Universitat Autònoma de Barcelona

2021/2022

Vaccines and Drugs

Code: 105064
ECTS Credits: 6

Degree	Type	Year	Semester
2500890 Genetics	OT	4	0

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

Name: Josep Antoni Pérez Pons

Email: JosepAntoni.Perez@uab.cat

Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Teachers

Jaume Piñol Ribas

Prerequisites

There are no official prerequisites but knowledge of Biochemistry and Molecular Biology, Genetics, Microbiology, Cell Biology, Recombinant DNA Methods, Genomics and Proteomics, and Bioinformatics are assumed.

Objectives and Contextualisation

The first biotechnological drugs were simply "substitution molecules". These drugs were substances from human or animal organisms (hormones, etc.), which were available in very limited quantities, and that the recombinant DNA techniques allowed to obtain in large amounts. The current paradigm of the application of biotechnology to the design of vaccines and drugs is based on the prior identification of vaccine targets (genes / proteins related to pathogenicity, virulence or immunogenicity) and pharmacological targets (enzymes, receptors , whole metabolic pathways related to pathology, etc.) an then obtain the corresponding vaccine or drug by a rational design. The different "omics" (genomics, transcriptomics, proteomics, interactions, metabolomics, systems biology ...) represent key methodologies to identify the targets. In fact, these methods have allowed the emergence of so-called "reverse vaccination" (where a "silico" genome can be obtained by obtaining a vaccine) and the rational design of drugs from the three-dimensional structure of proteins. "Omics" have also generated new concepts in drug design such as "druggable genome / proteome / targetome" or "diseasome".
This course is aimed to describe the main procedures to identify vaccine and therapeutic targets. Methods and strategies to develop vaccines and to design organic molecules to modulate the biological activity of a therapeutic target will also presented.

Competences

- Apply an entrepreneurial spirit in the area of genetics and genomics from an integrated vision of R+D+I processes.
- Apply knowledge of theory to practice.
- Appreciate the importance of quality and a job well done.
- Assume ethical commitment
- Be able to analyse and synthesise.
- Be able to communicate effectively, orally and in writing.
- Be sensitive to environmental, health and social matters.
- Design experiments and interpret the results.
- Develop creativity.
- Know, apply and interpret the basic procedures of mathematical calculation, statistical analysis and IT, the use of which is indispensable in genetics and genomics.
- Make decisions.
- Measure and interpret the genetic variation in and between populations from a clinical, conservational and evolutionary perspective, and from that of the genetic improvement of animals and plants.
- Perceive the strategic, industrial and economic importance of genetics and genomics to life sciences, health and society.
- Perform genetic diagnoses and assessments and consider the ethical and legal dilemmas.
- Reason critically.
- Take the initiative and demonstrate an entrepreneurial spirit.
- Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Learning Outcomes

1. Apply knowledge of theory to practice.
2. Apply the basic techniques commonly used in the human and cancer genetics laboratory.
3. Appreciate the importance of quality and a job well done.
4. Assume ethical commitment
5. Be able to analyse and synthesise.
6. Be able to communicate effectively, orally and in writing.
7. Be sensitive to environmental, health and social matters.
8. Design experiments and interpret the results.
9. Develop creativity.
10. Explain how knowledge of human genetic variation is applied to personalised medicine, pharmacogenomics and nutrigenomics.
11. Interpret scientific publications, and solve problems and example cases in the fields of human and cancer genetics.
12. Make decisions.
13. Produce a report on the results of genetic research.
14. Propose entrepreneurial genetics and genomics projects in the field of health.
15. Reason critically.
16. Recognise the strategic importance of genetic progress in the field of human health, especially applications of the genomic to personalised medicine, pharmacogenomics and nutrigenomics.
17. Take the initiative and demonstrate an entrepreneurial spirit.
18. Use and manage bibliographic information or computer or Internet resources in the field of study, in ones own languages and in English.

Content

*Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents.

Lesson 1. Introduction. History of vaccines. Generations of biotech vaccines. Diseases and orphan vaccines/drugs. Blockbuster vaccines/drugs. General characteristics, benefits and issues of vaccines.

Lesson 2. Economical and social interest of vaccines. Vaccines world market. R0-index of contagious diseases. Origin of infectious diseases: zoonosis. Relationship infection-disease-genes-evolution. Cronic diseases and infection. Pathogenicity and virulence. Pathogenicity factors.

Lesson 3. Vaccine development. Concept of Safety, Immunogenicity, Efficacy, and Effectiveness. Side effects. Risk/Benefit ratio. Development stages (Stage 0, I, II, III, and IV). Timeline and costs. Vaccine production. Main control tests. GLP and GMP regulation.

Lesson 4. Identification and characterisation of vaccine antigens. Mechanisms of genetic diversity and virulence. Pathogenomics nad omics applications: surfomics, comparative and differential proteomics, immunomics, protectomics. Analysis of virulence genes activation: TraSH, STM, IVET, DFI, RNAi-mediated knockdown. Bioinformatics resources. Reverse vaccinology. Structural vaccinology. MALDI-Imaging and BioTyping; Immune response. Vaccinomics.

Lesson 5. Types of vaccines. Classic vaccines: inactivated; autovaccines; attenuated. Modern vaccines: subunits and conjugated; peptide-based; recombinant-live (SAVE, DISC, and DIVA vaccines); nucleic acids vaccines; anti-idiotype vaccines; structure-based vaccines; therapeutic vaccines and cancer; carbohydrate-based vaccines.

Lesson 6. Adjuvants. Immune-enhancers. Delivery systems. New adjuvants. Nanovaccines. Adjuvant characteristics and modes of action. Vaccine administration. VIOLIN database (The Vaccine Investigation and Online Information Network).

Lesson 7. Drugs and Biopharmaceuticals. Concept and history of biopharmaceuticals. Different generations of biotechnological drugs. New paradigms for drug development. Pharmacoeconomics. Analysis and validation of the purity of biopharmaceuticals. Key concepts of pharmacological analysis: Pharmacokinetics, Pharmacodynamics and ADME. Key parameters in pharmacology. Biotransformation. Toxicity. Phases of the development of a drug: preclinical and clinical stages.

Lesson 8. Drug discovery. Therapeutic targets. Estimates on therapeutic targets from genomics and proteomics. Classification of therapeutic targets. Systems biology and network pharmacology. Concept of pharmacophore. Strategies for the identification of new therapeutic targets. Drugs and novelty.

Lesson 9. Drug development. Methods and rationale to validate pharmacological targets. Validation of hits and leads. Lipinsky rules. Methods for obtaining and improving leads: combinatorial chemistry, fragment analysis and click chemistry. Techniques to identify interactions between hits and targets: SPR-Biacore, NMR, mass spectrometry, double and triple hybrid, protein complementation assay. Structure-Function relationships. SAR and QSAR: descriptors and equations. Rational design of new drugs and structure-based drug design. Some examples of rational design. Design of anti-interaction drugs. Tools for attenuation of HERG polypharmacology.

Lesson 10. Discovery and development of antimicrobial drugs. Specificities and problems when developing new antimicrobial drugs. Pharmacoeconomics of antimicrobials. Main pharmaceutical targets. Strategies for the development of antimicrobials: specialized libraries, rational design, "iChips", silent operons, polyketides, antimicrobial peptides synthesized by ribosomaland non-ribosomal pathways, virulence factors and quorum sensing. New strategies for phage based therapies.

Lesson 11. Biopharmaceuticals of first and second generation. Biopharmaceuticals against a pharmacological target: monoclonalantibodies, peptides and antisense and interference RNAs. Biopharmaceuticals in replacement therapies: hormones, growth factors, cytokines and interleukins, regulatory microRNAs. Humanization, industrial production and stabilization of monoclonal antibodies. Drug-Antibody conjugates. Main monoclonal antibodies used in therapy. Design and modifications of interference RNAs.

Methodology

*The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

The course consists of theoretical lectures and laboratory practices.

Theoretical lectures:
The teacher will develop the contents of each topic with the support of powerpoint presentations that will be posted on Virtual Campus (Moodle classroom). These presentations constitute the most important piece of the study material and it is strongly recommended that students attend lectures with a printed form of them. The use of specialized bibliography is also encouraged.

Laboratory practices:
Three sessions (4 hours each), in which some basic proteomic techniques, applied to the design of vaccines and drugs, are illustrated and performed. The assistance to the practical sessions is required.

Exceptionally, each student group will be divided into two subgroups (A and B): first day subgroup A (4h); second day subgroup B (4h); third day subgroup A (2h) and subgroup B (2h).

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	12	0.48	1, 2, 4, 7, 9, 8, 13, 10, 11, 12, 17, 14, 15, 16, 6, 5, 18, 3
Theoretical lectures	40	1.6	1, 2, 4, 7, 9, 8, 13, 10, 11, 12, 17, 14, 15, 16, 6, 5, 18, 3
Type: Autonomous			
Study, recommended readings	94	3.76	1, 2, 4, 7, 9, 8, 13, 10, 11, 12, 17, 14, 15, 16, 6, 5, 18, 3

Assessment

*Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

The theoretical contents will be assessed continuously through two partial exams (multiple choice test) corresponding to the Vaccine and Drugs parts of the course, respectively. The weight of each exam on the global score is a 40%. A score equal or greater than 4.0 in the partial exam allows to pass the corresponding part of the subject.

Laboratory practices will be evaluated by means of an individual exam consisting of two or three questions related to the work carried out in the lab (weight 15%), plus the student's attitude and performance during the practical sessions (weight 5%). As described for theory exams, a score equal or greater than 4.0 allows to pass this part of the subject.

Those students who have not passed either theory and practices exams as a result of the continuous evaluation must attend a final exam in order to reassess any of the parts previously scored below 4.0. Moreover, the access to the final exam will only be allowed to the students who have previously been evaluated in a set of activities whose weight equals to a minimum of two thirds of the total grade of the subject.

On the other hand, those students who have passed the subject per course as a result of the continuous evaluation can also go to the final exam to improve their grades in any of the previous exams. In this case, the score obtained in the former exam will be preserved if greater.

The students will obtain the qualification of "Not Evaluable" if the number of their assessment activities is less than 67% of the programmed ones for the subject.

To pass the course a global score equal or greater than 5.0 must be attained.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory practices exam	20%	2	0.08	1, 2, 4, 7, 9, 8, 13, 10, 11, 12, 17, 14, 15, 16, 6, 5, 18, 3
Partial Exam 1 (part: Vaccines)	40%	1	0.04	1, 2, 4, 7, 9, 8, 13, 10, 11, 12, 17, 14, 15, 16, 6, 5, 18, 3
Partial Exam 2 (part: Drugs)	40%	1	0.04	1, 2, 4, 7, 9, 8, 13, 10, 11, 12, 17, 14, 15, 16, 6, 5, 18, 3

Bibliography

- "Plotkin's Vaccines". 7th Ed. S. A. Plotkin, W. A. Orenstein, P. A. Offit, K. M. Edwards. Elsevier, 2018.
- "Vaccine delivery technology: Methods and Protocols" (Methods in Molecular Biology, vol. 2183). B. A. Pfeifer & A. Hill editors. Humana Press, 2021.
- "Vaccine Design". F. Bagnoli & R. Rappuoli eds. Caister Academic Press, 2015.
- "Basic Principles of Drug Discovery and Development". 2nd Ed. B. E. Blass. Academic Press, 2021.
- "Textbook of Drug Design and Discovery". 5th Ed. K. Stromgaard, P. Krogsgaard-Larsen, U Madsen editors. CRC Press, 2018.
- "Drugs: From Discovery to Approval". 3rd Ed. N. G. Rick. Wiley Blackwell, 2015.
- "A Practical Guide to Rational Drug Design". 1st Ed. S. Hongmao. Woodhead Publishing, 2015.

Software

No specific software is used in the subject's teaching.