Course Specification

(Postgraduate Programs)

Course Title:	**Vaccine Development**
Course Code:	**BIO-6032**
Program:	**Master of Science in Applied Biology (Industrial and Environmental Biotechnology)**
Department:	**Biology**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**1**
Last Revision Date:	*Pick Revision Date.*

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A. General information about the course:

1. Course Identification:

1. Credit hours: 2 (Lecture 2 + lab 0)

2. Course type

A.	☐University	☐College	☐Department	☒ Track	
B.	☐ Required		☒ Elective		

3. Level/year at which this course is offered: (Undetermined level)

4. Course general Description:

In this course, as an introduction, we will explore why vaccination is important for yourself, your family and community.
This course delves into the critical biological tools and techniques used to develop vaccines manufacturing.
Unravel the secrets of how vaccines work and their impact on herd immunity, who cannot have vaccines and side effects of vaccination.
discovering what's in a vaccine (ingredients), how vaccine's safety is thoroughly tested using bioassays (testing on living organisms) before pass for approval.
Master the art of the vaccines manufacturing: Learn about the diverse approaches of vaccine types (Pathogen-Based Vaccines, Viral-Vector-Based Vaccines, Nucleic Acid–Based Vaccines, Protein-Based Vaccines), and explore model test systems like bacteria, algae, and invertebrates. Learn about the advances in genetic engineering in the improvements of vaccine design and strategies e.g. recombinant subunit vaccines as an emerging technology to prevent diseases spreading.
Dive into the realm of antigen display systems such as VLPs or those designed by nanotechnology as well as the innate RNA interference (RNAi) mechanism and their role in improving the efficacy of subunit vaccines. Shedding light on platforms used in production of recombinant vaccines from the first hosts such as *Escherichia coli* and *Saccharomyces cerevisiae*, to insect or mammalian cells.
Learn about the challenges and hurdles that are facing vaccines commercialization and seeking for saving a low-cost platform for vaccines production. Addressing some infectious diseases that still do not have a treatment and may create possible future pandemics such as COVID-19 induced by the SARS-CoV-2.
By the end of this course, you will be equipped to:
Apply biomonitoring tools and techniques used to produce Infectious-disease vaccines.
Interpret and communicate pathogen-derived future pandemics for informed decision-making.
Contribute to the development and implementation of strategies for society health protection and risk mitigation.
This course is ideal for anyone interested in medical science, biology, molecular biology, drug delivery and public health.

5. Pre-requirements for this course (if any):

6. Co-requisites for this course (if any):

7. Course Main Objective(s):

1-Understand the importance of vaccines and its impacts on human public health, and define the effect of vaccine design, delivery, and dynamics on its therapeutic effect.

2-Master the concepts and applications of techniques used in production of Infectious-disease vaccines at the national and international levels.

3- Recognize types of recombinant vaccines using various hosts such as *Escherichia coli* and *Saccharomyces cerevisiae*, to insect or mammalian cells.

3-Gain in-depth knowledge of new different strategies for vaccines developments such as Pathogen-Based Vaccines, Viral-Vector-Based Vaccines, Nucleic Acid–Based Vaccines, Protein-Based Vaccines).

4- Discover the potential and limitations of nanotechnology and RNAi applications in development of front-line therapies against viruses and pathogen-derived diseases.

5-Analyze the specific challenges and approaches for vaccines commercialization and seeking for saving a low-cost platform for possible future pandemics.

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	-	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning	-	-
4	Distance learning	-	-

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	-
3.	**Field**	-
4.	**Tutorial**	-
5.	**Others (specify) .....**	
	Total	30

B. Course Learning Outcomes, Teaching Strategies, Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Vaccines Essentials:** Define and explain the key concepts of vaccines. Identify different types of pathogen-derived diseases and history of vaccines production. Analyze the mode of action of Infectious-disease vaccines in living organisms. Assess the potential health impacts of vaccines on individuals and community. Evaluate the regulatory frameworks and policies		Two credits weekly lectures	-Quizzes -Presentations -Assignments -written exams

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	pertaining to vaccines development and infectious-disease risk management.			
1.2	**Vaccines properties and effectiveness:** Explain the principles and applications of vaccines for the combating infectious pathogens. Define the effect of vaccine design, delivery, and dynamics on its therapeutic effect. Differentiate between different types of pathogen-based vaccines as drug and the routes of administration. Describe the components and implementation of different types of vaccines. Define new different strategies for vaccines developments such as pathogen-based vaccines, viral-vector-based vaccines, nucleic acid–based vaccines, protein-based vaccines). Evaluate the strengths and limitations of nanotechnology and RNAi applications in development of vaccines		Two credits weekly lectures	Quizzes -Presentations -Assignments -written exams
1.3	**Key Aspects in Vaccine Design:** Define the key aspects of vaccine design and their effectiveness in the target populations. The use of animal		Two credits weekly lectures	Quizzes -Presentations -Assignments -written exams

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	models that accurately mimic human disease. Explain the emerging technologies in nonviral vaccine development. Recognize and comprehend the Virus-Like Particle and Nanoparticle Subunit Vaccines and DNA and RNA Vaccines			
1.4	**New Strategies for Vaccine Development** Identify different technologies used in vaccines manufacturing (Pathogen-Based Vaccines, Viral-Vector-Based Vaccines and Nucleic Acid–Based Vaccines) Evaluate the pros and cons of each		Two credits weekly lectures	Quizzes -Presentations -Assignments -written exams
1.5	**Specific Technologies:** Recognize new technologies such Nanotechnology applied to subunit vaccines (VLPs and Small Subviral Particles, Ferritin Cages, Vault Particles, Encapsulins, In Silico Designed Nanoparticles and innate RNA interference (RNAi) mechanisms. Explain the traditional platforms for protein vaccine manufacturing (Bacteria (E. coli, Yeast, Insect cell, Mammalian Cells) and recognizing types of recombinant vaccines using various hosts		Two credits weekly lectures	Quizzes -Presentations -Assignments -written exams
2.0	Skills			

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.1	**Vaccines Design and Implementation:** Design and implement appropriate vaccine strategy for addressing some infectious diseases. Select and adapt suitable bioassays vaccine's delivery components to key immune cells and lymphoid tissues. Perform basic bioassay procedures and laboratory techniques for vaccines effectiveness. Maintain accurate records and document biomonitoring activities as per scientific standards.		-Two credits weekly lectures -Tutorials	-Presentations -Assignments -written exams
2.2	**Data Analysis and Interpretation:** Analyze bioassay and results using appropriate statistical tools and software. Interpreting bioassay results in the context of established drug delivery and immunization knowledge and relevant published data. Identify and analyze potential confounding factors and limitations in biomonitoring data. Draw conclusions and inferences from biomonitoring studies to inform health risk assessment and management decisions.		-Two credits weekly lectures -Tutorials	-Presentations -Assignments -written exams

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.3	**Critical Thinking and Problem-Solving:** Critically evaluate existing knowledge and apply it to address future pandemic challenges. Develop creative solutions for Improving vaccines development strategies and interpretation of data. Recognize ethical considerations and potential biases in drug delivery research and data analysis. Contribute to the advancement of bioassay techniques and technologies for production of effective vaccines and evaluating risk assessment		-Two credits weekly lectures -Tutorials	-Presentations -Reports
2.4	**Continuous Learning and Professional Development:** Stay updated with the latest advancements in vaccines emerging technologies, bioassay techniques, and vaccines design, delivery, and dynamics. Seek out opportunities for professional development and collaboration with other professionals in biotechnology engineering. Adapt and expand student's skillset to address emerging universal challenges and contribute to innovative solutions			

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
3.0	Values, autonomy, and responsibility			
3.1	**Values** Biotechnological Stewardship: Develop an understanding of the intrinsic value of vaccines and a commitment to their development for effective therapeutic effect. Sustainability: Integrate principles of sustainability into bioassay practices, considering long-term consequences and challenges provoked by future pandemics. Precautionary Principle: Apply the precautionary principle when assessing potential contagious pathogens, favoring caution and protective measures even in the face of uncertainty. Social Justice: Recognize the unequal distribution of pathogenicity risks and advocate for equitable access to safe environments for all communities.		Group discussions	-Presentations -Reports
3.2	**Autonomy**: Critical Thinking and Problem-Solving: Foster independent thinking skills for evaluating bioassay data, interpreting results, and proposing innovative solutions to health risk challenges. Scientific Integrity: Uphold the principles of scientific integrity by		Group discussions	-Presentations -Reports

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	conducting research with honesty, transparency, and accountability. Lifelong Learning: Develop a passion for continuous learning and self-directed research to stay current with advances in biotechnological knowledge and techniques. Professional Communication: Hone effective communication skills to share complex infectious disease control and drug delivery data and analyses with diverse audiences, influencing informed decision-making.,			
3.3	**Responsibility**: Data Quality and Ethics: Ensure adherence to ethical research practices and maintain lofty standards of data quality control throughout the bioassay process. Risk Communication: Effectively communicate risks and uncertainties associated with infectious diseases control to stakeholders, empowering them to make informed decisions about their health and environment. Policy Advocacy: Engage in responsible advocacy for effective biotechnological and drug delivery policies and regulations based on sound scientific evidence, promoting informed risk management strategies.		Group discussions	-Presentations -Reports

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	Professional Accountability: Recognize and take responsibility for the potential impacts of biomonitoring activities on the human health and surrounding communities.			

C. Course Content:

No	List of Topics	Contact Hours
1	Introduction on vaccines and its impacts on public health, principles of structure-based vaccine design, mode of action of vaccines and their impact on herd immunity, who cannot have vaccines and side effects of vaccination.	3
2	Key Aspects in vaccine design, delivery, and dynamics and their effects on therapeutic efficiency.	3
3	Novel strategies for vaccine development (Pathogen-Based Vaccines, Viral-Vector-Based Vaccines and Nucleic Acid–Based Vaccines)	3
4	Nanotechnology applied to subunit vaccines (VLPs and Small Subviral Particles, Ferritin Cages, Vault Particles, Encapsulins, In Silico Designed Nanoparticles and innate RNA interference (RNAi) mechanisms	3
5	Traditional platforms for protein vaccine manufacturing (Bacteria (*E. coli*, Yeast, Insect cell, Mammalian Cells) and recognizing types of recombinant vaccines using various hosts	3
6	Alternative platforms for protein vaccine manufacturing (Non–E. coli Bacterial Systems, New Approaches in Yeast Platform, Transgenic Animals, Insects, Plant-Based Systems and Microalgae.	3
7	Recent applications of structure-based vaccine-design principles (e.g. SARS-CoV-2, Influenza virus, Nipah virus, Human metapneumovirus F, Ebola, and Marburg viruses and RNAi based vaccines for covid-19	3
8	Challenges and approaches of vaccines commercialization and assessment of vaccines safety	3

Total	30

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Midterm exam-1**	5th week	20%
2.	**Midterm exam-2**	10th week	20%
3.	**Assignments, presentations, attendance, data search, participation**	Throughout the course duration	20%
4.	**Final exam**	16th week	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	1- Arpagaus, C. (2023). *Spray drying of vaccines: from laboratory research to industrial applications*. Springer Nature. 2- Mao, H. H., & Chao, S. (2020). Advances in vaccines. *Current Applications of Pharmaceutical Biotechnology*, 155-188. 3- Orenstein, W., Offit, P. A., Edwards, K. M., & Plotkin, S. A. (2017). *Vaccines E-Book*. Elsevier Health Sciences. 4- Giese, M. (2013). *Molecular Vaccines*. Springer.
Supportive References	
Electronic Materials	Tizard, I. R. (2019). *Vaccines for Veterinarians E-Book*. Elsevier Health Sciences.
Other Learning Materials	

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**Classroom**

Items	Resources
Technology equipment (Projector, smart board, software)	**Projector, smart board**
Other equipment (Depending on the nature of the specialty)	

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Indirect
Effectiveness of students assessment	Faculty	Direct
Quality of learning resources	Faculty	Direct
The extent to which CLOs have been achieved	Faculty	Direct
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	**BIOLOGY DEPARTMENT COUNCIL**
REFERENCE NO.	**23**
DATE	**23/8/1445**