Course Specification

(Postgraduate Programs)

عبدالملك بن عبدالعزيز بن عبدالله رحيتي الناصر

Course Title: Bioinformatics
Course Code: BIO-6230
Program: Master of Science in Applied Biology (Industrial and Environmental Biotechnology & Sustainability)
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: 3 (Lecture 2+ Lab 2)				
2. Course type				
A.	☐University	☐College	☐Department	☒ Track
B.	☒ Required		☐ Elective	
3. Level/year at which this course is offered: (Level 2 / first year)				

4. Course General Description:

This postgraduate course provides the candidates with a comprehensive understanding of the theoretical foundations, practical skills, and applications of bioinformatics in the field of molecular biology and genomics. Through a combination of lectures, hands-on exercises, and projects, students will acquire various knowledge and skills. Understand the fundamental principles of bioinformatics and its role in biological research. Explore the relationship between molecular biology and computational methods. Master sequence alignment techniques for DNA, RNA, and protein sequences. Learn to identify homologous genes and analyze evolutionary relationships. Gain proficiency in predicting and analyzing protein structures. Understand the relationship between protein structure and function. Explore tools and methods for analyzing gene expression data. Understand the principles of functional annotation and pathway analysis. Learn to handle and analyze high-throughput sequencing data. Acquire skills in variant calling and genomic variant interpretation. Explore widely used bioinformatics databases (e.g., NCBI, Ensembl) for retrieving biological information. Learn to query and extract relevant data from diverse databases. Gain hands-on experience with popular bioinformatics software and tools. Understand the functionalities of tools used in sequence analysis, structural bioinformatics, and genomics. Learn to critically evaluate bioinformatics results and troubleshoot analysis issues. Apply problem-solving skills to address complex biological questions through computational methods.

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

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

7. Course Main Objective(s):

The objective of this course is to provide the students with a with a comprehensive understanding of the theoretical foundations, practical skills, and applications of bioinformatics in the field of molecular biology and genomics. Through a combination of lectures, hands-on exercises, and projects, students will acquire various knowledge and skills.

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**	30
3.	**Field**	-
4.	**Tutorial**	-
5.	**Others (specify) ……**	
	Total	60

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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	**Understand the basic principles and concepts of bioinformatics.**		Two credits weekly lectures	-Quizzes -Presentations -Assignments -written exams
1.2	**Explore protein structure and function through structural bioinformatics.**		Two credits weekly lectures	Quizzes -Presentations -Assignments -written exams
1.3	**Gain hands-on experience in utilizing bioinformatics software and databases**		Two credits weekly lectures	Quizzes -Presentations -Assignments -written exams
2.0	Skills			
2.1	**Analyze biological sequences using computational tools.**		-Two credits weekly lectures -Tutorials	-Presentations -Assignments -written exams
2.2	**Apply tools for functional genomics, including gene expression analysis.**		-Two credits weekly lectures -Tutorials	-Presentations -Assignments -written exams
2.3	**Critically evaluate and interpret bioinformatics results**		-Two credits weekly lectures -Tutorials	-Presentations -Reports
3.0	Values, autonomy, and responsibility			
3.1	**Show independence and responsibility and cooperate effectively in a team to carry out research work**		Group discussions	-Presentations -Reports
3.2	**Discuss the scientific issues and present research results**		Group discussions	-Presentations -Reports

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	via oral presentations and in written format.			

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C. Course Content:

No	List of Topics	Contact Hours
1.	**Fundamental principles of Bioinformatics:** • Definition and scope of bioinformatics • Historical development and milestones • Overview of bioinformatics applications in various biological fields • Introduction to databases and bioinformatics resources (e.g., NCBI, Ensembl)	4
2.	**Sequence analysis:** • Basics of biological sequences (DNA, RNA, proteins) • Sequence alignment algorithms (pairwise and multiple sequence alignment) • Database searching and similarity analysis (BLAST, FASTA) • Evolutionary analysis using sequence data	4
3.	**Structural Bioinformatics** • Protein structure basics • Predicting protein structures (homology modeling, ab initio methods) • Structure visualization and analysis tools (PyMOL, Swiss-PdbViewer) • Relationship between protein structure and function	4
4.	**Functional Genomics** •Introduction to functional genomics •Gene expression analysis (microarrays, RNA-seq) •Pathway and functional enrichment analysis •Functional annotation of genes and gene products	4
5.	**Genomic Data Analysis** • Introduction to high-throughput sequencing technologies • Handling and preprocessing of next-generation sequencing data • Variant calling and interpretation • Genomic data visualization tools (e.g., IGV)	4
6.	**Bioinformatics Databases and Tools:** • Exploration of popular bioinformatics databases (NCBI, Ensembl, UniProt)	4

	• Use of bioinformatics software for data analysis (BioPython, Bioconductor) • Hands-on exercises with data retrieval and manipulation	
7.	**Advanced Topics** • Network biology and systems biology • Personalized medicine and pharmacogenomics • Synthetic biology and gene editing technologies • Emerging trends and future directions in bioinformatics	4
8	**Research Project** • Formulation of a bioinformatics research project • Data collection, analysis, and interpretation • Project presentation and discussion	2
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	15%
2.	**Midterm exam-2**	10th week	15%
3.	**Assignments, presentations, attendance, data search, participation**	Throughout the course duration	10%
	Final lab exam	15th week	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	* Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. * Compeau, P., & Pevzner, P. (2014). Bioinformatics Algorithms: An Active Learning Approach. Active Learning Publishers. * Lesk, A. M. (2017). Introduction to Bioinformatics (4th ed.). Oxford University Press.

	Wünschiers, R. (2013). Computational biology: A practical introduction to biodata processing and analysis with Linux, MySQL, and R (Second edition). Springer.
Supportive References	• **NCBI Bookshelf:** Offers a variety of free online books and documents on bioinformatics and related topics. (https://www.ncbi.nlm.nih.gov/books/) • **Bioconductor Documentation:** Essential for those working with R in bioinformatics. (https://www.bioconductor.org/help/documentation/) • **Rosetta Code - Bioinformatics Category:** Provides code snippets in various programming languages for common bioinformatics tasks. (https://rosettacode.org/wiki/Category:Bioinformatics)
Electronic Materials	
Other Learning Materials	

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**Classroom**
Technology equipment (Projector, smart board, software)	**Projector, smart board**
Other equipment (Depending on the nature of the specialty)	

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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		

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

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

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

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