האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

# *The Hebrew University of Jerusalem*

## *Syllabus*

# *CHEMISTRY AND BIOCHEMISTRY OF FOOD - 71430*

*Last update 26-03-2017*

*HU Credits: 3*

*Degree/Cycle: 1st degree (Bachelor)*

*Responsible Department: Biochemistry & Food Sciences*

*Academic year: 0*

*Semester: 2nd Semester*

*Teaching Languages: Hebrew*

*Campus: Rehovot*

*Course/Module Coordinator: Prof.Joseph Kanner*

*Coordinator Email: jokanner@gmail.com*

*Coordinator Office Hours: By appointment*

*Teaching Staff:*

*Prof Joseph Kanner*

*Course/Module description:*

*Presentation material will include functional aspects:*
*1 - General Introduction.*
*2 - Chemistry of oxidation, a process that affects all components of quality.*
*3 - Color components.*
*4 - Components of taste and smell.*
*5 - Components of texture.*
*6 – Food Nutrients.*

*Course/Module aims:*

*To explain and understand the chemistry and biochemistry of functional food ingredients that affect the quality and nutritional value of foods for human nutrition.*

*Learning outcomes - On successful completion of this module, students should be able to:*

*• Describe chemical characterization of functional molecules in foods.*
*• Explain specific responses of food functional molecules.*
*• Assess chemical interactions between functional molecules with other active ingredients in foods, affected by technological treatments (heating, cooling, freezing, drying, concentration, radiation).*
*• Recommend specific examples of foods on the shelf which are affected by specific chemical and biochemical reactions.*

*Attendance requirements(%):*

*80*

*Teaching arrangement and method of instruction: 42 hours lecture with a presentation divided into 6 main topics that affect the quality of the food.*

*Course/Module Content:*

*Introduction,6h.*
*Structure of Matter - the distribution of electrons in a atom. Orbitals of type s,p, d,. Molecular electronic orbital networking, σ, π, n, and orbitals of bonding and anti-bonding. Orbital electron distribution of molecules with identical atoms, oxygen as an important triplet molecule, bi- radical and pramagnetic.*

*Chromophore center, coupled double bond, HOMO / LUMO, molecules which are natural and synthetic pigments.*
*Interactions between absorbed light and color, the effect of radiation on various electron orbitals. Electronic, vibrational and rotational energy. Jablonski Diagram, generation of fluorensece and phosphoresence light.*
*Chemistry of food oxidation, 6h.*
*1 - Electronic configuration of oxygen molecule and other active oxygen species as superoxide, hydroperoxyl radical, hydrogen peroxide,singlet oxygen, hydroxyl radical. Oxygen activation through transition metals and reducing compounds.*
*2 - Hydroxyl radical and other radicals as initiators. Transition metals, especially iron and copper as catalysts of food oxidation.*
*3 – Oxidation of lipids by enzymes and non-enzymes catalysts. Self-oxidation, auto-oxidation, chain reaction , intermediate compounds and toxicity. Coupled-oxidation and its impact on food quality.*
*4 - Effect of technological processes on food oxidation ; paprika powder, other dry products, oils and fried-foods. Oxidation of animal products - meat products.*
*5 - Anti-oxidant molecules, how they act and prevent oxidation.*
*6 - Prevention of oxidation in food products by antioxidants and technological processes.*

*Color components, 10 h.*

*1 - Chlorophyll - the abundant pigment in nature. Chemical characterization, specific responses, photosensitizer, antioxidant, stability of the pigment in foods.*
*2 - Myoglobin - the pigment of meat products. Chemical characterization, specific responses, chromophore center. Synthesis, the iron orbital electronic configuration in the molecule. Coordinative bonds, bonding of oxygen and other ligands. Low-spin, high-spin and interactions between the iron ion valence and color. Creating color in meat by nitrite, nitrosoamines, cytotoxicity. Preventing discoloration of fresh meat products and processed meat by nitrite.*
*3 - Anthocyanins - the red pigment of fruits, vegetables and wine. Chemical characterization of aglycons. Different anthocyanidins in nature and in foods. Specific responses to; pH,-OH, H2SO3, the heterocyclic ring, lost of chromophore center. Co-pigmentation and its effect on red-wine color. Oxidation of anthocyanins. The effect of technological processes on anthocyanins in food products. Stabilization of anthocyanins in food products. Betacyanins and anthocyanins.*
*4 - Enzymatic browning - creating dark pigments. Characterization of molecules formed following the oxidation of polyphenols. Polyphenol oxidase, its active center and specific responses. Production of black tea. Resulting chain reaction following the creation of free radicals, polymerization and dark pigments by non-enzymic reactions. Enzymatic browning a desirable and undesirable reaction in foods. Quinones as anti-nutritional compounds. The effect of technological treatments on browning and non-enzymatic browning dependent on polyphenols. Inhibiting the enzymic and non-enzymatic browning of polyphenols in food products.*
*5 - Carotenoids - important pigments in plants which imparting color and vision retinal pigments in animals. Molecular characterization and synthesis in plants.*

*Carotenoids in animals, sea food products, eggs, poultry and plants (peppers, tomatoes, other fruits). Specific anti-oxidants, singlet oxygen quenchers, carotenes oxidation, breakdown to fragrance molecules, communication and signaling in cells and between cells. Stability and stabilization of carotenoids in food products.*
*6 - Synthetic pigments in food products.*

*Taste and smell components of food. 6 h.*

*1 - The senses of taste and smell responsible for sensing food molecules. Some integrated sensing of flavor and off-flavor.*
*2 - Effect of carbohydrates, fats, and proteins on flavor and fragrance components, generally.*
*3 - Sensing tastes - sour, bitter, harsh, astringent, omammi, sweetness. Sweetness receptors. Interactions between sweeteners receptors. The theory of AH / B, Tinti / Nofre, excessive sweetness.*
*.4 - Sensing of odor. Characterization of molecules responsible for flavor/odors. Sensing threshold. Interactions between odor molecules, the effect of the combination of the sense of smell odor molecules inclusion.*
*5 - Creating fragrances by food enzymes. Being responsible for the odor molecules in tomatoes and cucumbers and off-flavor in fish. Release flavor molecules from existing sources, white-wine.*
*6 - Creating a fragrances process by non-enzymic reactions. Caramelisation of sugars. Millard reaction, Strecker degradation generation of flavors, desirable and undesirable. Creation of toxic and carcinogenic substances from sugars.*
*7 - Control of non-enzymatic browning processes for creating positive flavors, odor components generation during processing and storage of foods (heating, frying, roasting, drying).*
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*Texture components, 4 h.*

*1 - Food Texture characterization and molecular organoleptic aspects. Effect of carbohydrates, proteins, and fats on food texture, generally.*
*2 - Water molecular structure and the food texture. Interactions between water molecules and carbohydrates, proteins and fats.*
*3 - Carbohydrates and food texture. Cellulose / pectin imparting texture on plant material foods , food products (jams, sauces, gels). Alginate (engineered foods), Carrageenan (double- strend structure), starch (interaction with other molecules in baking, pasta).*
*4 - Protein and muscle texture products, milk and eggs.*
*5 - Fats and texture (tehina, mayonnaise, ice cream).*

*Nutrients. 10 h.*

*1 - Macro - nutrients. Proteins, fats and carbohydrates, changes in structure and composition caused by technological processes affecting the nutritional value of the*

*products, changes that do not undergo metabolism and absorption.*
*2 - Micro-nutrients.*
*Chemical characterization of vitamins that dissolve in lipids.*
*Vitamin A. Biological role, the presence in different foods. Carotenoids and pro - vitamin A. Destructive processes in the presence of other food molecules. The effect of technological processes on the vitamin. Improving stability of the vitamin in different foods, examples.*
*3 – Vitamin D. Characterization of chemical, biological role, the presence in different foods. Stability and destructive processes in the presence of other food molecules. The effect of technological processes on the vitamin. Improving stability in different foods, examples.*
*4 - Vitamin-E. Chemical characterization and differences between tocopherols. Biological role, the presence in different foods. Stability and destructive processes in the presence of other food molecules. . The effect of technological processes on the vitamin. Improving stability in different foods, examples.*
*5 - Vitamin-K. Biological role, the presence in foods. Stability and destruction in the presence of other foods. Improved stability.*
*6 - Vitamins dissolve in the watery.*
*Vitamin B1. Chemical characterization. Biological role, presence in foods. Vegetarian baby food containing the vitamin from soy supplements was unstable, why? Specific responses to HSO3-, HO-.*
*7 - Vitamin B2, riboflavin. . Chemical characterization. Biological role, the presence of the vitamin in foods. The effect of light on the vitamin in dairy products. Vitamin stability and ways to improve stability in foods.*
*8 - Vitamin B6, pyridoxal / pyridoxine. Chemical characterization. Biological role in the presence of different foods. Millard reaction by-products interaction with the vitamin, protection of functional proteins.*
*9 - Vitamins B 3 – Niacin, B-5 Pantothenic acid, B-7 - biotin,B- 9 folic acid, B-12 – Cyanocobaltamin.*
*Characterization of chemical, biological role, the presence of different foods, stability and responses to specific foods. The effect of technological processes on the stability of the vitamins and treatments that prevent the destraction.*
*10 - Co-enzyme Q-10.Obiquinol / Obiquinone. Characterization of chemical, biological role, the presence in different foods, stability and responses in specific foods. The effect of technological processes on the stability and treatments that prevent its degradation. Activation by cytochrome. Whether in the "third" age is a necessary additive.*
*11 - Vitamin C, ascorbic acid. . Characterization of chemical, biological role, the presence in different foods, stability and responses to specific food molecules. Technological processes affected stability and treatments that prevent the destraction of the vitamin. Paradoxical activities as pro-oxidant.The activities preventing or accelarating browning process in different foods.*
*12 – The stomach as a bioreactor. Continued oxidation processes in the stomach at low pH. Nitrite and Nitrosamine carcinogens. Sulphite as a catalyst for further oxidation processes. Lipid oxidation and coupled oxidation (fatty acids, cholesterol, vitamins) in the stomach. Red meat, production of cytotoxic compounds, active*

*carbonyls and detrimental impact on atherosclerosis in human. Nutrition for prevention these processes in human. Summary.*

*Required Reading:*
*None*

*Additional Reading Material:*
*Text Books.*

*1- Food Chemistry.1987, 2009 ed.*
*Belitz HD,. Grosch W, Editors*

*2- Food Chemistry.1985, 2009, ed.*
*Fennema OR, Editor*

*3- Lipid Oxidation. 1998, ed.*
*Frankel NE, Editor.*

*4- Oxidation in Foods and Beverages and Antioxidant Application. 2011*
*Decker EA, Elias RJ, McClements DJ, Editors.*

*Course/Module evaluation:*
*End of year written/oral examination 100 %*
*Presentation 0 %*
*Participation in Tutorials 0 %*
*Project work 0 %*
*Assignments 0 %*
*Reports 0 %*
*Research project 0 %*
*Quizzes 0 %*
*Other 0 %*

*Additional information:*
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