through a joint industry-academia effort, the ETP has developed an implementation action plan that will shape European food and health research for the next decade. The Roadmap is based on distinct but inter-related pillars and the full implementation plan sets out a total of 57 key deliverables.

The Roadmap is organised around two major research pillars: “Food and Health” and “Food Quality and Manufacturing”. Consumer research is placed centrally within these research pillars. Underpinning these three platforms is the research area “Food Chain Management” and two horizontal research areas bisecting the main pillars are “Food Safety” and “Sustainable Food Production”. At the apex over arching all the pillars there is “Communication, Training and Technology Transfer” (Figure 1).

Figure 1: A schematic outline of the integration of the main elements of the European Technology Platform Food for Life research strategy
The research portfolio of the UCD Food and Health Institute has been mapped against these detailed European deliverables and is available on our website. The following outlines the alignment of our research against the six key elements of the ETP model.

**Food and health:** Food is one of the key environmental determinants of an individual’s health, and a greater understanding of the relationship between food and health will underpin effective public health strategies around nutrition and food.

Major projects involving the UCD Institute of Food and Health includes Food for Health Ireland (jointly funded by industry and Enterprise Ireland and collaborates with University College Cork, the University of Limerick and Teagasc, Moorepark Food Research Centre); the Joint Irish Nutrigenomics Organisation (which is constructing the National Nutrition Phenotype Database); and the recently completed EU-wide FP6 Lippene project, on the relationship between lipids, genetics and the metabolic syndrome.

**Food quality and manufacturing:** Food manufacturing provides opportunities for innovation to improve the sensory and nutritional properties of consumer products. UCD has a number of funded projects, including industrial led projects, which focus on relating the physical properties and structure of food products to product and processing design. Isolation of bioactives from milk, herbs and seaweed is a core research activity and we hold a number of patents in the area. We also have extensive expertise in the development and application of encapsulation systems for the targeted delivery of these bioactives, and other food ingredients and nutrients. The Institute has significant funding and expertise in the area of assessing the impact of emerging thermal (radio frequency and ohmic heating) and non-thermal (high voltage pulsed electrical fields, high intensity light pulses, ultraviolet light and ultrasound) technologies on the quality (nutritional, sensory and microbial) of foods.

**Food chain management:** Traceability is a key element of food safety and is associated with increased consumer confidence in a highly diverse market. UCD is a partner in the FP6 programme TRACE and also co-ordinates another FP6 programme SigmaChain. We are also applying novel tracking systems to the food chain through the BIOTRAK project.

**Food safety:** With “food scares” such as contamination with dioxins, pathogenic bacteria and prions hitting the headlines, food safety is an important issue, not only in protecting the health of consumers, but also in securing their confidence. The UCD Centre for Food Safety is a WHO designated Collaborating Centre for Research, Reference and Training on *Cronobacter* and led a COST (European Cooperation in Science and Technology) programme on new strategies to combat antimicrobial resistance.

UCD has several EU Framework and National funded risk assessment projects on the major pathogens of concern in meat and dairy products and is the coordinator of an EU funded FP7 project on food chemical exposure. UCD has also held EU funded FP6 projects, which have developed protocols for risk ranking chemical and microbial hazards in food and feed chains.

**Sustainable food production:** Environmental awareness is a watchword for all competitive businesses, and the food industry is no exception. To foster more ecologically attuned food production processes, UCD has pioneered the measurement of *in vivo* greenhouse and trans-boundary gas production and has a number of funded projects in this area. We have developed feeding strategies to reduce methane emissions in beef and dairy cattle, as well as reducing odour and ammonia emissions and the excretion of nitrogen and phosphorus in pig manure. Similarly, we have also developed feeding strategies to improve the fatty acid profile and protein composition of ruminant products (meat and milk).

UCD has investigated the link between health and nutrition in pigs, and more specifically the strategic use of natural food components to produce a wide variety of disease avoidance and health maintenance measures. This will contribute to an improved and more acceptable system of animal production without the use of antibiotics.

UCD has also investigated the effect of non-digestible oligosaccharides and lactose sources on the microbial population of the gastro-intestinal tract of pigs and the structure and function of the gut; and also the role of pathogenic organisms such as *Escherichia coli*, and beneficial *Lactobacilli*, on the immune system.

**Food and the consumer:** The multidisciplinary food and the consumer team at UCD is currently involved in a number of funded research projects focused on developing the knowledge base in the area of consumer science in relation to food, nutrition and health. Projects include a Department of Agriculture, Fisheries & Food funded national survey of consumer risk perception relating to food issues. Using web based survey techniques, these approaches explore how individuals process and interpret food risk. The results will impact on the design of risk management and communication strategies in the public health arena and in the Irish food industry.
Into the Future

The UCD Institute of Food and Health will lead national and international science and policy on the complex issues and vulnerabilities facing the human food chain, now and into the future.

Through building a strategic, topical and integrated research portfolio, UCD will ensure the multi-disciplinary expertise spanning the entire food chain, from food production to human health and behaviour.

This will enable the UCD Institute of Food and Health to respond to real world threats facing the food chain such as, microbial and chemical hazards, food insecurity and climate change, which ultimately impact on the food industry and human health.
Looking forward, the UCD Institute of Food and Health will be a valuable resource for fostering and leading innovations in the food and health industries, both on the island of Ireland and internationally. This Roadmap will guide us in that vision.
Annex I

External Advisory Board

Professor Peter Van Bladeren (Chair), Vice President Nestlé Science & Research, Nestlé Research Centre

Mr Tom Arnold, Chief Executive, Concern Worldwide

Dr Diána Bánáti, Director General, Central Food Research Institute Hungary; Chair of the Management Board, European Food Safety Authority

Dr Mike Knowles, Vice President, Global Scientific and Regulatory Affairs, Coca-Cola; President, International Life Sciences Institute

Professor Ian Givens, Professor of Animal Science and Joint Leader, Food Chain & Health Research, University of Reading

Professor Peter Morgan, Director, The Rowett Institute of Nutrition and Health, University of Aberdeen

Mr Gerard O’Neill, Chairman, Amárach Group