

**SSAS INTERDISCIPLINARE 2021/2022**  
**GROUP “COMPLEXITY AND INTERDEPENDENCIES”**

**Fellow coordinator: prof. Mario Calabrese**  
**Student coordinator: Matteo Jarno Santoni**

## **INTRODUCTION**

With a broad range of information, presented in a simple and straightforward manner, this section covers the complexity and interdependencies related to the complex world of food. Indeed, global food systems have significantly increased in complexity since the mid-twentieth century, through a series of innovations (mechanization, genetic modification, globalization of supply chains). Nevertheless, over-complexification can lead systems to become increasingly dependent on external subsidies and vulnerable.

The section consists of three subsections that reviewed the theoretical and applied impact of complexity and interdependencies in addressing food-related issues.

The first group focused its analysis on the phenomenon of agri-food chains in order to assess patterns of environmental sustainability, thanks to various methods for evaluating sustainability based on different indicators. The research investigated the concrete case study relating to the wheat supply chain through the final product of dry pasta, for which an analysis of the environmental impact along the entire supply chain is proposed.

The second group focused on the ~~greater~~ relationship between nutrition, brain, and behavior. The ways in which we eat affect the functioning of the brain and the meaning we more or less consciously give to the very act of feeding ourselves. Lastly, a model is proposed which considers anorexia nervosa as a learned pathological behavior linked to reward mechanisms.

The third group studied the correlations between unhealthy nutrition and the risk of developing tumours and studied the physicochemical mechanisms underlying the carcinogenicity of certain foods and cooking methods. In addition, the research was aimed at understanding if the plant world can provide us with arms against cancer. At last, a survey of the population was carried out to understand how much their eating habits would change in a preventive key, even by including in the diet foods modified in an anticancer sense.

## **GROUP I: “Sustainability between resources and waste”**

**Fellows:** Prof. Ernesto D’Albergo, Prof.ssa Anna Irene Del Monaco, Prof. Fabio Giglioni, Prof. Andrea Salvatore, Prof. Luca Scuccimarra

**Students:** Andrea Annunziata, Francesco Ciaanfrocca, Gabriele Ciccarello, Niccollò Geracitano, Sergio Moroni, Francesco Pontrelli, Marcello Romano, Elisabetta Romeo, Matteo Jarno Santoni

**PhD student supervisors:** Alessandra Quintigliano

Our research activity aims at investigating food supply chains as phenomena of the complex world where we live. The concept of “chains” allows us to understand how the different stages in the agri-food system are strongly connected and how important is to consider the supply chain as a unitary process that begins on the field and ends at the fork. Each factor that characterizes the chain is measurable: its evaluation is fundamental in order to identify the technical and technological improvements that can be adopted to reduce the impact on the environment. A standard international method to evaluate food chains is the Life Cycle Assessment, which takes into account every step of the chain. The method consists in collecting data from the phases of the chain, and in interpreting

the results. We focused our attention on the inventory analysis, and we studied how data are collected, noticing that there is a significant subjectivity in the choice of the indicators to be used, and hence in the valuation itself. This problem was confirmed by two experts we interviewed. The research has then moved onto a real case that has been identified in the wheat supply chain. This choice has been made due to its relevance in both the economy and tradition of our country. The first case we studied aimed at identifying the main hotspots of the wheat semolina pasta supply chain and analyzing possible mitigation actions. The second one, carried out by a company itself, is an example of how LCA analysis conducted in compliance with the above-mentioned PEF standards, has been applied in optimizing the production process. In conclusion, our work aimed at trying to underline the importance of establishing objective and precise rules for the application of indicators, which could cancel arbitrariness in the evaluation of sustainability.

**Speakers:** Francesco Cianfrocca, Matteo Jarno Santoni, Andrea Annunziata, Marcello Romano, Elisabetta Romeo, Niccolò Geracitano

## **GROUP II: “Nutrition, brain and behaviour”**

**Fellows:** Prof. Mario Calabrese, Prof. Vittorio Lingiardi, Prof. Antonio Musarò

**Students:** Clemente Calabrese, Emilia Maria Cappuccini, Salvatore Falciglia, Giulia Lucciola, Elena Maron, Vittorio Moretti, Elena Tittarelli, Shiheng Zheng

**PhD student supervisors:** Federica Fuso, Monia D’Angiò

There exist a close connection between nutrition, brain and behaviour. The ways in which what we eat influences the functioning of the brain and the meaning we more or less consciously give to the very act of feeding ourselves condition our daily life often without us realising it, and this is critically evident in the appearance of eating disorders, the analysis of which is the body of our work. Specifically, we will analyse the Anorexia Nervosa from a microscopic to a macroscopic point of view. Beginning from the very micro aspect of the genetic and epigenetic modifications, we will give an overview on the multifactorial etiopathogenesis of the eating disorder in analysis, taking into consideration the role of microbiota and the influence of society. We will proceed focusing on the cognitive processes that contribute to the maintenance of the AN, as the process does not cause cognitive control-related systemic changes but it determines the learning of pathologic behaviours. Two different hypotheses are presented: the top-down and the bottom-up. This allows us to perform a modeling analysis, studying the general macro-behaviour of a complex system by abstracting and transferring it to models which enable the observation of emerging synergies between the micro-behaviors observed in real life. In the end, the role of the society in the development of eating disorders will be discussed under the law perspective, giving examples of existing laws and examining their effectiveness and their limits. By following this order, the discussion takes the form of an ascending climax: it begins with the analysis of what happens inside the nucleus, proceeds considering the parts that form the human body and ends with the investigation of the role of society.

**Speakers:** Emilia Maria Cappuccini, Salvatore Falciglia, Elena Maron, Vittorio Moretti, Elena Tittarelli, Shiheng Zheng

## **Group III: “Nutrition, biotechnological applications and health. Food, plants and cancer”**

**Fellows:** Prof.ssa Isabella Screpanti, Prof. Francesco Fazi, Prof. Alessandro Fatica

**Students:** Chiara Cataldi, Luca Argirò, Francesco Mannaioli, Emanuele Nuzzi Somasca, Riccardo Panza, Eleonora Pariset, Matteo Praticò, Leonardo Riglietti, Pietro Todesco

**PhD student supervisors:** Jacopo Fiore, Vittorio Padovano

Our work is focused on the relationship between cancer, food and plants. Firstly, we will analyse how certain foods can be carcinogenic, secondly, if plants, even reinforced with the newest biotechnologies, and Physics innovations, can help us fight cancer. Finally, we will show the results of a survey assessing the awareness and acceptance of these topics in a mostly-under-30 population. Food can have pro- or anti-tumoral qualities, and caloric intake can influence tumor prevention. Indeed, there is a correlation between carcinogenesis and obesity, as suggested by a recent mathematical model. On the other hand, a hypocaloric diet, in addition to classical treatment, can increase patients' outcomes. Even habits from everyday-life, such as cooking, can increase the carcinogenic risk of food. In particular, we will study the formation of polycyclic aromatic hydrocarbons in meat cooked at high temperatures. These notions can be translated in terms of personalized care with the aid of Nutrigenomics, the science of the relations between diet and genes, which explains how the food we eat can define the individual with its pro- and anti-tumoral effects. Regarding what could help the cancer fight, the plant world can provide phytonutrients with highly valuable benefits for health and tumor prevention. Examples of reinforced-for-health plants already exist, like the genetically modified Purple tomato and the non-transgenic Black tomato, both with a higher content of antioxidant anthocyanins. Moreover, in vivo studies have showed that life expectancy of cancer-prone mutant mice increased when they were fed a purple tomato-enriched diet. On a final note, Physics can play an important role in many phases of the healthy food and tech processing. An example is crystal engineering approaches to crystallisation in food systems, especially in the case of quercetin, a flavonoid with antioxidant and anticancer properties.

**Speakers:** Chiara Cataldi, Leonardo Riglietti, Emanuele Nuzzi Somasca, Matteo Praticò, Luca Argirò, Eleonora Pariset