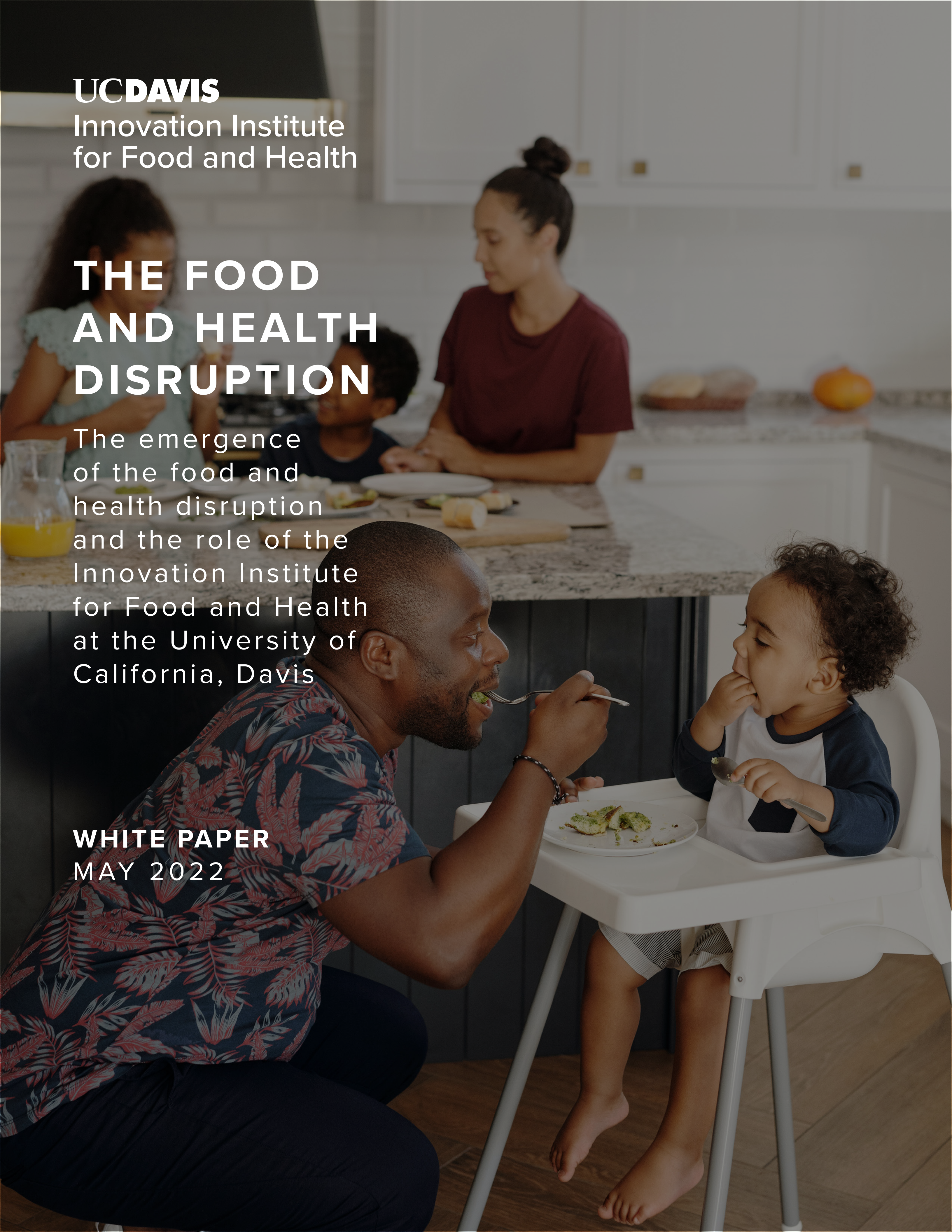

UC DAVIS
Innovation Institute for Food and Health

THE FOOD AND HEALTH DISRUPTION

The emergence of the food and health disruption and the role of the Innovation Institute for Food and Health at the University of California, Davis

WHITE PAPER
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INTRODUCTION

The economic, social, and environmental impacts of the food system are being disrupted by a new generation of technologies reimaging the relationship between food and human health. While much attention recently has been focused on the possibilities presented by “alternative” food ingredients, this will likely be eclipsed in both value and impact by the food and health transformation. An increasingly informed consumer is a key stakeholder and decision maker who will seek benefits for themselves and their families, and in turn, drive disruption across food and health systems.

This white paper will share Institute’s approach to collaboration with partners on food and health, and discuss the food and health disruption, including the central role of metabolic health. This transformation holds the potential both for significant value creation, and happier, healthier, longer lives for everyone.

BRIDGING THE GAP WITH INNOVATION

While 2021 again saw new records set in foodtech investment, much of the new wave of discovery in food and health has not yet made it in into the marketplace [1]. As is typically the case with new scientific discoveries, there is a gap between the basic research that creates new insights, and the development of technology, tools and companies which translate these insights into products and services used by people every day to live happier, healthier, longer lives.

The Institute aims to – with its partners – bridge this gap between research and commercialization by facilitating innovation through programming in three key areas.

First, the Institute will engage its partners to conduct ***use-inspired research*** in food and health. Use-inspired research focuses on expanding the frontiers of knowledge with the needs of the end user in mind [2]. This understanding of the end users' needs is developed through focused collaborations between industry experts and academic researchers. The Institute's cooperative, inter-disciplinary approach creates both appreciation of the search for new knowledge in food and health from multiple stakeholders, and an understanding of how new food and health knowledge can create both individual and societal impact. This facilitates continued growth for both research and translation.

Second, the Institute is focused on ***talent development***. The lack of available scientific talent for food and health in the private sector is one of the biggest challenges in commercial translation. There is both a lack of commercial understanding by scientists, and a lack of scientific understanding by business leaders and investors. An example of our programming to address this need is our Innovator Fellowship, which embeds Ph.D. and post-doctoral researchers in venture capital and other investment firms. This approach brings business skills and understanding to the researcher, and also scientific understanding to the investors. We continue to explore new programming in this space.

Third, the Institute conducts ***market discovery*** activities. It can be hard to understand where new food and health technologies will fit in the marketplace. Which consumers will be the early adopters? Where is the beachhead market? Which companies have – or can develop the systems – to support the technology's integration? To answer these questions and others, the Institute partners with the University of California, Davis Graduate School of Management (GSM) to create ***Market Discovery Forums (MDFs)***. MDFs bring together leading scientific researchers on a given topic with business leaders focused on commercializing products and services to achieve health outcomes. Together they explore the further research that is needed to bridge the gap to commercialization, as well as the initial markets for products in food and beverage, consumer health, and health. Select papers from these MRDUs are shared publicly to further public understanding of the food and health disruption.

THE EPICENTER OF THE DISRUPTION: METABOLIC HEALTH

We are at the beginning of the next wave of discovery in food and health, driven by the availability of new life and data science tools within the past decade. We are gaining deeper insights into the interaction between food and the human body at the molecular level. This is leading to disruptive visibility to the role our metabolic system – otherwise known as our body biochemistry – plays as the foundation of our health. A healthy metabolic system means a happier, healthier, longer life. An unhealthy metabolic system leads to chronic diseases like diabetes, heart disease, stroke, and dementia; and plays a major role in acute diseases like cancer [3]–[5].

It is increasingly clear that optimizing or enhancing our remarkable natural body biochemistry unlocks a whole range of human health benefits. Imagine being able to eat food which delivers specific benefits like:

- preventing or even treating neurodegenerative diseases such as dementia, Alzheimer's, Parkinson's, Huntington's and amyotrophic lateral sclerosis diseases through the foods that contain ketones and taste good [6];
- strengthening the growth and function of immune cells through foods with the right combination of macro- and micro- nutrients, leading to increased resistance to infectious disease [7];
- addressing muscle and bone loss through aging – sarco- and osteopenia – through foods that provide enhance protein uptake along with Omega-3s [8]; and

- curbing the negative impact of refined carbohydrates in the prevalence of metabolic syndrome – a cluster of factors increasing risk of strokes, CVD and type II diabetes while maintaining the taste and sensory experience of food [9].

But instead of realizing this potential, the opposite is happening. The metabolic system is the source of a pandemic that is becoming the leading cause of death and disability globally [10]. Six in ten adults in the U.S. have one chronic disease, and four in ten have two or more [11]. Only one in twelve Americans is metabolically fit.

The bodily processes and systems which once gave us an evolutionary advantage – lead by our craving for sugar and the ability to store it as fat – are now creating a global health and environmental crisis. Our diets have changed faster than our bodies.

THE NEXT WAVE OF DISCOVERY

The food and health disruption presents us with an opportunity to reimagine the food system not only to address this crisis, but also realize new frontiers in human and planetary health. Specifically, advances in the biological sciences now allow us to examine macronutrients at the molecular level, as opposed to the broad categories of carbohydrates, proteins, and fats. Similar to how our understanding of micronutrients brought about a revolution of the food system – vitamins, minerals, essential amino acids – the molecular understanding of macronutrients impacts on human health has the promise to have an equal, if not larger, human and planetary impact.

We can also see – for the first time – how the molecular composition of food interacts with our metabolism, affecting the bioavailability and bioactivity of both micro- and macro-nutrients. For example, both fibers within human breast milk – oligosaccharides – and a sugar – fructose – are carbohydrates. However, human milk oligosaccharides (HMOs) are essential to human brain and immune development, through a pathway that includes gut microbiota [12]. The other – fructose – drives chronic illness when overconsumed, resulting in liver damage and death [13]. The way in which foods get converted and used by the body is also highly dependent on the interaction among nutrients themselves. Antioxidants can bind to fiber; minerals can be trapped by phytate – an antinutrient found in plants – limiting their overall bioavailability. Alternatively, positive interactions between nutrients can enhance the health benefits of food [14].

Our nutrient needs change by life stage and lifestyle; due not only to the demand placed by different body systems, but also because, like all other body systems from your brain to your muscles, your metabolic system adapts as we develop. From pre-natal to late adulthood, food design offers a unique opportunity to provide a tailored nutritional experience fitting everyone's needs.

Shaping food to support health is a practice as old as human history. For thousands of years, food cultures have incorporated practices focused on optimizing metabolic health. For example, the preparation of corn in Mesoamerica typically includes calcium hydroxide lime. Why? Corn soaked in lime addressed a major food safety issue with corn – aflatoxin – and promoted vitamin B3 (niacin) – a process called nixtamalization [15]. Without this step, corn consumers were susceptible to pellagra, as was common throughout the American South [16].

This work to advance health through the food system took a major leap forward during the first half of the 20th Century, with the discovery of micronutrients, their implementation throughout the food system, and the subsequent significant reduction of related diseases like rickets, goiter, xerophthalmia, beriberi, and

NOBEL PRIZES AND VITAMINS

DISCOVERY OF VITAMINS

1929	Christiaan Eijkman	Vitamin B1
	Sir Frederick Gowland Hopkins	Growth Stimulating Vitamins
1934	George Hoyt Whipple	Vitamin B12
	George Richards Minot	Vitamin B12
	William Parry Murphy	Vitamin B12
1943	Henrik Carl Peter Dam	Vitamin K

ISOLATION OF VITAMINS

1928	Adolf Otto Reinhold Windaus	Vitamin D
1937	Albert von Szent-Györgyi Nagyrapolt	Vitamin C
1938	Richard Kuhn	Vitamin B2 & B6
1943	Edward Adelbert Doisy	Vitamin K

SYNTHESIS OF VITAMINS

1937	Walter Norman Haworth	Vitamin C
	Paul Karrer	Vitamin E
1965	Robert Burns Woodward	Vitamin B12

STRUCTURE OF VITAMINS

1937	Paul Karrer	Vitamin A & B
1938	Richard Kuhn	Vitamin B2
1957	Lord (Alexander R.) Todd	Vitamin B12
1964	Dorothy Crowfoot Hodgkin	Vitamin B12

pellagra [17]. This has had profound repercussions in global health as illustrated by the number of Nobel Prizes awarded for their pioneering work in the field with no less than 16 laureates in about 35 years [18].

These discoveries deeply transformed our relationship to food. In fact, we have been so successful in building a food system that supports health in well understood that it has simply become part of the fabric of our world. It could be argued that this success has contributed to a loss of perspective on the critical role of food in health, and the inability to see the potential of the emerging food and health disruption.

REALIZING VALUE AND IMPACT

By working with the Institute's partners to drive innovation through programs in use-inspired research, talent development, and market discovery, the gap between research and commercialization can be bridged, creating healthier, happier, longer lives for billions. The emerging food and health disruption will create an inflection point that can meet and exceed the positive economic, social, and environmental impacts of scientific discovery in food and health during the first half of the 20th Century. Over the next decade this disruption will become a significant driver of both value and impact in the food and health systems.

INSTITUTE STAFF

Antoine Abrieux
Strategic Research Associate, Innovation Institute for Food and Health

Mary Avilla
Program Administrator, Innovation Institute for Food and Health

Veronica Keys
Program Assistant, Innovation Institute for Food and Health

Marissa Pickard
Lead Communication Coordinator, Innovation Institute for Food and Health

Justin B. Siegel
Associate Professor of Chemistry, Biochemistry & Molecular Medicine, UC Davis
Faculty Director, Innovation Institute for Food and Health

INSTITUTE ADVISORY BOARD

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Jonna Mazet
Vice Provost, Grand Challenges at the University of California, Davis
Chancellor's Leadership Professor of Epidemiology and Disease Ecology
Founding Executive Director, One Health Institute

Harold Schmitz
Founding Partner, The March Fund

Roy Steiner
Senior Vice President, The Rockefeller Foundation

Bernhard Van Lengerich
Founder, Seeding The Future Foundation

Wesley Wilson
Executive Chair, Innovation Institute for Food and Health

ENDNOTES

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