Universitat Autònoma de Barcelona

2020/2021

Vaccines and Drugs

Code: 100900
ECTS Credits: 6

Degree	Type	Year	Semester
2500252 Biochemistry	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

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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 general laboratory security and operational standards and specific regulations for the manipulation of different biological systems.
- Apply the legal and ethical principles that govern the development and application of molecular life sciences.
- Apply the principal techniques used in biological systems: methods of separation and characterisation of biomolecules, cell cultures, DNA and recombinant protein techniques, immunological techniques, microscopy techniques, etc.
- Be able to self-evaluate.
- Clearly perceive current advances and possible future developments by reviewing scientific and technical literature in the area of biochemistry and molecular biology.
- Collaborate with other work colleagues.
- Combine research and and the generation of knowledge with problem-solving in one's own field, showing sensibility to ethical and social questions.
- Describe intercellular and intracellular communication systems that regulate the proliferation, differentiation, development and function of animal and plant tissues and organs.
- Design experiments and understand the limitations of experimental approaches.
- Interpret experimental results and identify consistent and inconsistent elements.
- Manage information and the organisation and planning of work.
- Read specialised texts both in English and ones own language.
- Stay abreast of new knowledge of the structure, organisation, expression, regulation and evolution of genes in living beings.
- Take responsibility for one's own learning after receiving general instructions.
- Think in an integrated manner and approach problems from different perspectives.
- Use ICT for communication, information searching, data processing and calculations.
- Write an article on a scientific or technical topic aimed at the general public.

Learning Outcomes

1. Apply general laboratory security and operational standards and specific regulations for the manipulation of different biological systems.
2. Apply pathogenomic information in order to identify target genes and proteins for the design of vaccines and antiviral compounds and for diagnosis.
3. Be able to self-evaluate.
4. Collaborate with other work colleagues.
5. Combine research and and the generation of knowledge with problem-solving in one's own field, showing sensibility to ethical and social questions.
6. Describe the criteria and general requirements for applying for patents and registration of vaccines and drugs.
7. Describe the principal biochemical techniques for studying the interaction between ligands and receptors and the molecular action mechanisms of drugs.
8. Design experiments and understand the limitations of experimental approaches.
9. Exemplify action mechanisms of drugs that act on membrane receptors, signal transduction, ion channels, transport systems, enzymes and gene expression.
10. Interpret experimental results and identify consistent and inconsistent elements.
11. Manage information and the organisation and planning of work.
12. Read specialised texts both in English and ones own language.
13. Take responsibility for one's own learning after receiving general instructions.
14. Think in an integrated manner and approach problems from different perspectives.
15. Use ICT for communication, information searching, data processing and calculations.
16. Use bioinformatic databases, algorithms and programmes to identify targets for therapy, vaccination and diagnosis.
17. Use the principal biochemical techniques for identifying, cloning and expressing target genes and proteins used in the design of vaccines and biodrugs.
18. Write an article on a scientific or technical topic aimed at the general public.

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. R_0-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 ribosomal and 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).

Activities

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

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, 7, 8, 11, 10
Partial Exam 1 (part: Vaccines)	40%	1	0.04	15, 2, 1, 4, 6, 7, 8, 18, 9, 11, 10, 12, 14, 5, 13, 3, 16, 17
Partial Exam 2 (part: Drugs)	40%	1	0.04	15, 2, 1, 6, 7, 8, 9, 11, 10, 12, 14, 16, 17

Bibliography

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