KURUKSHETRA UNIVERSITY KURUKSHETRA

(Established by the State Legislature Act-XII of 1956)
('A^{++}' Grade, NAAC Accredited)

Syllabus of Examination
for
Under-Graduate Programme

Subject: Genetics (Scheme – A)
Semesters III to IV

With Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020 w.e.f. 2023-24 (in phased manner)

PLOs for Life Sciences

PLOs	UG Certificate in Life Sciences
After the completion of UG certificate in Life Sciences, the student should be able to:	
PLO_1: Knowledge and Understanding	· Demonstrate the knowledge of basic principles, concepts, facts and broad linkage of chosen subjects of Life sciences.
PLO_2: Skills And creativity	· Selecting and using relevant methods, tools, and materials to assess the appropriateness of approaches for solving problems associated with the chosen subjects of Life sciences.
PLO_3: Application of knowledge and Skills	· Apply the acquired operational or theoretical knowledge, and a range of practical skills to select and use basic methods, tools, materials, and information to generate solutions to specific problems relating to the chosen subjects of Life sciences.
PLO_4: Critical thinking	· Listen carefully, read texts, make judgments and make decisions based on analysis of data and evidence.
PLO_5: Ethics	· Put forward convincing arguments to respond to the ethical and moral issues associated with the chosen subjects, practice ethical and moral values in one's life.
PLO_6: Communication	· Express scientific thoughts and ideas effectively in writing and orally and communicate on scientific activities with others using appropriate media.
PLO_7:Lifelong Learning	· Acquire knowledge and skills including learning 'How to learn' that are necessary for participating in learning activities throughout life.
PLO_8: Environmental Awareness	· Demonstrate knowledge of effects of environmental degradation, climate change and pollution, effective waste management.
PLO_9:Digital Literacy	· To use ICT in a variety of learning and work situations.

PLOs	UG Diploma in Life Sciences
After the completion of UG Diploma in Life Sciences, the student should be able to:	
PLO_1: Knowledge and Understanding	· Demonstrate the deeper knowledge and understanding of principles, concepts, facts and broad linkage of chosen subjects of Life sciences.
PLO_2: Skills And creativity	· Selecting and using relevant methods, tools, and materials to assess the appropriateness of approaches from a range of sources for solving complex problems associated with the chosen subjects of Life sciences.
PLO_3: Application of knowledge and Skills	· Apply the acquired operational or theoretical knowledge, and a range of practical skills to select and use appropriate methods, tools, materials, and information to generate solutions to specific problems relating to the chosen subjects of Life sciences.
PLO_4: Critical thinking	· Listen carefully, read texts, make judgments and make decisions based on analysis of data and evidence, present complex information in a clear, scientific and concise manner.
PLO_5: Ethics	· Formulate arguments in support of actions to address the ethical and moral issues associated with the chosen subjects, practice ethical and moral values in one's life.

PLO_6: Communication	· Express scientific thoughts and ideas effectively in writing and orally and communicate on scientific activities with others using appropriate media.
PLO_7:Lifelong Learning	· Acquire knowledge and skills including learning 'How to learn' that are necessary for participating in learning activities throughout life.
PLO_8: Environmental Awareness	· Apply knowledge, skills and attitude to mitigate the effects of environmental degradation, climate change and pollution, and effective waste management.
PLO_9:Digital Literacy	· To use ICT in a variety of learning and work situations.

PLOs	**Bachelor Degree in Life Sciences**
After the completion of Bachelor degree in Life Sciences, the student should be able to:	
PLO_1: Knowledge and Understanding	· Demonstrate the comprehensive and specialized knowledge and deep understanding of principles, concepts, and facts about current and emerging issues relevant to chosen subjects of Life sciences.
PLO_2: Skills And creativity	· Selecting and using relevant methods, tools, and materials to assess the appropriateness of approaches for solving specific problems associated with the chosen subjects of Life sciences.
PLO_3: Application of knowledge and Skills	· Apply the acquired operational or theoretical knowledge, and a range of practical skills to analyze quantitative and qualitative data to assess the different approaches to generate solutions to specific problems related to the chosen subjects of Life sciences.
PLO_4: Critical thinking	· Listen carefully, read texts, make judgments and make decisions based on analysis of data and evidence, present complex information in a clear, scientific and concise manner.
PLO_5: Ethics	· Follow ethical practices in all aspects of research and development, including avoiding unethical practices such as fabrication, falsification or misrepresentation of data or committing plagiarism.
PLO_6: Communication	· Able to communicate effectively on complex scientific activities with the scientific community and with society at large, such as, being able to comprehend and write effective scientific reports and design documentation, make effective presentations.
PLO_7:Lifelong Learning	· Acquire knowledge and skills including learning 'How to learn' that are necessary for participating in learning activities throughout life.
PLO_8: Environmental Awareness	· Apply knowledge, skills and attitude to mitigate the effects of environmental degradation, climate change and pollution, effective waste management.
PLO_9:Digital Literacy	· To use ICT in a variety of learning and work situations, appropriate software to analyze the data.
PLO_10:Research Aptitude	· Ask relevant/appropriate questions, identifying, formulating and analyzing the research problems and to draw conclusions from the analysis.

Session: 2024-25			
Part A - Introduction			
Subject	GENETICS		
Semester	III		
Name of the Course	MICROBIAL GENETICS		
Course Code	B23-GEN-301		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-3/MCC-4		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLOs)	After completing the course learner will be able to: 1. Understanding the structure, life cycle, genetic recombination of viruses. 2. Basic understanding of structure, life cycle, genetic recombination of bacteria and gene mapping. 3. Students will acquire knowledge about linkage analysis and gene mapping in Neurospora. 4. Understanding numerous applications of genetic engineering and transgenics. 5. * Students will be able to understand the practical aspects of isolation of microbes, different media preparation for culturing of microbes and linkage detection.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks:** 20 **End Term Exam Marks:** 50	**Time:** 3 hours		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks:** 10 **End Term Exam Marks:** 20	**Time:** 4 hours		

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be a short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise, selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

Unit	Topics	Contact Hours
I	**Genetics of Viruses:** Introduction to viruses, Viral chromosome, Life cycle of Bacteriophage (DNA- Phages), Genetic Recombination in Phages, Mapping of genes in Phages, Genetic Map of Phage Lambda, RNA Phages.	11
II	**Bacterial Genetics:** Bacterial Chromosome, Plasmids, Genetic Recombination in Bacteria: Lederberg experiment on *E.coli*., Mechanism of Genetic Recombination: Conjugation, Transformation and Transduction. Chromosome mapping in Bacteria, Horizontal gene transfer.	12
III	**Linkage and Recombination in *Neurospora*:** Tetrad analysis, Single gene mapping in *Neurospora.* Detection of Linkage between two genes.	11
IV	**Genetic Engineering:** Applications of genetically engineered microbes in agriculture, medicine and industries; GMOs	11
V*	**List of Practicals** 1. To prepare different media for microbial growth (PDA, CDA and NA) 2. To measure cell size using micrometry. 3. To isolate microbes from a given soil sample by serial dilution method.	30

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory** ·Class Participation: 05 ·Seminar/presentation/assignment/quiz/class test etc.: 05 ·Mid-Term Exam: 10 ➢ **Practicum** ·Class Participation: - ·Seminar/Demonstration/Viva-voce/Lab records etc.: 10 ·Mid-Term Exam: NA	Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Gupta R & Mukherji K. G. (2001). Microbial technology, APH Publ. co., New Delhi.
- Pelezar, M.J., Chaing, ECS & Krieg, N.R. (1993). Microbiology, Tata McGrawHill Publ. New Delhi.
- Prescott, L. M., Harley, J.P.& Klein, D.A. (1996). Microbiology Wm. C. Brown Publ. New Delhi
- Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons,Inc. NY.
- Griffiths, A.J.F., J.H.Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An Introduction to genetic analysis. W.H. Freeman and Company, NewYork.
- Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
- Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley & Sons.
- Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steiz and A.M. Weiner, Molecular Biology of Genes. The Benjamin/Cummings Pub. Co. Inc. Tokyo

<table>
<tr><th colspan="4">Session: 2024-25</th></tr>
<tr><th colspan="4">Part A - Introduction</th></tr>
<tr><td>Subject</td><td colspan="3">GENETICS</td></tr>
<tr><td>Semester</td><td colspan="3">III</td></tr>
<tr><td>Name of the Course</td><td colspan="3">TRANSGENICS IN BIOLOGY</td></tr>
<tr><td>Course Code</td><td colspan="3">B23-GEN-302</td></tr>
<tr><td>Course Type:
(CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)</td><td colspan="3">MDC-3</td></tr>
<tr><td>Level of the course (As per Annexure-I</td><td colspan="3">100-199</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">Nil</td></tr>
<tr><td>Course Learning Outcomes (CLOs)</td><td colspan="3">After completing the course learner will be able to:
1. Get an overview of the history of Recombinant DNA Technology.
2. Basic understanding of DNA cloning and Gene transfer methods.
3. Students will acquire knowledge about different methods to identify clones and gene therapy
4. Understanding numerous applications of transgenic plants and animals as well biosafety concerns.

5. * Students will be able to understand the practical aspects of DNA manipulation, cloning vectors, cloning methods and identification of clones.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>1</td><td>3</td></tr>
<tr><td>Contact Hours</td><td>2</td><td>2</td><td>4</td></tr>
<tr><th colspan="4">THEORY</th></tr>
<tr><td colspan="2">Max. Marks: 50
Internal Assessment Marks: 15
End Term Exam Marks: 35</td><td colspan="2">Time: 3 hours</td></tr>
<tr><th colspan="4">PRACTICAL</th></tr>
<tr><td colspan="2">Max. Marks: 25
Internal Assessment Marks: 5
End Term Exam Marks: 20</td><td colspan="2">Time: 4 hours</td></tr>
</table>

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be a short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise, selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

Unit	Topics	Contact Hours
I	Introduction to Transgenics: Historical perspective of Recombinant DNA technology Enzymes for DNA manipulation: restriction endonucleases, DNA ligase, polymerases	8
II	An introduction to DNA cloning techniques. Gene transfer methods: Liposome mediated, electroporation, microinjection and *Agrobacterium* assisted.	7
III	Methods of Clone identification: Colony and plaque hybridization, chromosome walking Transgenic Animals: Transgenic animals, methods of their production and importance. Introduction to Gene therapy	8
IV	Applications of plant transgenic technology in conferring plant resistance against biotic and abiotic stresses. Global status and biosafety of transgenic plants and animals.	7
V*	**List of Practicals** 1. Demonstration and hands-on practice of DNA extraction from plant tissue (e.g., banana or spinach leaves). 2. To purify seed storage proteins. 3. Isolation of DNA from yeast. 4. Isolation of RNA from yeast.	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** ·Class Participation: 04 ·Seminar/presentation/assignment/quiz/class test etc.: 04 ·Mid-Term Exam: 07 ➢ **Practicum** ·Class Participation: - ·Seminar/Demonstration/Viva-voce/Lab records etc.: 05 ·Mid-Term Exam: NA	**End Term Examination:** Theory : 35 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Old, R.W.& Primrose, S.B. (1994). Principles of gene manipulation: An introduction to genetic engineering. Blackwell Scientific Publications.
- Stewart, C.N. (2016). Plant biotechnology and genetics: principles, techniques, and applications. John Wiley & Sons.
- Stewart, C.N. (2016). Plant biotechnology and genetics: principles, techniques, and applications. John Wiley & Sons.
- Brown, T.A. (2016). Gene Cloning and DNA Analysis: An Introduction. John Wiley & Sons.
- Fundamental Molecular Biology; Allison LA; 2007
- Recombinant DNA, Watson *et al*; 5thEd; 2006
- Techniques for Engineering Genes; Curell BR *et al*;2004
- Techniques for Molecular Biology; Tagu D &Moussard C; INRA; 2006
- Gene Cloning and DNA Analysis; 5thEd; Brown TA; 2006
- Analysis of Genes and Genomes; Reece RJ; Wiley; 2004 7) Recombinant DNA and Biotechnology; 2ndEd; Kreuzer H and Massey A;ASM;2006
- Human Genetics and Genomics; Korf BR; 3rdEd; Blackwell; 2007
- Molecular Cloning; 3rd Ed; Sambrook & Russel: Cold Spring Harbour Laboratory press, NY; 2001
- ICRF Handbook of Genome Analysis; Spurr NK, Young BD, Bryant SP;1998

Session: 2024-25			
Part A - Introduction			
Subject	GENETICS		
Semester	IV		
Name of the Course	MOLECULAR GENETICS		
Course Code	B23-GEN-401		
Course Type: (CC/MCC/MDC/CC-M/DSEC/VOC/DSE/PC/AEC/VAC)	CC-4/MCC-6		
Level of the course (As per Annexure-I	200-299		
Pre-requisite for the course (if any)	Nil		
Course Learning Outcomes (CLOs)	After completing the course learner will be able to: 1. Basic understanding of genetic material and transposons. 2. Students will acquire knowledge about the basics of DNA replication and different repair mechanisms. 3. Understanding basic concepts of transcription and translation. 4. Understand gene regulation in prokaryotes and eukaryotes. 5. * Students will be able to understand the practical aspects of isolation of DNA and RNA, gene regulation in prokaryotes.		
Credits	Theory	Practical	
	3	1	4
Contact Hours	3	2	5
THEORY			
Max. Marks: 70 **Internal Assessment Marks:** 20 **End Term Exam Marks:** 50	**Time:** 3 hours		
PRACTICAL			
Max. Marks: 30 **Internal Assessment Marks:** 10 **End Term Exam Marks:** 20	**Time:** 4 hours		

Part B- Contents of the Course

Instructions for Paper- Setter

1. Nine questions will be set in all. All questions will carry equal marks.
2. Question No.1 will be a short answer type covering the entire syllabus and will be compulsory. The remaining eight questions will be set unit wise, selecting two questions from each unit. The candidate will be required to attempt question No. 1 and four more questions selecting one question from each unit.

Unit	Topics	Contact Hours
I	**Genetic Material:** Identification evidence, chemical nature, structure of DNA and RNA, different forms of DNA. **Transposable elements:** Types, Mechanisms of their transposition, Prokaryotic and eukaryotic transposons.	11
II	**DNA Replication:** Models of DNA replication, replication origins, DNA replication in prokaryotes and eukaryotes. **DNA repair mechanism:** Mismatch, Direct, Base-Excision and Nucleotide-Excision repair.	11
III	**Transcription:** Initiation, elongation and termination in prokaryotes and eukaryotes, **Translation:** Initiation, elongation and termination in prokaryotes and eukaryotes.	11
IV	**Regulation of gene expression in prokaryotes:** Operon concept and structure, lac operon, trp operon and their regulation. **Regulation of gene expression in eukaryotes:** Transcriptional level and Post-transcriptional level	12
V*	**List of Practicals** 1. To study meiotic stages in the floral bud of *Allium cepa.* 2. To prepare a standard curve for RNA estimation using the orcinol method. 3. Workout the genetics of a cross from the given F2 harvest. 4. To study the karyotype and draw a karyogram from the given chromosomal picture of *Allium cepa.* 5. To study Hardy Weinberg's law of equilibrium using a given seed mixture representing a sample of population.	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** ·Class Participation: 05 ·Seminar/presentation/assignment/quiz/class test etc.: 05 ·Mid-Term Exam: 10 ➢ **Practicum** ·Class Participation: - ·Seminar/Demonstration/Viva-voce/Lab records etc.: 10 ·Mid-Term Exam: NA	**End Term Examination:** Theory : 50 Practical : 20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Old, R.W., & Primrose, S.B. (1994). Principles of gene manipulation: An introduction to genetic engineering. Blackwell Scientific Publications.
- Stewart, C.N. (2016). Plant biotechnology and genetics: principles, techniques, and applications. John Wiley & Sons.
- Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5thEd.). Garland Publishing Inc., New York.
- Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
- Burns GW and Bottino PJ (1989) The Science of Genetics, Macmillan Publishing Co. New York.
- Clark D (2005) Molecular abiology, Understanding the Genetic Revolution. Elsevier Inc. C. California.
- Gustafron JP (2002) Genomes.Kluwer Academic Plenum Publishers, New York, USA.
- Hartl DL (1999) Genetics Principles and analysis. (4thEd.) Jones and Bartle, Boston.
- Henry RJ (1997) Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK.
- Klug WS and Cunning MR (1996) Essentials of Genetics. Prentice Hall London.
- Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2ndEd.), Jones and Barlett Publishers.
- Lewin B (2005) Genes VIII. Oxford University Press, New York.
- Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6thEd), W.H. Freeman and Company, New York, USA.
- Pierce BA (2012) Genetics- A Conceptual Approach (4thEd.), W.H. Freeman and Company, New York, USA.
- Russell PJ (2006) Genetics (6th Ed.), Addison Wesley Longman, California, USA.
- Snustad P and Simmons MJ (2011), Principles of Genetics. (6thEd.), John Wiley, New York.
- Swanson CP, Mertz T and Young WJ (1981) Cytogenetics- The Chromosome in Division, Inheritance and Evolution (2ndEd.), Englewood Cliffs, Prentice Hall, New Jersey.
- Weaver RF and Hedrick PW (1997). Genetics (3rdEd.) WMC Brown, Chicago.
- Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6thEd.), CSHLP, New York.