#### – Physical chemistry and biochemistry of food

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#### *COURSE AIMS AND INTENDED LEARNING OUTCOMES*

The course is aimed to provide a general comprehension of the physical-chemical processes governing food perception, formulation and stability together with the biochemical reactions underlying food structure rather than the development and perception of flavours and tastes. The chemistry and biochemistry of food additives, preservatives and flavours will be a further learning outcome of the course.

At the end of the course the student is expected to achieve a KNOWLEDGE AND COMPREHENSION of

* The thermodynamics of solutions.
* The chemical structure of the main classes of lipids of interest in food chemistry, together with their stability, plasticity, and reactions.
* The concepts of surface tension and surface are, the processes involved in emulsion, the activity of emulsifiers, the mesomorphic behaviour.
* The emulsification, foaming and gelling properties of proteins, their stability towards oxidation and their reaction with carbonyls.
* The non-enzymatic browning (Maillard reaction) from carbohydrates
* The role of polysaccharides in food chemistry: gelatinization and retrogradation of starch, the structure and ability of alginates, pectin, guar and carrageenan.
* The light absorption ability of colorants; the structure and uses of anthocyanins, carotenoids, betanains, caramel, dyes.
* The mechanism of taste sensation, glutamate and umami receptors, taste enhancers, the stereochemical theory of olfaction.
* The chemistry and properties of sweeteners.
* The chemistry and biochemistry of vitamins.
* The chemistry and biochemistry of natural toxicants such as cyanogenic glycosides, glycoalkaloids, glucosinolates, heterocyclic amines, nitrosamines.

Concerning the skills TO APPLY KNOWLEDGE AND COMPREHENSION, the student will be able to critically discuss and apply the concepts concerning:

* the inclusion/enrichment of food components with the aim of improving the structure and stability of foods.
* The mechanisms underlying the development and perception of tastes and flavours.
* The relationship between food components and food quality, including functional quality.

#### *COURSE CONTENT*

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| **Module “BIOCHEMISTRY OF FOOD”** | ECTS |
| Structure of the main classes of lipids of relevance in food chemistry. Thermal and oxidative stability of lipids. Lipids hydrogenation. | 1 |
| The regulation of food intake. The biochemistry of sensory analysis. Sensing and receptors, CNG and TRP ionic channels. Taste perception and taste enhancers. Sweeteners. The process of olfaction. Chemesthesis. | 1.5 |
| Functional food components. Prebiotics. The chemistry and biochemistry of vitamins. Phenolic compounds, carotenoids and other antioxidants: mechanism and classification. ROS compounds and redox imbalance. | 1.5 |
| Natural toxicants (cyanogenic glycosides, alkaloids, glucosinolates, heterocyclic amines, nitrosamines). Process-related toxicants. Gluten and other food allergens. | 1 |
| *Exercises.* Practical classroom in the laboratory | 1 |

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| **Module “PHYSICAL CHEMISTRY OF FOOD”** | ECTS |
| The thermodynamics of solutions: ideal solutions, osmotic pressure, macromolecules in solution. Texturizing agents. Polysaccharides, gelatinization and retrogradation of starch. Alginates, pectin, guar and carrageenan and other polysaccharides used in food preparations. | 0.5 |
| Surface tension and surface area, surfactant compounds, properties and classification. Formation, stability and breakdown of emulsions, capillary effect, adsorption, formation of micelles, creaming and flocculation. Typical food emulsion. The mesomorphic behaviour. Foaming and gelling properties of proteins; proteins stability towards oxidation and reaction with carbonyls. Foam structure, Plateau and Laplace law, methods for foam formation. Foam stability. Typical food foams. Gels classification, gels formation. Typical food gels. | 1 |
| Non enzymatic browning (the Maillard reaction). Enzyme technologies. Enzymatic browning. Enzymes in food manufacturing. | 1 |
| Light absorption, colorants. Natural colorants. Chlorophylls and eme groups, myoglobin, anthocyanins, carotenoids, caramel, dyes, melanoidins. Artificial colorants. Other additives. | 0.5 |
| *Exercises.* Practical classroom in the laboratory | 3 |

#### *READING LIST*

* Dominic W.S. Wong – Mechanism and theory in food chemistry, second edition. Springer ed.
* Christos Ritzoulis - Introduction to the physical chemistry of foods, CRC press.
* deMan, John M.; Finley, John W.; Hurst, W. Jeffrey; Lee, Chang Yong - Principles of Food Chemistry, second ed.- Springer ed.

#### *TEACHING METHOD*

The teaching method is based on classroom lectures, during which the active partecipation of students is strongly encouraged. Even thought the slides used will be made available in advance via the Blackboard online platform, these information must not be considered as exaustive and should be better considered a base that graphically supports lectures. Therefore the student is advised to attend lectures and to integrate the information provided by slides with the reference texts (as provided in the reading list above-reported).

Besides lectures, laboratory exercices (where the student will apply in practical exercices the concepts introduced in lectures) integrate the teaching method.

***ASSESSMENT METHOD AND CRITERIA***

The method applied to assess the degree of competence acquired includes a) a written exam (intermediate, mid-term assessment, at the end of first module) with open questions on the first module of the course, taking 1 hour; b) a final exam done orally, with 3-6 questions.

The intermediate assessment is facultative and, in case the test is positive (hence with a score of 18/31 as minimum), the corresponding topics will not be investigated further during the oral examination. However, in case of negative scores, it is still possible to do the oral exam on the whole course contents. The students not carrying out or not passing the intermediate written exam can do the oral exam; in that case, they will be examined on the whole course content (i.e., both module 1 and module 2).

The oral exam consists of 3 questions (5-6 in case the written test was unsuccessful). The final score is a weighted average between the (eventual) written and the oral assessments, with a relative weight of 50% each.

During the assessments, the skills regarding (i) the knowledge of the physical-chemical processes governing food stability and texture; (ii) the knowledge of their technological role(s) in food manufacturing and food design; (iii) the knowledge on the chemical processes affecting stability, appearance and taste of foods, as well as (iv) the bioactive components (either desired or undesired) of food will be investigated. The student is asked to argument and defend his conclusions regarding the impact of physical chemical and biochemical processes into food design.

***NOTES AND PREREQUISITES***

The student is asked to possess previous skills from general biochemistry such as carbohydrate structure, glycosidic bonds, chemical structure and nomenclature of fatty acids, amino acids structure and peptide bonds, tertiary and quaternary structure of proteins. Furthermore, the previous concepts of basic principles of thermodynamics are essential. The knowledge about the structure and linkage between units of macrobiomolecules is of particular importance.

***TEACHER AVAILABILITY***

The teacher is available in the 2 hours following the lectures, at his office in the seat in Cremona. It is advisable to schedule in advance with the teacher (by email), the eventual appointment.