

BIO 1408 Biomedical Science and Technology

Βιοϊατρική Επιστήμη και Τεχνολογία

Σεπτέμβριος-Οκτώβριος /Διάρκεια: 3 εβδομάδες

A. Scientific methodology and logic

N. Tavernarakis 2h

Historical perspective: Examples of discoveries and breakthroughs in Biology. Rise and fall of paradigms and dogmata in Biology.

Principles of scientific model building

Principles of experimental testing and control

Επιστημονική Μέθοδος/Επιστημονική Λογική/Επιστημολογία

Ιστορική προοπτική: Παραδείγματα ανακαλύψεων και σημαντικών εξελίξεων στη Βιολογία. Άνοδος και πτώση εννοιών και δογμάτων στη Βιολογία. Αρχές

δημιουργίας επιστημονικών μοντέλων και υποθέσεων εργασίας. Αρχές πειραματικού σχεδιασμού και έλεγχου.

B. Molecular Evolution-Metagenomic era

Ladoukakis (2h)

How much human kind differs from its closest relatives on the genetic level? What evolutionary forces have shaped human genome? Are there genetic differences among human populations? These long standing and fundamental questions remained controversial for many decades. Now, in metagenomic era, both massive data collection and analytical tools have been used to approach these questions. Here we' ll review recent literature on human molecular evolution and we' ll discuss the differences -on the DNA level- between humans species and its closest relatives as well as the differences among human populations in different geographical regions

Η επίδραση της φυσικής επιλογής στη διαφοροποίηση του ανθρώπινου γονιδιώματος: μέθοδοι και δεδομένα από τη μεταγονιδιωμική ανάλυση

Στη δίωρη αυτή διάλεξη θα παρουσιάσουμε τις βασικές μεθόδους ανίχνευσης της φυσικής επιλογής σε κωδικοποιούσες και μη κωδικοποιούσες περιοχές του γονιδιώματος και θα αναλύσουμε τα τελευταία δεδομένα που προέρχονται από την ανάλυση του γονιδιώματος του ανθρώπου. Θα προσεγγίσουμε ερωτήματα που αφορούν στην γενετική διαφοροποίηση του ανθρώπου από τους κοντινούς του συγγενείς όπως και στα γενετικά αποτυπώματα της γεωγραφικής κατανομής του ανθρώπου

C. Genome organization, editing/analysis and functional genomics

Molecular Diagnostics, Μοριακά διαγνωστικά 2h I. Vontas

Ορισμός (μέθοδοι ανίχνευσης μοριακών δεικτών). Μοριακοί δείκτες: παθογόνου, μεταλλαγής (SNP, deletion amplification, disomy κλπ) που σχετίζεται με χαρακτηριστικό κλπ. Τεχνολογίες (probing, PCR-based, molecular beacons, Lamp, HOLA, multiplex diagnostic platforms-strip test κλπ, Lab-on-disk κλπ). Εφαρμογές (ιατρική, βιοτεχνολογία, τρόφιμα - γενετικά τροποποιημένα, νοθευμένα κλπ, γεωπονία & εντομολογία - ταυτοποιήσεις ειδών κλπ).

Genetic engineering and genome editing technologies 2h A. Pavlopoulos

This session will cover the basic forward and reverse genetic approaches that have been developed to generate random and targeted modifications within genomes of interest and investigate the function of coding and noncoding sequences. Special emphasis will be given to programmable nucleases, in particular the most recent and powerful CRISPR-based technologies for gene knock-out and knock-in approaches. Students will also receive hands-on training on the design of guide RNAs for CRISPR-based genome editing applications.

D. Transcriptomics

Transcriptomics methods, next- and third-generation sequencing approaches 2h E. Ntini

Keywords: short read-sequencing, long-read sequencing, Nanopore, nascent RNA transcriptomics

E. Imaging in biological research

Imaging Technologies from molecules to organisms 2h J. Papamatheakis

Overview of cell and molecular imaging technologies with emphasis in fluorescence. Optogenetics, optoacoustics, in vivo imaging.

Principles of digital image processing in biomedical sciences 4h A. Pavlopoulos

The aim of this joined theory/practice session is to provide students the basic principles and the practical knowledge of digital image processing. The session will

cover fundamental concepts in image acquisition and analysis for biomedical applications using the open-source Fiji/ImageJ software.

Introduction to biomedical imaging. 2h G. Zacharakis

Methods and applications (X-ray CT, MRI, PET, US, Optical). Principles of tomographic imaging. Multiscale and multiparametric imaging and data handling. Small animal in vivo imaging.

Linear and non-linear optical and optoacoustic microscopy.

Eleftheriadis- (3h)

Theory and hands on experience on computational tools for structure-based drug design.

F. Protein Structure-Function, Analysis tools, Proteomics and structure-based drug-design

Protein Structure and Structural dynamics 3h G. Gouridis

- i. Introduction to protein structure (primary, secondary, tertiary and quaternary)*
- ii. Methods of structure determination and prediction*
- iii. Structural dynamics (Folding and Native state dynamics)*
- iv. Methods for monitoring structural dynamics and predicting allosteric networks*
- v. Protein Evolution*

Practical section in Protein structure and Structural dynamics 3h G. Gouridis

The aim of this theory/practice section is to introduce MSc candidates to basic software and servers to visualize and analyze protein structures.

All candidates are kindly asked to bring their own laptop.

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G. Probing physiological function from the molecular to behavioral level

Neurophysiological technologies used to study molecular, cellular and behavioral functions 2h K. Sidiropoulou

a) patch-clamp recording techniques: from single channel to whole-cell recordings

b) extracellular electrophysiological techniques in vitro and in vivo

Froudarakis (2h)

c) calcium imaging; d) optogenetics and behavior

H. Nano-biotechnology and biosensors

Introduction to nano-biotechnology 2h E. Gizeli

will describe new biological, physical and engineering principles that focus on the design, synthesis, characterization and application of bio-materials and devices in the nanometer scale; examples will include the interaction of proteins with surfaces for the design of biocompatible implantable materials as well as the interaction of cells with surfaces A74 stem-cell adhesion studies and tissue engineering.

Sensors and integrated systems for diagnostic purposes 2h E. Gizeli

will include description of biosensors' principle of operation; methods for surface-attachment of biomolecules and cells; kinetics of biological interactions; integrated nano/micro systems and their application to clinical diagnostics.

I. Single cell technologies and applications and functional genomics

Lavigne Mat (3h)

Genome organization, editing/analysis and functional genomics

Levels of chromatin organization. Experimental approaches for the study of chromatin/chromosome organization in the eukaryotes. Novel imaging and biochemical approaches for the study of chromatin (de)compaction and chromosome topology

Single cell technologies and applications

Levels of chromatin organization. Experimental approaches for the study of chromatin/chromosome organization in the eukaryotes. Novel imaging and biochemical approaches for the study of chromatin (de)compaction and chromosome topology

Round table

Exams