SUBJECT GUIDE

Academic year 2018-2019

Molecular Biology Applied to Foodstuffs

MODULE	CONTENT	YEAR	TERM	CREDITS	TYPE
	Molecular Biology applied to foodstuffs	3rd	2nd	6	Optional

LECTURER(S) Abdelali Daddaoua (Practice) Luis Fontana-Gallego (Theory) Ángel Gil-Hernández (Theory) María Dolores Mesa-García (Theory)	**Postal address, telephone nº, e-mail address** Dept. Biochemistry and Molecular Biology II 4th floor, School of Pharmacy, +34958243838 daddaoua@ugr.es, fontana@ugr.es, agil@ugr.es, mdmesa@ugr.es
TUTORING HOURS	A Daddaoua: Tue and Wed 9:00 – 12:00 h L Fontana: Tue and Wed 9:00 – 12:00 h A Gil: Mon and Tue 9:30-12:30 h MD Mesa: Wed 9-12:30 and 13:30 – 16:00 h
DEGREE WITHIN WHICH THE SUBJECT IS TAUGHT	Degree in Science and Food Technology

PREREQUISITES and/or RECOMMENDATIONS (if necessary)

It is recommended that students have completed the following subjects: Biology, Biochemistry, Human Physiology and Microbiology.

BRIEF ACCOUNT OF THE SUBJECT PROGRAMME

Regulation of gene expression by nutrients and other bioactive compounds in foods.
Applications of molecular biology in the agri-food industry.
Strategies for the use of microorganisms and ingredients modified by genetic engineering in the food industry.
International legislation applicable to the production, commercialization and consumption of genetically modified organisms.
Detection and analysis of genetically modified organisms.

GENERAL AND PARTICULAR ABILITIES

GENERAL COMPETENCES
CT.1 Ability to express oneself fluently in the Spanish language in its disciplinary field.
CT.2 Troubleshooting.
CT.7 Analysis and synthesis capacity.

SPECIFIC COMPETENCES
CE.1 Recognize and apply the physical, chemical, biochemical, biological, physiological, mathematical and statistical fundamentals necessary for the understanding and development of food science and technology.
CE.3 Know the techniques and perform food analyses that guarantee optimum conditions for human consumption.
CE.6 Know, understand and apply the classical methodology and the new technological processes aimed at improving the production and treatment of food.
CE.7 Analyse the biological, physical and chemical hazards of the food chain in order to protect public health.
CE.12 Know and establish nutritional guidelines and design food to promote healthy eating and eating.

OBJECTIVES (EXPRESSED IN TERMS OF EXPECTED RESULTS OF THE TEACHING PROGRAMME)

At the end of the term the student will be able to:
• Understand the procedures in order to study gene expression modulated by nutrients.
• Know the transformation and transfection techniques of cells with prokaryotic and eukaryotic vectors of interest in food.
• Analyze the techniques of production of transgenic foods.
• Describe examples of the application of recombinant DNA engineering and cell culture techniques to obtain products of interest.
• Know related technology and methods.

DETAILED SUBJECT SYLLABUS

THEORETICAL SUBJECT
PART ONE: REGULATION OF GENE EXPRESSION BY NUTRIENTS AND OTHER BIOACTIVE FOOD COMPOUNDS.
● Topic 1. Fundamental characteristics of nucleic acids. DNA: Structure, gene organization in prokaryotes and eukaryotes. Basic aspects of gene expression and its regulation. Concepts of nutrigenomics and nutrigenetics. Silencing by methylation of DNA. Epigenetics Regulation of chromatin condensation. 2 hours.
● Topic 2. Transcription: RNA polymerase. Stages of transcription. Initiation, elongation and termination. Postranscriptional modifications. Control of transcription in eukaryotes. Promoters and enhancers. Types of transcription factors for RNA polymerase II: general factors, factors located in the 5 'direction and inducible factors. Steroid receptors. Regulation of gene expression by vitamins A and D. 3 hours.

● Topic 3. Regulation by glucose of transcription in mammals. Regulation of genes encoding hepatic pyruvate kinase. Regulation of the genes encoding fatty acid synthase and acetyl Co-A carboxylase. Regulation of the insulin gene by glucose. 2 hours.
● Topic 4. Regulation of gene expression by lipids. Modulation of gene expression by polyunsaturated fatty acids; PPAR, SREBP, HNF4, LXR and NF-kB. Modulation of gene expression by sterols. Regulation of gene expression by other lipid components. 2 hours.
● Topic 5. Protein synthesis and degradation. Stages of translation: activation of amino acids, initiation, elongation and termination. Translation control. Regulation of expression by miRNAs. Protein detection techniques. 2 hours.
● Topic 6. Regulation by amino acids and glucose of translation in mammals. Regulation of gene expression by iron and zinc. 2 hours.

SECOND PART: RECOMBINANT DNA TECHNOLOGY
● Topic 7. Purification and analysis of DNA and RNA. Extraction of nucleic acids from tissues and cells. Isolation of plasmid DNA. Nucleic acid labelling techniques. DNA and RNA analysis by hybridization techniques in solid supports (Southern and Northern blots). Western blot. DNA sequencing. In vitro amplification using the polymerase chain reaction. 2 hours.
● Topic 8. General cloning strategies. Enzymes used in recombinant DNA technology. Restriction and methylation DNA and RNA enzymes. Nucleases. DNA ligases. Kinases and phosphatases. Other enzymes of interest. 2 hours.
● Topic 9. Prokaryotic host-vector systems. Host cells. Plasmid vectors. Vectors derived from lambda phage. Phage M13. Phagemids and phasmids. Cosmids BACs. YACs. 2 hours
● Topic 10. Cloning of genes in bacteria. Advantages of bacteria as cloning hosts. Selection of recombinant clones by genetic and hybridization methods. Detection of clones with oligonucleotides. Inactivation of marker genes by insertion of DNA fragments. 2 hours.
● Topic 11. Construction and analysis of libraries. Genomic and cDNA libraries. Cloning in lambda phage. Digestion of genomic DNA and selection by size. Cloning with cosmids. Construction of cDNA libraries. Reverse transcriptase Tracking libraries with oligonucleotides. 2 hours.
● Topic 12. Directed mutagenesis and expression in bacteria. Deletions, insertions and substitutions. Mutagenesis with oligonucleotides. Expression of cloned genes. Direct expression, fusion proteins and secretion proteins. 1 hour.
● Topic 13. Gene transfer to mammalian cells. Vectors derived from the SV40 virus. Other vectors Transfection methods. Co-transfection with marker genes: CAT, GFP and luciferase. 2 hours.
● Topic 14. Gene transfer to plants. Production of transgenic plants. Biology of *Agrobacterium tumefaciens*. Ti Plasmid. T segment. Opines. *Agrobacterium tumefaciens*-based vector. *Agrobacterium rhizogenes* system. Ri plasmid. Vectors based on DNA and RNA viruses. 2 hours.

THIRD PART: APPLICATIONS OF MOLECULAR BIOLOGY IN THE FOOD INDUSTRY
● Topic 15. Applications of genetic engineering in the design and production of probiotics. Lactic acid bacteria 1 hour.
● Topic 16. Production of transgenic plants with constitutive resistance to parasites and against microorganisms. Plants that produce substances of interest in food and nutrition. 1 hour.

● Topic 17. Improvement of meat and milk production through the use of transgenic animals. Other applications of transgenic animals. 1 hour.
● Topic 18. Large-scale cell growth. Monolayers and cells in suspension. Separation of cells. Immobilization of cells and cellular components. 1 hour.
● Topic 19. Processing and purification of products of interest produced by gene manipulation. Practical aspects of large-scale protein purification. 1 hour.
● Topic 20. Principles of industrial enzymology. Immobilization of enzymes. 1 hour.

PRACTICE TOPICS
Detection by means of recombinant DNA techniques of the presence of GMOs in food.
● Practice 1. Introduction. Fundamentals of the practices. Isolation of genomic DNA from food samples.
● Practice 2. Quantification and spectrofluorimetric characterization of isolated DNA. Amplification by PCR of authorized transgenes in the European Union and other countries.
● Practice 3. Analysis by agarose electrophoresis of the products amplified by PCR.
● Practice 4. Determination by ELISA of the antigenicity of proteins and enzymatic hydrolysates of milk.
● Practice 5. Presentation and discussion of results.

READING

MAIN READING:
· Lewin's Genes XI. Krebs JE, Kilpatrick ST, Goldstein ES. 9ª ed. Massachusetts: Jones and Barlett Publishers, 2013.
· Biotechnology for Beginners. Renneberg, R. Elsevier/Academic Press 2008.
· Lodish H, Berk A, Kaiser CA, Krieger M. Molecular cell biology, 7ª ed. New York: WH Freeman, 2012.
· Principles of Gene Manipulation. 7ª edición. Primrose SB y Twyman RM. Blackwell Scientific Publications. 2007.
· Lactic Adic Bacteria. Microbiology and Fuctional Aspects. 2ª Edición. Salmien S y von Wright A. Marcell Dekker Inc. 1998.
· Heller KJ. Genetically engineered food. Methods and detection. 2nd Ed Wiley-VCH Verlag GmbH & Co. KGaA, Weiheim, 2006.
· Ramón D. Los genes que comemos. Ed. Algar, 1ª Edición. Alzira, 1999.
· Sociedad Española de Biotecnología. El libro verde de la biotecnología en la agricultura. Ed.Sebito. 1ª Edicion. Madrid, 1997.
· Watson JD, Gilman M, Witkowski J, Zoller M Recombinant DNA, 2nd Edition, Scientific American books, WH Freeman , New York, 1992.

COMPLEMENTARY READING:
· Blanca Herrera RM, López Martínez, MC. Análisis jurídicos de la regulación de los OMG, en la UE. (1ª y 2ª parte) Alimentaria 2000; Nº 316: 17-31 y Nº 317: 20-42.

· Broun P, Gettner S, Somerville C. Genetic engineering of plant lipids. Annu Rev Nutr 1999; 19: 197-216.
· Lemaux PG: Genetically engineered plants and foods: A Scientist's analysis of the issues (Part II). Annu Rev Plant Biol 2008; 59: 771-812.
· Lucca P, Hurrell RF, Potrykus I. Genetic engineering approaches to improve the bioavailability and the level of iron in rice grains. Theoret Appl Genet 2001; 102: 392-397
· Mercenier A, Wiedermann, Breiteneder H. Edible genetically modified microorganisms and plants for improved health. Current Opinion in Biotechnology 2001; 12: 510-515.
· Rodríguez MA, López MC y Blanca Herrera RM. Evaluación de la salubridad de los nuevos alimentos modificados genéticamente. Alimentación Equipos y Tecnología. 2000; Abril: 153-157.
· Rodríguez López, MA, Blanca Herrera, RM, López Martínez, MC. Repertorio legislativo de biotecnología agroalimentaria: Internacional, comunitaria y nacional. 1ª, 2ª, 3ª y 4ª Partes. Alimentaria 2001; julio-agosto: 131-192.
· Rodríguez López, MA, López Martínez MC, Blanca Herrera, RM Legislación del etiquetado de los nuevos alimentos obtenidos por ingeniería genética. Alimentaria 2000; octubre: 37-43.
· Rodríguez López, MA, López Martínez, MC, Blanca Herrera, RM. Patentabilidad biotecnológica para obtener nuevos productos alimenticios. Cienc. Tecnol. Aliment. 2000; 3 (1): 48-54.
· Ye X, Al-Babili S, Kloti A, Zhang J, Lucca P, Beyer P, Potrykus I. Engineering the provitamin A (β-carotene) biosynthetic patways into (carotenoid-free) rice endosperm. Science 2000; 287: 303-305.

RECOMMENDED INTERNET LINKS