MEDITERRANEAN AGRONOMIC INSTITUTE OF CHANIA
(MAICh)

Natural Products and Biotechnology

POSTGRADUATE ACADEMIC GUIDE

&

ECTS GUIDE

2006 - 2007

Natural Products and Biotechnology

Postgraduate Specialisation and M.Sc. Programme

SCIENTIFIC COORDINATOR: **Dr. Antonios Makris**

EDUCATIONAL AND PROFESSIONAL GOALS

The Master on Natural Products and Biotechnology is a two-year programme for graduates holding a university Bachelors degree in Biology, Chemistry, Agriculture, or other related sciences.

In the first year participants follow the Postgraduate Specialization Course. The objectives of this Course are to: i) provide knowledge on the living systems producing secondary metabolites and their characteristic features; ii) introduce the current advances in the biosynthesis, characterization, and isolation of plant and microbial natural products; iii) provide extensive laboratory training in the genetic, computational and biochemical tools utilized in Natural Products Biotechnology; iv) enable a thorough scientific evaluation of the current and potential uses of natural products by the industry and the pharmaceutical sector.

Laboratory exercises combined with these courses provide a practical and tangible perspective. The qualified first year graduates are entitled of pursuing their research in an environment fully equipped with the most updated facilities.

In the second year, students who have successfully completed the first year develop a thesis based on research work and economic development study leading to a Master's of Science degree.

The scientific results of graduate studies are usually announced in International Conferences and/or published in World renowned journals.

POST GRADUATE SPECIALISATION PROGRAMME

The programme is organized in 5 sections

Section I - Introductory Discipline

The cycle includes introductory courses on Scientific English, use of Computer and Statistics..

Section II - Introduction to Advanced Biology

The cycle is devoted to Cell Biology, Molecular Biology and Biochemistry and Genetics courses. It aims to bring students from diverse scientific disciplines (Chemistry, Biology, Agriculture) on an equally high level of knowledge and address diverse issues such as genetics, biosynthesis, and biotechnology of Natural Products..

Section III - Chemistry of Natural Products

The cycle is a specialized unit in Natural Products including topic in Organic Chemistry, Biochemistry of Plant Secondary Metabolism, Chemistry and Biosynthesis of terpenoids, alkaloids, flavonoids and other phenolics, extensive laboratory in the analysis of natural products and evaluation of their role in the natural environment..

Section IV - Biotechnology of Natural Products

The cycle is a specialized unit focusing on the enzymes participating in the synthesis of Natural Products, heterologous systems of expression and large-scale production approaches..

Section V - Genomics and Proteomics of Natural Products

The cycle provides a comprehensive guide to the fascinating area of Plant Genomics and Proteomics, presenting an integrated, broadly accessible treatment of the complex relationship between the genome, transcriptome, and proteome of plants. This introduces the student to the range of molecular techniques applicable to investigating the unique facets of plant growth, development, and response to the environment, with emphasis to the applications related to plant secondary metabolism and the biosynthesis of natural products. The subject includes:

- Functional and structural genomics addressed within the context of natural products
- Current techniques and challenges to come
- How to utilize DNA and protein sequence data
- Practical considerations for choosing and employing the most commonly available computer applications
- A review of applications for biotechnology, including genetic modification and defence against pathogens
- Bioinformatics tools and Web resources
- Numerous examples from the latest research in the field of secondary metabolism and natural products.

TRAINING SEQUENCE

Section I - Introductory Discipline [4 ECTS]
from October to November

NPB.501 - Scientific English (3 ECTS)
NPB.502 - Introductory Computing (1 ECTS)

Section II - Introduction to Advanced Biology [21 ECTS]
from November to January

HOB.511 - Cell Biology (3 ECTS)
NPB.512 - Biochemistry (3 ECTS)
HOB.513 - Genetics (3 ECTS)
NPB.514 - Molecular Biology (3 ECTS)
NPB.515 - Molecular Biology Techniques (3 ECTS)
NPB.516 - Advanced Topics in Plant Cytology (3 ECTS)
NPB.517 - Tissue Culture Technology (3 ECTS)

Section III - Chemistry of Natural Products [18 ECTS]
from January to March

NPB.521 - Topics in Organic Chemistry (3 ECTS)
NPB.522 - Biochemistry of Secondary Metabolism (3 ECTS)
NPB.523 - Chemistry of Terpenoids and Essential Oils (3 ECTS)
NPB.524 - Chemistry of Alkaloids, Flavonoids and Other Phenolics (3 ECTS)
FQC.534 - Laboratory Techniques I (3 ECTS)
FQC.535 - Laboratory Techniques II (3 ECTS)

Section IV - Biotechnology of Natural Products [15 ECTS]
from March to May

NPB.531 - Enzyme Structure and Function (3 ECTS)

NPB.532 - Techniques in Biochemical Analysis (3 ECTS)
NPB.533 - Ecological and Stress Biochemistry (3 ECTS)
NPB.534 - Bioinformatics & Applications in Secondary Metabolism (3 ECTS)
NPB.535 - Industrial Biotechnology (3 ECTS)

Section V - Genomics and Proteomics of Natural Products [6 ECTS]
June
NPB.541 - Genomics and Proteomics of Natural Products I (3 ECTS)
NPB.542 - Genomics and Proteomics of Natural Products II (3 ECTS)

ANALYTICAL SYLLABUS

NPB.501 - **Scientific English** (3 ECTS)

LECTURER: Mrs Linda Lucas

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: The development of scientific writing and communication skills.

PREREQUISITES: Good knowledge in English language.

COURSE CONTENTS
Note-taking skills in order to better understand lectures; the study of scientific texts and their development; terminology related to the students' chosen field; a review of the fundamentals of English grammar with a view to studying advanced grammar skills for the purposes of writing a M.Sc. thesis; development of academic writing skills; public speaking, communication skills and theme-related discussions based on the students' chosen field of study. The final grade is awarded on the basis of the following:

- examination marks (based on grammar and scientific texts);
- presentation marks (based on oral and written presentations of students' own work);
- participation in classwork and attendance; homework assignments.

RECOMMENDED READING
Papers provided by the instructor.

ASSESSMENT METHODS: Written exam, Project Presentation

NPB.502 - **Introductory Computing** (1 ECTS)

LECTURER: Mr. Nicolas Boretos

TYPE OF COURSE AND TEACHING METHODS: Computer-assisted teaching

OBJECTIVE OF THE COURSE: Introduce scientists to the computer-based resources available.

PREREQUISITES:

COURSE CONTENTS
Computer hardware components, peripherals and controllers; architecture; operating systems. Interacting with computers. Data communications and computer networks. The Internet; brief history, protocols, addressing and domain name service(DNS). E-mail, News-Groups, Telnet, Ftp, WWW (World Wide Web). Computer applications; word processing, spread-sheets, data-bases, graphics, scientific software, schedulers. Computer Security.

RECOMMENDED READING

European Computing Driving Licence.

ASSESSMENT METHODS: Written exam, Computer-Assisted Exam

HOB.511 - **Cell Biology** (3 ECTS)

LECTURER: Dr. Constantinos Vlachonasios

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: To introduce to the fundamentals of plant cell biology. To strengthen their background on biological mechanisms that takes place in the eukaryotic and prokaryotic cell. Students understand the complexity of cells and the environment where fundamental processes preserve cell homeostasis.

PREREQUISITES: Undergraduate Biology

COURSE CONTENTS

Eukaryotic versus prokaryotic cells. Cell structure and compartmentation. Cell membranes and their principles. Cell organelles and their physiology. Intracellular and intercellular communication. Genetic information storage – nucleus. Nuclear cytoplasmic interactions. Cell specialization - animal and plant cells. Cell responses to environmental stimuli.

RECOMMENDED READING

Biochemistry & Molecular Biology of Plants, B. Buchanan, W. Gruissem, R. Jones, eds. 2000, American Society of Plant Physiologist.

ASSESSMENT METHODS: Written exam

NPB.512 - **Biochemistry** (3 ECTS)

LECTURER: Prof. K. Sekeris

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: To familiarise with all the important components of the chemistry of life. To introduce students to the structure and function of proteins and nucleic acids.

PREREQUISITES: Undergraduate Chemistry

COURSE CONTENTS

Water, solvent of life; Properties of solutions; buffers. Biological macromolecules; (proteins, nucleic acids, polysaccharides, lipids)

Proteins: Levels of protein organization, Protein interactions, Cell environment factors controlling protein assembly, Protein synthesis, Post-translation modifications, Protein compartmentation, Protein stability and turnover, Multiple functional stages of proteins, Multiplicity of protein forms and functions, Plant and insect hormones and their receptors

Polysacharides: Cell surface diversification, Cell adhesion, Natural products

Lipids: Simple and complex lipids, Lipoproteins, Lipid messengers

Nucleic acids: (See molecular biology)

RECOMMENDED READING

Lehninger: Chapter 3 (Biomolecules, Ch. 4 (Water), Ch. 5 (Aminoacids and peptides), Ch. 6 (An introduction to proteins), Ch. 7 (The three dimensional structure of proteins), Ch. 9 (Lipids), Ch. 11 (Carbohydrates), Ch. 12 (Nucleotides and nucleic acids) and Ch. 26 (Protein Metabolism).

ASSESSMENT METHODS: Written exam

HOB.513 - **Genetics** (3 ECTS)

LECTURER: Prof. Athanasios Tsaftaris

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: Provide an introduction into the science of Genetics, a historical perspective and understanding of the current issues.

PREREQUISITES: Undergraduate Biology

COURSE CONTENTS

Historical perspective of Genetics. Early genetic experiments. Experimental derivation of the laws of inheritance/ Mendel. Critical experiments in the development of Genetics. Chromosome theory of inheritance. The unit of heredity. The nature of the gene; Cistrons. Position effects of DNA (Mc Clintock's work). Gene synthesis. Genetic engineering. Impact of Genetics on Society.

RECOMMENDED READING

The double Helix-50 years, Nature Publishing Group Supplement (2003) Vol. 421, p 395-453.

RNA-directed DNA methylation, (2000) M. Wassenegger, Plant Molecular Biology, 43: 203-220.

Status of genome projects for nonpathogenic bacteria and archaea, K. E. Nelson, Ian T. Paulsen, J. F. Heidelberg and C. M. Fraser (2000) Nature Biotechnology Vol. 18, 1049-1054.

Functional genomics, Nature insight, Reprinted from Vol. 405, no. 6788, 2000, p 819-822.

The Evolution of Epigenetics (2001), Science, Vol. 293, p 1063-1105.

Epigenetic Mechanisms of Gene Regulation, Edited by Vincenzo E.; A. Russo, Robert A. Martienssen and Arthur D. Riggs, p. 5-24.

Bioinformatics: A Biologist's Guide to Biocomputing and the Internet, Stuart M. Brown, Ch. 2 and Ch. 3.

DNA sequence of both chromosomes of the cholera pathogen Vibrio cholerae, J. F. Heidelberg, J. A. Elsen, W. C. Nelson, R. A. Clayton, M. L. Gwinn, R. J. Dodson, D. H. Haft, E. K. Hickey, J. D. Peterson, L. Umayam, S. R. Gill, K. E. Nelson, T. D. Read, H. Tettelin, D. Richardson, M. D. Ermolaeva, J. Vamathevan, S. Bass, H. Qin, I. Dragoi, P. Sellers, L. McDonald, T. Utterback, R. D. Fleishmann, W. G. Nierman, O. White, S. L Salzberg, H. O. Smith, R. R. Colwell, J. J. Mekalanos, J. Graig Venter and C. M. Fraser (2000), Nature Vol. 406, p. 477-483.

Molecular Cloning, A Laboratory Manual, Joseph Sambrook and David W. Russell.

The Unseen Genome: Gems among the Junk, Scientific American (2003)

The Asteroid Tugboat, R. L. Shweickart, E. T. Lu, P. Hut and C. R. Chapman (2003), Scientific American.

ASSESSMENT METHODS: Written exam

NPB.514 - **Molecular Biology** (3 ECTS)

LECTURER: Dr. Kafetzopoulos

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: To familiarize with DNA science and provide an understanding of the fundamental molecular processes taking place in a cell. To introduce students to the basic steps in the flow of genetic information.

PREREQUISITES: Basic knowledge of Genetics and Biochemistry.

COURSE CONTENTS

Stereochemistry of DNA and DNA topology. DNA replication, In vitro genetics. Restriction enzymes. Transcription factors. Transcriptional machineries. Pleiotropic effects of transcription. The substrate of transcription (chromatin). Role of introns-exons. Post transcriptional regulation. Post translational regulation. Differential gene expression and chromosomal domains. Extranuclear DNA. Environmental effects of gene expression.

RECOMMENDED READING

Molecular Cell Biology, 5th Edition, Ch. 4,l Ch. 9.

ASSESSMENT METHODS: Written exam

NPB.515 - **Molecular Biology Techniques** (3 ECTS)

LECTURER: Dr. Antonios Makris

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory

OBJECTIVE OF THE COURSE: To familiarize in the laboratory with the basic technology of recombinant DNA work.

PREREQUISITES: Basic knowledge of molecular biology.

COURSE CONTENTS

Aseptic techniques; media preparation; Subculturing of bacteria, dilution, replica plating, storage; Bacterial transformation with plasmids. Chemical transformation; electroporation; Isolation of plasmid DNA; digestion of plasmid DNA; Agarose gel electrophoresis extraction of DNA from gel; Plant DNA extraction, techniques and problems; DNA hybridisation using radioactive probes, PCR, methodologies.

RECOMMENDED READING

Molecular Cloning, A Laboratory Manual, 3rd Edition, Joseph Sambrook and David W. Russell, Ch. 1, 2, 5 and 8.

Molecular Biology of the Cell, 4th Edition, Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Ch. 7.

ASSESSMENT METHODS: Written exam

NPB.516 - **Advanced Topics in Plant Cytology** (3 ECTS)

LECTURER: Prof. Artemios Bozabalidis

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: An in depth understanding of the ultrastructure of a plant cell.

PREREQUISITES: Basic knowledge of cell biology.

COURSE CONTENTS

The compartmentation of the plant cell. Morphometric assessment of the cell structural elements. The biomembrane (fluid mosaic, active transport, fusion, potential, endo/exocytosis). The cytoskeleton (microtubules, actin filaments, intermediate filaments). Ribosomes and protein synthesis. The endomembrane system (fine structure of the Golgi apparatus and the endoplasmic reticulum, transport of glycoproteins, dynamic membrane flow, microbodies with specific functional activities). Organization of the interphase nucleus, cell division. Structural composition of the cell fundamental energy centers (mitochondria) and their implication in the process of respiration. Types of plastids and their participation in specific intracellular procedures. Fine structure of the chloroplasts in regards to the course of photosyntesis. The vacuoles as osmotic, depository and lytic sites of the plant cell. The cell wall (membrane rosettes and genesis of cellulose microfibrils, the sceletic lattice, mechanism of microfibril orientation, thickening of the cell wall, plasmodesmata, functional activities).

RECOMMENDED READING

Power Point Presentation, notes provided.

ASSESSMENT METHODS: Written exam

NPB.517 - **Tissue Culture Technology** (3 ECTS)

LECTURER: Prof. Dimitrios Voyatzis, Mr. Nikolaos Leventakis

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory

OBJECTIVE OF THE COURSE: To provide a theoretical and practical perspective of plant tissue and plant propagation methodologies.

PREREQUISITES: Knowledge of plant physiology and cell biology.

COURSE CONTENTS

Aseptic techniques, Media preparation, Callus induction, Plant regeneration, Cell suspension cultures. Seed production procedures. Production and propagation material in of vegetatively propagated crops. Use of tissue culture and transformation in plant propagation and genetic engineering. Genetic engineering in plant breeding. Genetic improvement of vegetatively propagated crops.

RECOMMENDED READING

Plant Propagation (Conventional, Micropropagation, Genetic Engineering), Principles and Applications, Demetrios G. Voyiatzis (2003).

Plant Propagation by Tissue Culture, K. Grigoriadou and N. Leventakis.

ASSESSMENT METHODS: Written exam, Quiz

NPB.521 - **Topics in Organic Chemistry** (3 ECTS)

LECTURER: Dr. Elias Couladouros

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: This course aims to provide students coming from a wide range of disciplines (biology, agriculture, microbiology, biochemistry, physiology) with a comprehensive understanding of the basic concenpts of organic chemistry.

PREREQUISITES: Undergraduate Chemistry

COURSE CONTENTS

The course is designed to introduce the students to the principles of organic reactions and reaction mechanisms particular to the synthesis and analysis of natural products. The rational design and synthesis of novel compounds with desired properties based on natural products and the application of combinatorial chemistry are other aspects of this course.

RECOMMENDED READING

Organic Chemistry, John McMurry, 5th Edition, Ch. 1, Ch. 2, Ch. 3, Ch. 4, Ch. 5, Ch. 6, Ch. 9, Ch. 15.

ASSESSMENT METHODS: Written exam

NPB.522 - **Biochemistry of Secondary Metabolism** (3 ECTS)

LECTURER: Dr. Joerg Degenhardt

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: A thorough overview of plant secondary metabolism.

PREREQUISITES: Good knowledge in Organic Chemistry, Biochemistry, Molecular Biology, and Plant Physiology.

COURSE CONTENTS

Introduction to plant metabolism. Plant structure and cell structure. Chemical nomenclature, the logic of metabolism and reaction mechanisms. Building blocks-biosynthetic pathways. Shikimate,

mevalonate, methylerythritol phosphate pathway, glyceraldehyde-3-phospate/ pyruvic acid pathway.

Important secondary metabolite groups: Fatty acids and polyketides, phenylpropanoids and lignin, terpenoids and steroids, tropane alkaloids, terpenoid indole alkaloids.

Gene regulation in secondary metabolism. Tissue specificity (phenylpropanoids) and stress responsiveness (terpenoid indole alkaloids). Compartmentation, storage and transport.

RECOMMENDED READING

Biochemistry & Molecular Biology of Plants, Buchanan, Gruissem and Jones, Ch. 24.
Plant Physiology, 2nd Edition, Taiz and Zeiger, Ch. 13.
Power Point Presentation.

ASSESSMENT METHODS: Written exam

NPB.523 - **Chemistry of Terpenoids and Essential Oils** (3 ECTS)

LECTURER: Ass. Prof. Vassilios Roussis

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory

OBJECTIVE OF THE COURSE: Provide advanced knowledge in the field of fragrance and flavour through the prism of chemistry and industrial approach.

PREREQUISITES: Organic Chemistry.

COURSE CONTENTS

Fragrance and flavouring compounds : essential oils, terpenoids-oleoresins- Detailed biochemical pathways for the production of volatile compounds in specific plant species; Chemical structure, distribution, diurnal and seasonal fluctuations; Infraspecific differences in volatiles oil production, differentiation between geographical origins; Turpentine and terpene industry and, biological activity).Raison d'être.

RECOMMENDED READING

Methods in Plant Biochemistry, 1991, Barry V. Charlwood and Derek V. Banthorpe, Vol. 7, Ch. 1, Ch. 4 and Ch. 5.

ASSESSMENT METHODS: Written exam

NPB.524 - **Chemistry of Alkaloids, Flavonoids and Other Phenolics** (3 ECTS)

LECTURER: Ass. Prof. E. Kokkalou

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: Provide advanced notions of the chemistry and pharmacology of various natural products.

PREREQUISITES: Organic Chemistry

COURSE CONTENTS

Pharmacological action of alkaloids : Pyridine-piperidine alkaloids, Tropane alkaloids, quinoline alkaloids, isoquinoline alkaloids, indole alkaloids, imidazole alkaloids, steroidal alkaloids. Detailed biochemical pathways for the production of alkaloids in specific plant species. Chemical structures, subcellular localization, distribution and evolution in gymnosperms and angiosperms, biological activity & role of alkaloids in plants. Detailed biochemical pathways for the production of flavonoids in specific plant species. Chemical structures, subcellular localization, natural distribution and evolution in gymnosperms and angiosperms. Biological activity: role of flavonoids in plants, Natural

pigments:anthocyanins-flavonoids-other phenolic compounds and other miscellaneous natural pigments.

RECOMMENDED READING

The Systematic Identification of Flavonoids, 1970, Marby and Thomas Markham, Published by Springer Vertag.

ASSESSMENT METHODS: Written exam

FQC.534 - **Laboratory Techniques I** (3 ECTS)

LECTURER: Dr. Anastasia Detsi

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory

OBJECTIVE OF THE COURSE: To provide knowledge and know how over techniques and methodologies applied in chemical laboratories for food and natural products.

PREREQUISITES: Undergraduate organic chemistry or undergraduate analytical chemistry.

COURSE CONTENTS

Theory of chromatography, instrumental techniques (GC, HPLC) and applications, principles of mass spectroscopy and applications (LC-MS, GC-MS), principles of photospectroscopy, other spectroscopic methods (IR, NMR), identification, quantitation, structural determination, laboratory exercises.

RECOMMENDED READING

Power Point Presentation.

ASSESSMENT METHODS: Written exam

FQC.535 - **Laboratory Techniques II** (3 ECTS)

LECTURER: Dr. Dimitrios Makris

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory

OBJECTIVE OF THE COURSE: As continuation of "Laboratory techniques I", the course provides knowledge and know how over techniques and methodologies applied in chemical laboratories for food and natural products.

PREREQUISITES: Undergraduate organic chemistry or undergraduate analytical chemistry.

COURSE CONTENTS

Theory of chromatography, instrumental techniques (GC, HPLC) and applications, principles of mass spectroscopy and applications (LC-MS, GC-MS), principles of photospectroscopy, other spectroscopic methods (IR, NMR), identification, quantitation, structural determination, laboratory exercises.

RECOMMENDED READING

Laboratory Techniques, Dimitris Makris, Ph.D. AMRSC, 2005

ASSESSMENT METHODS: Written exam

NPB.531 - **Enzyme Structure and Function** (3 ECTS)

LECTURER: Dr. Sotirios Kampranis

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: To familiarize with the world of enzymes and the mechanisms of catalysis.

PREREQUISITES: Good knowledge of Biochemistry.

COURSE CONTENTS

Enzymes are fundamental to all life. Without proteinaceous catalysts the chemistry of life would simply not occur. They are supremely efficient catalysts and are capable of exquisite feats of molecular recognition. They are responsible for the biosynthesis of natural products and they form the molecular targets of compounds with pharmacological properties. For these reasons they are of prime importance to the biotechnology of natural products. Moreover, much of modern biotechnology is involved with the production and use of proteins. Enzymes, not only are important to the pharamaceutical industry, but also are relevant to food and plant biotechnology. To the former, they are sources of novel functionality in the complex systems that make up food, whilst to the latter, they are the target of rational strategies to redesign the properties of crop plants. This module is aimed at students with a range of backgrounds and is designed to provide the knowledge base and intellectual framework for more advanced studies of particular relevance to Natural Products and Biotechnology.

RECOMMENDED READING

Fundamentals of Enzyme Kinetics, Athel Cornish-Bowden, Portland Press Ltd, ISBN: 1855781581.

Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems (Wiley Classics Library), ~Irwin H. Segel, John Wiley & Sons Inc. ISBN: 0471303097.

DNA Topology, ~A. Bates, Tony Maxwell, Oxford University Press, ISBN: 019856709X.

Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, ~Irwin Harvey Segel, John Wiley and Sons (WIE), ISBN: 0471774219.

Introduction to Protein Structure, ~Carl Branden, John Tooze, Garland Science, ISBN: 0815323050.

DNA-protein Interactions: A Practical Approach (Practical Approach S.), ~Andrew Travers (Editor), Malcolm Buckle (Editor), Oxford University Press, ISBN: 0199636923.

ASSESSMENT METHODS: Written exam

NPB.532 - **Techniques in Biochemical Analysis** (3 ECTS)

LECTURER: Dr. Sotirios Kampranis

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory, Computer-assisted teaching

OBJECTIVE OF THE COURSE: To provide a hands-on approach into the basic techniques of protein expression and purification.

PREREQUISITES: Good knowledge of Biochemistry, Enzymology.

COURSE CONTENTS

This laboratory-based course covers the basic techniques of protein expression, purification and characterisation. These include: Production of recombinant proteins in bacteria, cell lysis, gel-filtration chromatography, ion-exchange chromatography, affinity chromatography, hydrophobic interaction chromatography, SDS-PAGE, isoelectric focusing, Western blotting, determination of protein concentration and enzyme activity assays.

RECOMMENDED READING

Molecular Cloning (3-volume set), ~Joe Sambrook, David Russell, Cold Spring Harbor Laboratory Press, ISBN: 0879695773.

Protein Purification Techniques: A Practical Approach (Practical Approach S.), ~E.L.V. Harris (Editor), et al., Oxford University Press, ISBN: 0199636737.

Protein-ligand Interactions: A Practical Approach: Structure and Spectroscopy (Practical Approach S.),~S.E. Harding (Editor), B. Chowdhry (Editor), Oxford University Press, ISBN: 0199637474.

Protein Structure Prediction: A Practical Approach (Practical Approach S.), ~Michael J.E. Sternberg (Editor), Oxford University Press, ISBN: 0199634963.

Protein Purification Applications: A Practical Approach (Practical Approach S.), ~E.L.V. Harris (Editor), et al., Oxford University Press, ISBN: 0199636710.

ASSESSMENT METHODS: Written exam

NPB.533 - **Ecological and Stress Biochemistry** (3 ECTS)

LECTURER: Dr. Christopher Johnson

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: To provide an in-depth perspective of the interactions between plants and their environment and the ecological role of secondary metabolism.

PREREQUISITES: Knowledge in Plant Physiology.

COURSE CONTENTS

Biosynthesis of secondary compounds in plants. Control mechanisms; biochemistry and molecular basis. Ecological role of plant secondary metabolites. Biochemistry of plant pollination (flower colour, flower scent). The role of secondary compounds in plant-pollinator interactions. The role of secondary compounds in plant-herbivore interactions (insects, vertebrates, fungi). Plant toxins and their effects on animals (cyanogenic glycosides, cardiac glycosides), The cost of resistance to herbivores. Animal pheromones and defence substances (insect pheromones, mammalian pheromones, defence substances). Effects of higher plants on micro-organisms mediated by plant secondary compounds (Phytoalexins, Phytotoxins), plant-plant biochemical interactions (inhibition of seed germination, allellopathy). Environmental and genetic control of nitrogen assimilation in relation to secondary metabolism.

RECOMMENDED READING

Plant Physiology, 2nd Edition, Teiz and Zeiger, Ch. 13, Ch. 17.

Introduction to Ecological Biochemistry, J. B. Harborne, Ch. 1, Ch. 2, Ch. 3, Ch. 7.

ASSESSMENT METHODS: Written exam

NPB.534 - **Bioinformatics & Applications in Secondary Metabolism** (3 ECTS)

LECTURER: Dr. Panagiotis Kanellopoulos

TYPE OF COURSE AND TEACHING METHODS: Computer-assisted teaching

OBJECTIVE OF THE COURSE: The course aims to introduce the basic tools used in computational biology for analyzing genes, proteins and metabolic pathways.

PREREQUISITES: Knowledge in Molecular Biology and Biochemistry.

COURSE CONTENTS

The topics include: Introduction to the GenBank sequence database; Structure databases; Information retrieval from biological databases; tools for DNA sequence analysis, multiple sequence alignment; tools for protein analysis, protein linkage-maps; constructing phylogenetic trees; Introduction to metabolic pathways; mining data for understanding secondary metabolism.The course is inclusive of all the modern approaches that enable scientists to establish genetic relationships, construct phylogenetic trees, dissect secondary metabolic pathways and understand basic concepts of structure-function relationships of the enzymes involved in secondary products formation.

RECOMMENDED READING

Vector NTI Suite, Application Program, Molecular Biology Software, PC, MAC.

Bioinformatics: A practical guide to the analysis of genes and proteins, 1998, A. D. Baxevanis, B. F. Francis Ouellette.

ASSESSMENT METHODS: Written exam, Computer-Assisted Exam

NPB.535 - **Industrial Biotechnology** (3 ECTS)

LECTURER: Prof. Dimitrios Kyriakidis

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: This course is designed to familiarise the students with the methods used to produce compounds of high commercial value in the Biotechnological Industry.

PREREQUISITES: Knowledge in Biochemistry and Molecular Biology.

COURSE CONTENTS

The course will cover the following topics: Bioprocessing (Microorganisms with biotechnological interest, Bioreactors for microorganisms, Criteria of biotechnological processes), Industrial applications of recombinant technology, Purification of proteins (recombinant, membrane-bound, antibodies, pharmaceutical proteins etc), Protein engineering of enzymes with biotechnological interest, Regulatory mechanisms of biosynthetic enzymes (Metabolic engineering), Immobilization of enzymes, coenzymes and cells, Downstream processing, Sterilization, Bioreactors (Types of Bioreactors, Designing of Bioreactors, Enzymes for Bioreactors), Examples of Biotechnological processes (Production of pharmaceutical proteins and vaccines, Production of polysaccharides and aromatic compounds, Production of biodegadative polymers, Monoclonal Antibodies, Other biotechnological applications).

RECOMMENDED READING

Industrial Biotechnology, Prof. D. Kyriakidis, provided by he instructor.

ASSESSMENT METHODS: Written exam

NPB.541 - **Genomics and Proteomics of Natural Products I** (3 ECTS)

LECTURER: Dr. Sotirios Kampranis, Dr. Nikolaos Panopoulos, Dr. Kriton Kalantidis

TYPE OF COURSE AND TEACHING METHODS: Lectures

OBJECTIVE OF THE COURSE: A two course unit composed of advanced series of seminars on the genomics and proteomics approaches in secondary metabolism.

PREREQUISITES: Molecular Biology and Biochemistry.

COURSE CONTENTS

- Functional and structural genomics addressed within the context of natural products
- Current techniques and challenges to come
- RNA interference: Concepts and applications in plant biology
- Agrobacterium transformation concepts and uses
- A review of applications for biotechnology, including genetic modification and defence against pathogens
- Mechanisms of signal transduction in plants for disease resistance
- FPLC protein purification

RECOMMENDED READING

Dr. N. Panopoulos, The Plant Cell.

Dr. Kriton Kalantidis, Gene silencing as an adaptive defence against viruses (2001). Peter M. Waterhouse, Ming-Bo Wang and Tony Lough, Nature, Vol 411, p. 834-842.

Post-transcriptional gene silencing in plants (2001). H. Vaucheret, Ch. Beclin and M. Fagard, Journal of Cell Science 114, 3083-3091.

On the role of RNA amplification in dsRNA-Triggered gene silencing (2001). Cell, Vol. 1074, 465-476.

Exploring Plant genomes by RNA-Induced gene silencing. Peter M. Waterhouse and Christopher A. Helliwell. Nature. http//www.nature.com/cgi-taf/DynaPage.taf?file=/nrg/journal/v4/n1/full/nrg982_r.html.

Power point presentation.

ASSESSMENT METHODS: Written exam

NPB.542 - **Genomics and Proteomics of Natural Products II** (3 ECTS)

LECTURER: Prof. Paul Christou

TYPE OF COURSE AND TEACHING METHODS: Lectures, Laboratory

OBJECTIVE OF THE COURSE: A two course unit composed of advanced series of seminars on the genomics and proteomics approaches in secondary metabolism.

PREREQUISITES: Molecular Biology and Biochemistry.

COURSE CONTENTS

- Applied Plant Biotechnology: An overview
- World Agricultural production: current situation, prospects and challenges
- The legal framework in plant Biotechnology
- Plant Biotechnology for Natural Products

RECOMMENDED READING

Between myth and reality: genetically modified maize, an example of a sizeable scientific controversy (2002). Jean-Pierre Wisniewski, Nathalie Frangne, Agnes Massonneau, Christian Dumas, Biochimie 84, p. 1095-1103.

The science and politics of plant biotechnology – a personal perspective (2003). Nature Biotechnology, Vol. 21, no 8, p. 849-851.

No credible scientific evidence is presented to support claims that transgenic DNA was introgressed into traditional maize landraces in Oaxaca, Mexiko. Paul Christou, Transgenic Research 11: iii-v 2002.

Transgenic Maize and the Evolution of Landrace Diversity in Mexico. The importance of Farmer's Behavior (2004). Mauricio R. Bellon and Julien Berthaud, Plant Physiology Vol. 134, p. 883-888.

How should Society Approach the real and Potential risks posed by new technologies? (2003). Carl F. Cranon, Plant Physiology, Vol. 133, p. 3-9.

Power Point presentation

ASSESSMENT METHODS: Written exam

ACADEMIC SUPPORT FACILITIES

Laboratory of Plant Molecular Biology and Biochemistry

The laboratory of Plant Molecular Biology and Biochemistry aims to provide the necessary facilities and molecular tools to meet the research and training needs of the department of Natural Products & Biotechnology.

The ongoing research activities taking place in the laboratory include:

Research topics on biochemistry and molecular biology, tissue culture and plant physiology.

Selection, genetic and chemical characterisation, and breeding of Medicinal and Aromatic plants.

Manipulation and Genetic engineering of plant secondary metabolism.

Isolation and Characterisation of plant components involved in resistance to environmental stress and Programmed Cell Death.

The facility includes an extended line–up of up–to–date computer–assisted apparatae, including: Fast Protein Liquid Chromatography (FPLC), Capillary Electrophoresis, Gas chromatography (GC), HPLC coupled to Electrospray Mass–Spectrometer (ES/MS); HPLC with Diode–Array Detector (DAD) and Refractive Index Detector (RID), Diode-array UV–Visible Spectrophotometer, Fluorescence Spectrophotometer, ELISA Plate Reader, 2 PCR Thermo–cyclers, 2 Centrifuges (up to 24,000 rpm), Bench–top Centrifuges (up to 6,000 rpm), microcentrifuges, DNA and protein Electrophoresis Apparatae, 2–Dimensional Protein Electrophoresis Apparatus, Isoelectric Focusing (IEF) Apparatus, Electroporation Apparatus, Sonicator, Shaking Incubators, Microscopes linked to digital camera, Laminar Flow, Gel Documentation System, Autoclave, Lyophiliser, LI–COR 6400 Portable Photosynthesis meter, Controlled Environment Chambers, Deep Freeze Chambers (-70°C), Cold Rooms (4°C), Tissue Culture Room, Growth Room, Radioactive Work Room, Photo dark room.

The Laboratory also includes a state of the art: **Microbiological Safety Room**

Isolated biological safety room, equipped with a Heraeus HS-15 class-II biological safety cabinet. Designated area for microbiological analysis of pathogenic microorganisms and tissue culture.

MASTERS OF SCIENCE PROGRAM

Research Project (9 month duration)

Requirement
60 ECTS credits

Laboratory techniques (Related to the subject of the Master Thesis)

Research Subject Areas (topics generally available for Master of Science thesis)**:**

- Isolation and characterisation of the components of the cellular machinery involved in the biosynthesis of natural products (terpenoids, flavonoids etc.).
- Biotechnological production of natural products by the means of in vitro (bio-reactor) or in vivo (cell factory) reconstition of the biosynthetic pathway.
- Manipulation and genetic engineering of plant secondary metabolism to yield plants with improved production characteristics.
- Engineering of plant resistance to biotic (pathogen) and abiotic (drought, chill) stress through manipulation of the secondary metabolism

Indicative master thesis realized within the area

TITLE: Novel developments in luminal chemiluminescene: Application of the luminal/Co(II)-EDTA and luminal/hemin systems on oils (2006)

AUTHOR: Siham Bezzi, Algeria

PLACE OF REALIZATION: Department of Food Quality Management and Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Anthony C. Calokerinos, Panagiotis Kefalas

TITLE: Studies on the biological and biochemical properties of a *Salvia fruticosa* isoflavone reductase homologue (2005)

AUTHOR: Mohamed Abd El Ghani Ali El Sayed, Egypt

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Antonios Makris, Sotirios Kampranis

TITLE: Functional expression in-vitro and biochemical characterization of terpene synthases of *Salvia fruticosa* (2005)

AUTHOR: Samir Anssour, Algeria

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Christopher Johnson, Sotirios Kampranis

TITLE: Transposon tagging in yeast to identify genes involved in resistance to bax lethality (2005)

AUTHOR: Samer Matta, Lebanon

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Antonios Makris

TITLE: Environmental and ontogenic variation of terpene biosynthesis (2005)

AUTHOR: Mohamed Sadok Ennaifer, Tunisia

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Christopher Johnson

TITLE: Differential roles of glutathione S-Transferases in oxidative stress (2005)

AUTHOR: Nicolas Clatot, France

PLACE OF REALIZATION: Department of Natural Products & Biotechnology

THESIS DIRECTOR: Sotirios Kampranis

TITLE: Flavonoid composition of Greek honey. Qualitative and quantitative variation among pine honey samples from different geographical areas of Greece (2005)

AUTHOR: Farid Aboud, Algeria

PLACE OF REALIZATION: Department of Food Quality Management and Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Panagiotis Kefalas

TITLE: Chemical investigation of the volatile metabolites of species of the genus *Rosa* growing in the Lebanon (2005)

AUTHOR: Dominique Choueiter, Lebanon

PLACE OF REALIZATION: Department of Food Quality Management and Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Vassilios Roussis

TITLE: A study on the antioxidant properties of Mediterranean algae: preliminary chemical investigation of the sea grass *Posidonia oceanica* (2005)

AUTHOR: Raluca Alexandra Stoiculescu, Romania

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Vassilios Roussis

TITLE: Sonochemical degradation of the Olive-oil wastewater phenolics monitored by Co(II)EDTA-Induced luminol chemiluminescence (2004)

AUTHOR: Dora Atanasova, Bulgaria

PLACE OF REALIZATION: Department of Food Quality Management & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTORS: Antonios Calokerinos, Elefteria Psillakis

TITLE: Functional studies of Jemma and Emsy proteins (2003)

AUTHOR: Taha El-Metwali Ahmed El-Metwali, Chemist, Egypt

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Sotirios Kampranis

TITLE: Elaboration of extraction methods from the orange peel for fingerprinting and in view of obtaining natural pigments for use in the industry as added value natural products (2003)

AUTHOR: Dani Georges Fadel, Lebanon

PLACE OF REALIZATION: Department of Food Quality Mangement & Chemistry of Natural Products, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Damaso Hornero Mendez

TITLE: Establishing genetic models in yeast for dissecting program cell death processes in Eukaryotes (2003)

AUTHOR: Soumaya Belhocine, Algeria

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Antonios Makris

TITLE: Isolation of yeast genes restoring sensitivity to Bax tolerant mutants (Bax lethality in yeast affects the vacuoles in addition to mitochondria in a distinct manner) (2003)

AUTHOR: Cecilia Mbithe Mweu, Kenya

PLACE OF REALIZATION: Department of Natural Products & Biotechnology, Mediterranean Agronomic Institute of Chania, Greece

THESIS DIRECTOR: Antonios Makris

References of the main academic staff teaching within the M.Sc.

More than 25 invited lecturers from about 4 countries participate in each edition of the M.Sc. programme of which, 20% came from Research Institutes, 74% from Higher Education Institutions, 6% from Private Companies. Considering their implication in the programme, the following academic staff is taken as reference:

GERMANY

Research Institutes

- Joerg Degenhardt. Max Planck Institute for Chemical Ecology, Jena

Higher Educational Institutions

- Dr. Rainer Fischer. University of Aachen, Aachen

GREECE

Higher Education Institutions

- Konstantinos Vlachonasios. Aristotle University of Thessaloniki, Thessaloniki
- Athanasios Tsaftaris. Aristotle University of Thessaloniki, Thessaloniki
- Dimitrios Voyatzis, Aristotle University of Thessaloniki, Thessaloniki
- Artemios Bozabalidis. Aristotle University of Thessaloniki, Thessaloniki
- Elias Couladouros. Agricultural University of Athens, Athens
- Vassilios Roussis. University of Athens, Athens
- Eugenios Kokkalou. Aristotle University of Thessaloniki, Thessaloniki
- Dimitrios Kyriakidis. Aristotle University of Thessaloniki, Thessaloniki

Research Institutes

- K. Sekeris. National Research Institute, Athens
- Dimitrios Kafetzopoulos. Institute of Molecular Biology and Biotechnology, Heraklion
- Panagiotis Kanellopoulos, Laikon Hospital, Biochemistry Laboratory, Athens
- Anastasia Detsi. Institute of Organic and Pharmaceutical Chemistry, Athens
- D. Tzamarias. Institute of Molecular Biology and Biotechnology, Heraklion
- Nikolaos Panopoulos. Institute of Molecular Biology and Biotechnology, Heraklion
- Kriton Kalantidis. Institute of Molecular Biology and Biotechnology, Heraklion

Private Companies

- Nikolaos Leventakis. In Vitro Hellas, Imathia

SPAIN

Higher Education Institutions

- Paul Christou, University of Lleida, Lleida

THE NETHERLANDS

Research Institutes

- Andy Pereira, Centre For Plant Breeding and Reproduction Research, Wageningen

UNITED KINGDOM

Higher Education Institutions

- Christopher Johnson, University of Reading, Reading

UNITED STATES

Higher Education Institutions

- E. Moudrianakis, John Hopkins University
- John Scandalios, North Carolina State University, Raleigh

The Institute reserves the right to replace its visiting faculty according to its evaluation process.