

## Factsheet on alternative proteins

### Potential of alternative proteins

The demand for food is increasing. Global market forces driving food demand and innovation include the need for food sustainability in response to environmental pressures and climate change, and an increasing protein consumption due to a growing global population and rising middle class. Therefore, new innovations and alternative methods to produce protein-rich food more productively and sustainably are needed.

2 Alternative protein is one such innovation with the potential to serve as sustainable sources of protein for the population, as large volumes can be produced with relatively small amounts of land and labour, with some innovations doing so in a climate-resilient and sustainable manner. While traditional meat producers will still need to optimise existing resources for environmental sustainability, alternative protein can complement these protein sources and, together, tackle climate change challenges to feed the growing global population.

### Types of alternative proteins

3 Alternative proteins generally refer to proteins derived from sources other than animal protein. While these could possibly include a large variety of protein sources, current technologies for alternative proteins are typically in the following forms:

- a. Plant-based proteins: Although familiar protein sources such as soy and wheat proteins have been a traditional feature in Asian diets, proteins extracted from other commonly consumed plants such as mung beans, pea and rice have also been used in plant-based food. Companies are also working on innovations that help to give these plant-based proteins tastes and textures that resemble meat. An example of plant-based proteins can be found in the Impossible Burger<sup>1</sup>.
- b. Algae and fungi-based proteins: Proteins derived from the dried cells of algae and fungi. Some algae species such as blue-green and green algae contain high levels of protein (40-60% dry weight). An example of algae-based proteins is spirulina. The meat-substitute Quorn is an example of fungal protein (also known as mycoprotein).
- c. Cultivated meat: Meat developed from animal cell culture (e.g. tissue engineering). The process to produce cultivated meat involves growing animal cells, such as chicken or shrimp, in a bioreactor with culture media. Some companies are also looking into the growing of cells onto edible "scaffolds" to produce products that resemble the shape and texture of meat. An example of cultivated meat is Eat Just, Inc.'s cultivated chicken, which was allowed to be sold in Singapore as an ingredient in their nugget's product since December

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<sup>1</sup> Key ingredients are soy protein, heme molecule (made using a yeast genetically engineered with the gene for soy leghemoglobin, which is derived from soy plants), sunflower fat and coconut oils, and binders.

2020. Some examples of cultivated meat companies in Singapore include Umami Bioworks and Ants Innovate, which are in the R&D phase and working towards pilot production.

- d. Insect proteins: Several species of edible insects have been traditionally consumed by humans. These include insects such as silkworm pupae and crickets, which are traditionally consumed in Korea and Thailand respectively. In recent years, the commercial farming of insects for human consumption and livestock feed has been promoted by the Food and Agriculture Organisation (FAO) and has received commercial interest.

### Ensuring the safety of novel food

4 Food and food ingredients that do not have a history of being consumed by humans as food are considered novel food. This applies to some forms of alternative proteins such as cultivated meat, which must be assessed for safety before they can be allowed to be used in food for sale in Singapore.

5 Food safety is SFA's principal consideration. SFA ensures that food products entering Singapore are safe for consumption, novel or otherwise.

6 Food safety must also be a principal consideration when companies develop food products. For novel food, companies must conduct safety assessments of their products and put in place systems and processes to provide the assurance of food safety.

7 In view of this, then-Agri-Food & Veterinary Authority<sup>2</sup> initiated a series of conversations with members of the scientific community and food businesses on the possible approaches for the regulatory framework for novel food and novel food ingredients in 2018, including the definition and examples of novel food. Following from the conversations, SFA introduced the regulatory framework in November 2019 which requires companies to seek pre-market allowance for novel food that do not have a history of use as food.

### Novel food regulatory framework

8 Companies producing novel food products are required to conduct and submit safety assessments of their products for SFA's review before they are allowed for sale.

9 In order to facilitate this process, SFA has released a document in November 2019 on the food safety information that would be required for novel food safety assessment. The information should cover potential food safety risks, such as toxicity, allergenicity, safety of its production method, and dietary exposure arising from consumption. Companies must also provide detailed information on the materials used in their manufacturing processes and how these manufacturing processes are controlled to prevent food safety risks.

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<sup>2</sup> SFA was formed as a new statutory board under the then-Ministry of the Environment and Water Resources on 1 April 2019. SFA brings together food-related functions carried out by the then-Agri-Food & Veterinary Authority of Singapore, the National Environment Agency and the Health Sciences Authority.

10 SFA will then review these safety assessments to ascertain that potential food safety issues have been addressed.

11 As novel food is a rapidly evolving area, SFA will periodically update and revise the document to facilitate the safety assessments by the industry and ensure food safety.

12 To ensure that the safety assessments are rigorously reviewed, SFA has established a Novel Food Safety Expert Working Group to provide scientific advice. The expert working group is chaired by the Head of the Centre for Regulatory Excellence, which seeks to strengthen health product regulatory systems across Asia. The group comprises eleven experts specialising in food science, food toxicology, bioinformatics, nutrition, epidemiology, public health, genetics, carcinogenicity, metabolomics, fermentation technology, microbiology, and pharmacology (see Annex).

13 “Alternative proteins are at the forefront of food science innovation. Nevertheless, food safety must be a principal consideration in production and SFA will review the safety assessments of these alternative protein products scientifically and consult experts to safeguard food safety and public health. We will also monitor such new products when they enter the market,” said Dr Tan Lee Kim, Director-General (Food Administration) and Deputy CEO, SFA.

14 “We believe the assurance of food safety does not lie with the government alone. We encourage food innovators to engage SFA early in their development process, to facilitate the regulatory approval process”, added Dr Tan.

15 To facilitate this early engagement process, SFA introduced Novel Food Virtual Clinics in September 2021, where novel food companies are able to proactively engage SFA at early stages of their research. With a clearer understanding of SFA’s requirements at an early stage, companies can prioritise resources towards productive research directions which will minimise compliance costs and time.

16 SFA has worked alongside A\*STAR and the Nanyang Technological University to launch the Future Ready Food Safety Hub (FRESH), a public-private partnership platform, in early 2021. A key function of FRESH is to build food safety science R&D capabilities for novel foods, functional ingredients, and new food processing techniques as well as provide consultancy to the industry. This will support companies, including our local enterprises, to develop and launch their food tech products in Singapore and beyond.

#### Safety assessment of cultivated meat

17 For cultivated meat products like Eat Just, Inc.’s cultivated chicken nuggets, the safety is reviewed at three levels.

18 Dr Tan shared, “Firstly, we assess the safety of the individual inputs in the production process and the products. This includes cell lines, culture media and reagents. For example, we review the toxicology of the inputs to see if they are toxic, or if they carry microorganisms that can cause illness in people.

19 Secondly, we review the production process and controls. This is to ensure that there is no introduction of microorganisms that can contaminate the product. The production process must be properly controlled and adhere to good safety and hygiene practices.

20 Lastly, the final product must meet the standards in our food regulations. This includes not exceeding the regulatory limits for additives and heavy metals, among others. It will also be compared to similar food with a long history of being consumed and known to be safe. For instance, for cultivated meat, we assess if it contains unexpected allergenic proteins. This is to ascertain if the product will cause allergic reaction more commonly than meat from conventional farming.”

### Singapore as a player in the alternative protein scene

21 Alternative protein is a relatively nascent but fast-growing global market opportunity that is expected to reach USD 140 billion in size over the next decade, or 10% of the world’s USD 1.4 trillion global meat sector. Many companies in this space have identified the unmet needs of consumers in Asia as a priority to address. As such, Singapore’s support of innovation and R&D will help accelerate the growth of the local agri-food and alternative protein sectors.

22 The Economic Development Board (EDB), Enterprise Singapore (EnterpriseSG) and the Agency for Science, Technology and Research (A\*STAR) have been working to encourage leading companies in food production to anchor in Singapore and provide the innovation support needed for agri-food companies to innovate and build up capabilities, in order to grow and thrive. This will in turn create good jobs in Singapore in the aforementioned sectors.

23 EDB is seeing growing interest in Singapore as a trusted base for global companies to anchor related activities, with a growing eco-system of over 70 alternative protein companies employing approximately 790 people driving innovation in the agrifood space. For instance, companies like Firmenich, Bühler and Givaudan have chosen Singapore for their plant-based Protein Innovation Centres. ADM and Cremer have also set up alternative protein contract development and manufacturing facilities in Singapore – with the ADM-backed ScaleUp Bio helping propel innovation in precision fermentation with access to 10,000L of fermentation capacity, and Cremer Sustainable Foods supporting plant-based protein production with a manufacturing capacity of 1,300 tonnes per annum. To build the talent pipeline of next-generation novel food innovators, the Nanyang Technological University (NTU) and National University of Singapore (NUS) have also launched undergraduate-level and graduate-level programmes in alternative proteins – the first of such programmes in Asia Pacific and Southeast Asia respectively.

24 Concurrently, EnterpriseSG has focused on strengthening the food tech ecosystem in Singapore as well as accelerating the growth of promising local agri-food

companies both locally and overseas by building up their capabilities to raise productivity and strengthen innovation. For example, it developed and launched a platform called FoodInnovate, a multi-agency initiative<sup>3</sup> to provide resources (knowledge and infrastructure) to Singapore food companies to drive food-tech and innovation, enabling them to develop new and sustainable food products to meet the ever-changing consumers' demands and nutrition needs. Local firm Esco Aster has also been granted a license for manufacturing cultivated meat at commercial scale. Additionally, EnterpriseSG is building a vibrant start-up ecosystem to uncover more talent as well as anchor technical experts, incubators, accelerators, and potential investors here.

25 Singapore is also facilitating more investments in the agri-food space to encourage R&D. For example, additional funding of \$165 million has been allocated to further the second phase of the Singapore Food Story (SFS) R&D Programme, which was launched in 2019 with an initial investment of \$144 million. The SFS R&D Programme was jointly developed by A\*STAR and SFA to grow a vibrant and forward-looking agri-tech and food ecosystem, with one of the three research themes being Future Foods: Advanced Biotech-based Protein Production. This theme will look at supplementing Singapore's protein needs through R&D into future foods, such as alternative proteins.

26 "A\*STAR partners with companies to translate research findings into healthy, tasty food that is sustainable and safe, enabling them to capture new growth opportunities in the global food market. Our capabilities in biotechnology, nutrition, food process engineering and cutting-edge analytics advance the development of high value-added ingredients, future foods and enable the innovation of new food systems in a sustainable manner." said Prof Ng Huck Hui, Assistant Chief Executive, Biomedical Research Council (BMRC), A\*STAR.

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<sup>3</sup> Other agencies include A\*STAR, EDB, Innovation Partner for Impact (IPI), JTC Corporation (JTC) and SFA.

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## Annex

### Members of Novel Food Safety Expert Working Group

<b>Chair</b>		
Professor John Lim	Executive Director, Centre of Regulatory Excellence, Duke-NUS Medical School	
<b>Members</b>		<b>Specialisation fields</b>
Professor Zhou Weibiao	Head of Department, Department of Food Science and Technology, National University of Singapore	Food science (Food engineering, food processing and functional foods)
Professor William Chen	Director, Food Science and Technology Programme, Nanyang Technological University	Food science (fermentation)
Professor Christiani Jeyakumar Henry	Senior Advisor, Singapore Institute of Food and Biotechnology Innovation, A*STAR	Nutrition
Associate Professor Yew Wen Shan	Head, Department of Biochemistry, Yong Loo Lin School of Medicine, National University of Singapore	Precision fermentation and microbiology
Adjunct Professor Sebastian Maurer-Stroh	Executive Director, Bioinformatics Institute, A*STAR	Bioinformatics (allergenicity prediction)
Adjunct Associate Professor Annie Ling	Group Director, Policy, Research and Surveillance Division, Health Promotion Board	Epidemiology
Adjunct Assistant Professor Chow Wai Leng	Director, Disease Policy and Strategy Division, Ministry of Health	Public health
Assistant Professor Ching Jianhong	Assistant Professor, Director, Metabolomics @Duke-NUS Medical School	Metabolomics
Professor Chan Chun Yong, Eric	Professor, Department of Pharmacy and Pharmaceutical Sciences, Faculty of Science, National University of Singapore	Pharmacology and Toxicology (physiological-based pharmacokinetics-pharmacodynamics modelling)

Associate Professor Tan Soo Yong	Head of Advanced Molecular Pathology Laboratory, Institute of Molecular and Cell Biology, A*STAR	Biobanking, molecular pathology, cancer genomics
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