JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

Ph.D.-I Semester (BT&BI)

COURSE CODE (CREDITS): 18P1WGE101 (3) MAX. MARKS: 25

COURSE NAME: Research Methodologies Incl. Quantitative methods and Computer Applications

COURSE INSTRUCTORS: Dr. Gopal Singh Bisht MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*
(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

Q.No	Question	Marks
Q1	Plant viral infections are a major cause of agricultural losses worldwide, reducing crop yield, affecting global food supply, and increasing production costs. Farmers often fail to detect viral infections early because conventional diagnostic methods—such as ELISA or PCR—require specialized equipment, trained personnel, and centralized laboratories. As a result, infected plants remain in the field for prolonged periods, facilitating viral spread and economic loss. A research team led by Dr. Jaikishan, a biotechnology faculty member at an agricultural university, plans to develop a CRISPR-Cas12a–based field-deployable diagnostic assay for rapid detection of Tomato Leaf Curl Virus (ToLCV), a major threat to tomato crops in India. The proposed assay aims to deliver results within 30 minutes using minimal equipment, enabling early intervention by farmers. The problem statement in proposal highlights two gaps: 1. Current detection methods are accurate but not feasible at the field level. 2. CRISPR-based diagnostics have shown promise for human pathogens but are underexplored for plant viruses in rural agricultural settings. To justify the study, the team reviews existing diagnostic technologies such as SHERLOCK, DETECTR, and loop-mediated isothermal amplification (LAMP). They find that combining LAMP for amplification with CRISPR-Cas12a for sequence-specific detection could provide high sensitivity and specificity without expensive machines. Based on this, Dr. Jaikishan formulates three research questions: 1) Can a CRISPR-Cas12a detection system be optimized to identify ToLCV with high sensitivity? 2) What combination of guide RNA and reaction conditions yields the fastest and most reliable detection? 3) How does the performance of the CRISPR assay compare to conventional PCR under field-simulated conditions? The proposed methodology includes: ➢ Designing guide RNAs targeting conserved regions of ToLCV. ➢ Running LAMP pre-amplification followed by CRISPR-Cas12a detection with a fluorescent reporter. ➢ Validating the assay using infected and healthy plant samples collected from local farms. ➢ Comparing limit of detection, speed, and accuracy with existing PCR assays. Ethical and biosafety considerations include safe handling of plant viral samples, proper disposal of nucleic acids, and avoiding misuse of CRISPR components.	

	In the expected outcomes, the team predicts that the CRISPR-LAMP assay will detect ToLCV at very low viral loads, require less than 30 minutes per test, and perform effectively in outdoor temperature ranges. If successful, the assay could be adapted for other plant viruses, ultimately contributing to agricultural sustainability and food security. The university's internal review committee will evaluate the proposal based on scientific merit, feasibility, innovation, and potential agricultural impact. The case highlights key components of a biotechnology research proposal: identifying a gap, grounding the work in current literature, designing testable research questions, and outlining clear methods. a) Analyze the main weaknesses in current plant virus detection methods that justify Dr. Jaikishan's proposal. b) Evaluate whether CRISPR-Cas12a combined with LAMP is an appropriate methodological choice for this study. c) Propose an improved research question that deepens the scope of the study. d) Design an additional experimental step that would strengthen the proposal.	[4] [4] [4] [5]
Q2	Answer the following questions. a) Analyze how a well-defined research hypothesis influences the selection of research design, data collection methods, and statistical tools in an experimental study. b) A PHD student discovers that a senior researcher in their laboratory has selectively excluded data points that contradict the expected hypothesis in an upcoming publication. Evaluate the ethical, scientific, and institutional implications of this action, and justify what the student's most appropriate course of action should be.	[4] [4]