Choice Based Credit System (CBCS)

Maharaja Ganga Singh University

B. Sc. BIOTECHNOLOGY (VOCATIONAL) (Semester III to VI) 2024-26

Undergraduate Programme
(Effective from Academic Year 2024-25)

SYLLABUS
SCHEME OF EXAMINATION AND COURSES OF STUDY

Disclaimer: The CBCS syllabus has been approved by the Academic Council on and Board of Management. Any query may kindly be addressed to the concerned Faculty.

Preamble

Considering the curricular reforms as instrumental for desired learning outcomes, Maharaja Ganga Singh University made a rigorous attempt to revise the curriculum of postgraduate and undergraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP". The roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms. The University Grants Commission (UGC) has devised a series of regulations and directives over time with the intention of enhancing the higher education system's quality and enforcing minimum standards in Higher Educational Institutions (HEIs) throughout India. The recent academic reforms suggested by the UGC have contributed to an overarching enhancement of the higher education system.

With NEP-2020 in background, the revised curricula articulate the spirit of the Policy by emphasizing upon- integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points, integration of extracurricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical, vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. The University has also developed consensus on adoption of Blended Learning with component of online teaching and face to face classes for each programme.

Choice Based Credit System (CBCS)

The Choice Based Credit System (CBCS), a part of academic reform process to enhance quality of education and facilitate transferability of students from one University/institution to another at the national and international level, provides substantive autonomy to teachers to formulate their own curricula and enable them to introduce innovations in teaching and learning process and upgrade overall quality of higher education. The CBCS provides scope for Comprehensive and Continuous Evaluation (CCE) of students and encourages them to learn. The CBCS provides a cafeteria type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.

The grading system is widely regarded as an improvement over the traditional marks system, which is why leading institutions in India and abroad have adopted it. Thus, there's a strong rationale for establishing a consistent grading system. This would facilitate seamless student mobility among institutions within the country and abroad, while also allowing prospective employers to accurately assess students' performances. To achieve the desired standardization in the grading system and the method for calculating the Cumulative Grade Point Average (CGPA) based on students' examination results, the UGC has devised these comprehensive guidelines.

B.Sc. BIOTECHNOLOGY (VOCATIONAL)

Applicable to students admitted during the academic year 2024 onwards

SEMESTER III

SCHEME OF EXAMINATION

Semester-III												
Paper Code	**Paper Name**	**Code**	**L**	**T**	**P**	**Total Credits**		**Maximum Marks**			****Minimum Passing Marks (%)**	**Hours/ week**
								Internal Marks	External Marks	**Total marks**		
VBT5DCCT32	Microbiology and Immunology	DCC	3	1	0	4	6	30	80	150	36	06
VBT5DCCP32	Practical	DCC	0	0	2	2			40		36	04
Total Credits						**06**						10
Total Marks								150				

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. For Internal Evaluation of 30 Marks (20 Marks theory paper, 10 Marks practical paper} (Internal assessment include assignment/seminar, Logical thinking/application of knowledge and skills in internal assessment).

Pattern of Paper and Content

There shall be three (3) sections in the question paper. A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each Unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will be prepared such that questions i through v are multiple-choice questions, while questions vi through x will be fill-in-the-blank questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

Microbiology and Immunology VBT5DCCT32 (Theory)	
Unit – 1	Introduction to microbiology: History and Scope of microbiology. Microbial Diversity: Prokaryotic and Eukaryotic microbial cell. General features and Classification of Archaea, Bacteria, Fungi, Algae, Protozoa, Viruses and Prions. Ultra structure of microbes (mycoplasma, viruses, bacteria and cyanobacteria).
Unit – 2	Microbial Nutrition: Classification of microorganisms based on their nutritional types, Preparation of media, types of media, culturing of microbes, Microbial growth curve, Effect of biotic and abiotic factors on the growth of organisms. Microbial Control: Sterilization, disinfection, antisepsis, fumigation. Physical control: Temperature (moist heat, autoclave, dry heat, hot air oven and incinerators),

	desiccation, osmotic pressure, radiation, filtration. Chemical control: Antiseptics and disinfectants (halogens, alcohol, gaseous sterilization)
Unit – 3	Some common human diseases: Influenza, Herpes, Pox, AIDS, SAARS, Dengue and Meningitis: causes, symptoms, prevention and control. Role of microbes in: Agriculture: Nitrogen fixation, phosphate stabilization, pest control; Medical: pharmaceutical industry including vaccines and antibiotics; Environment: waste treatment and bio-geochemical cycles.
Unit – 4	Immunity: Types of immunity, nature of antigens and antibodies, antigen antibody reactions: Complement and lytic reaction, precipitation, agglutination reaction and neutralizing reaction. Immunity: Types of immunity, nature of antigens and antibodies, antigen antibody reactions: Complement and lytic reaction, precipitation, agglutination reaction and neutralizing reaction.
Unit – 5	Cells of immune system (A brief account): B-lymphocytes, T-lymphocytes, macrophages and natural killers. Measurement of antigens and antibodies: Radio Immuno Assay (RIA), Enzyme Linked Immuno Sorbant Assay (ELISA), fluorescent antibody technique, hypersensitivity.

Microbiology and Immunology VBT5DCCP32 (Practical)

List of Practical Exercises

1. General instructions for microbiology laboratory.
2. Study of construction, care and use of a compound microscope.
3. To demonstrate the importance of concept of asepsis and methods of sterilization.
4. Isolation of bacteria from the soil sample in Nutrient broth
5. To become familiar with preparation of bacterial smears for the microscopic visualization of bacteria.
6. To perform the monochrome staining for the given bacterial samples (*E. coli, Bacillus cereus, Staphylococcus aureus*) to compare morphological shapes and arrangement of bacterial cells using crystal violet stain.
7. To perform the Gram staining procedure for the given bacterial samples (*E. coli, Lactobacillus spp,. Rhizobium*) and to differentiate two groups of bacteria gram-positive and gram-negative.
8. Extraction of antigens from microbes
9. Raising polyclonal antibodies
10. Purification of antibodies
11. Conjugation and labeling of antibodies

12. Enzyme linked immunoassay

13. Slide & Tube Agglutination Reaction

14. Antigen-antibody reactions

15. Diagnosis of an infection diseases by an immunoassay

SCHEME OF PRACTICAL EXAMINATION
Practical Based on Theory Paper

Time: 4hrs Maximum Marks: 40 Minimum Marks: 13

Combined Practical	**Marks**
1. Exercise of Microbiology	
Major	[06]
Minor	[04]
2. Exercise of Immunology	
Major	[06]
Minor	[04]
3. Spots (Four)	[08]
4. Viva-voce	[05]
5. Practical Record	[07]

References:

- Microbiology, R. C. Dubey, D. K. Maheshwari, S. Chand & Company Ltd.
- Microbiology, P. D. Sharma, Rastogi Publications
- Textbook of Microbiology, Ananthanarayan R and Paniker CKJ. 7th edition (edited by Paniker CKJ). University Press Publication.
- Medical Microbiology. 24th edition Brooks GF, Carroll KC, Butel JS and Morse SA. Jawetz, Melnick and Adelberg's. McGraw Hill Publication.
- Prescott, Harley and Klein's Microbiology. 7th edition. Willey JM, Sherwood LM, and Woolverton CJ. (2008). McGraw Hill Higher Education
- Microbiology, Michael J Pelczar (Jr) ESC Chan, N R Kreig, Tata McGraw Hill.
- Microbiology, Fundamentals and applications Atlas, R.M. 2nd Edition McMillan Publishing Co. New York.
- An introduction to Microbiology Auro, P.T. Kapoor, K. K. Yadav, K.S. ,New Age International Pvt. Ltd.
- Immunology, Janis Kuby, W H Freeman and Company, USA
- Essential Immunology, Ivan Roitt, Blackwell Science Ltd.
- Immunology, G. Reever & I. Todd, Publ: Blackwell Science Ltd.
- Cellular and Molecular Immunology, Abbas AK, Lichtman AH, Pillai S.. Saunders Publication, Philadelphia
- Microbiology and Immunology (2nd edition) Kumar. M.S, Leela K Sai, Jaypeebooks
- Experiments in Microbiology Plant Pathology and tissue culture. Aneja, K.R.

SEMESTER IV

SCHEME OF EXAMINATION

Semester-IV												
Paper Code	**Paper Name**	**Code**	**L**	**T**	**P**	**Total Credits**		**Maximum Marks**			****Minimum Passing Marks (%)**	**Hours/ week**
								Internal Marks	External Marks	**Total marks**		
VBT5DCCT42	Molecular Biology and Genetic Engineering	DCC	3	1	0	4	6	30	80	150	36	06
VBT5DCCP42	Practical	DCC	0	0	2	2			40		36	04
Total Credits						**06**						10
Total Marks								150				

**A candidate shall be required to obtain 36% marks to pass in theory, practical and internals separately. For Internal Evaluation of 30 Marks (20 Marks theory paper, 10 Marks practical paper} (Internal assessment include assignment/seminar, Logical thinking/application of knowledge and skills in internal assessment).

Pattern of Paper and Content

There shall be three (3) sections in the question paper. A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each Unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will be prepared such that questions i through v are multiple-choice questions, while questions vi through x will be fill-in-the-blank questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

Molecular Biology and Genetic Engineering VBT5DCCT42 (Theory)	
Unit – 1	History and concept of molecular biology, Genetic material: Structure, chemical composition, replication, reverse transcription, satellite DNA, DNA damage and repair, Recombination in prokaryotes: transformation, conjugation and transduction
Unit – 2	Transcription and translation in prokaryotes & eukaryotes, processing of eukaryotic m-RNA, post translational modifications of protein. Inhibitors of transcription and translation, Genetic code, Regulation of gene expression.
Unit – 3	Brief history and development of genetic engineering, recombinant DNA technology: Basic principles and method. Restriction endonuclease (types, classification and application) and other enzymes needed in genetic engineering. Cloning vectors: Plasmid vectors, bacteriophage vectors, cosmid vectors, phasmid
Unit – 4	Integration of DNA insert into the vector, introduction of the vector into the suitable host. Transposons and their uses in genetic manipulation Molecular cloning, selection of recombinant clone, construction of cDNA and genomic library,

	Blotting Techniques-Southern, Western and Northern blot, DNA Fingerprinting, PCR, DNA sequencing, DNA probes
Unit – 5	Applications of r-DNA technology in agriculture, human health Production of recombinant vaccines, Hepatitis B Production of human growth hormone. Human genome project and its implication. Gene Transfer methods, Production and applications of transgenic plants and animals. Biosafety, Bioethics

Molecular Biology and Genetic Engineering VBT5DCCP42 (Practical)

List of Practical Exercises

1. Preparation of DNA model.
2. Demonstration of Conjugation, transformation and transduction by charts
3. Estimation of RNA by Orcinol method.
4. Estimation of DNA by DPA method and determination of Tm value and purity of DNA.
5. Detergent lysis of RNA.
6. Osmotic lysis of RNA
7. Preparation of buffers
8. Isolation / extraction of genomic DNA from yeast /plant Tissues.
9. Isolation of plasmid from bacteria
10. Agarose gel electrophoresis of DNA.
11. Quantification of DNA.
12. Study of gene cloning through charts
13. Study of DNA finger printing: Comparison of two plates of monomorphic and dimorphic bands (Photographs).
14. Perform restriction digestion of plant genomic DNA and its visualization.
15. Check the presence of insert in the recombinant plasmid.
16. Preparation of competent cells of *E. coli* (strain DH5 a) using CaCl2 treatment.
17. Demonstration of polymerase chain reaction.
18. Working of instruments- Thermocycler, Transilluminator, Spectrophotometer, and Electrophoresis

SCHEME OF PRACTICAL EXAMINATION
Practical Based on Theory Paper

Time: 4hrs Maximum Marks: 40 Minimum Marks: 13

Combined Practical	**Marks**
1. Exercise of Molecular Biology	
Major	[06]
Minor	[04]
2. Exercise of Genetic Engineering	
Major	[06]
Minor	[04]
3. Spots (Four)	[08]

4. Viva-voce [05]
5. Practical Record [07]

References:

- Cell and Molecular Biology, P. K. Gupta, Rastogi Publication
- Elements of Molecular Biology, Sandhya Mitra, MacMilan Publications.
- Biotechnology Expanding Horizons, B. D. Singh, Kalyani Publishers
- Genetic Engineering and its Applications, P. Joshi, Agrobios India
- Biotechnology &Genomics: P.K. Gupta ,Rastogi Publication
- Gene Cloning - An introduction, T.A. Brown. Van Reinhold
- Molecular Biotechnology, Bernard R. Glick, Jack J. Pasternak, ASM Press, Washington DC
- Genetic Engineering Principle and Methods, Setlow J. K. & Hollaender, Plenum Press, New York.
- Molecular cell biology Darnell J., Lodish H., and Baltimore D. 1990, Scientific American books inc., New York.
- Essentials of molecular biology Freifelder D and Malacinski G.M 1993, Jones and Barklett Publishers Inc.
- Molecular biotechnology, principles and applications of recombinant DNA Glick B.R. and Pasternak, J.J. American Society for microbiology, Washington DC
- Gene cloning and manipulation, Howe C, Cambridge university press, USA.
- Cell and Molecular biology concept and experiment. Karp G, John Wiley and sons Inc. New York
- Molecular Biology and Biotechnology, Walker J.M and Gingold E. B. Indian edition Royal society of chemistry UK

SEMESTER V

SCHEME OF EXAMINATION

Semester-V

Paper Code	Paper Name	Code	L	T	P	Total Credits		Maximum Marks		Total marks	**Minimum Passing Marks (%)	Hours/ week
								Internal Marks	External Marks			
VBT5.5DCCT 52	Industrial Biotechnology, Environmental Biotechnology & Bioinformatics	DCC	3	1	0	4	6	30	80	150	36	06
VBT5.5DCCP 52	Practical	DCC	0	0	2	2			40		36	04
Total Credits						**06**						10
Total Marks								150				

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Pattern of Paper and Content

There shall be three (3) sections in the question paper. A paper/course will contain 5 units. The question paper shall contain following three sections.

- **Section A** (10 marks) shall contain 10 questions two from each Unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will be prepared such that questions i through v are multiple-choice questions, while questions vi through x will be fill-in-the-blank questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.
- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

Industrial Biotechnology, Environmental Biotechnology & Bioinformatics VBT5.5DCCT52 (Theory)	
Unit – 1	Introduction to industrial biotechnology, Isolation and screening of microorganisms for industrial products. Strategies for Strain improvement (mutation, selection, recombination). Maintenance and Preservation of industrial microorganisms. Basic principle of fermentation technology. types of fermenters – Stirred tank, airlift, Bubble up fermenter. Fermentation Medium, Formulation and sterilization of fermentation media. Kinetics of microbial growth and death.
Unit – 2	Downstream processing: extraction, separation, concentration, recovery & purification. Industrial production of organic acids (citric acid, acetic acid) amino acids (glutamic acid, lysine, tryptophane), solvents (ethanol, glycerol), vitamins (Vitamin C, A, B2, B12), antibiotics (penicillin, streptomycin, tetracycline), steroids and alkaloids. Basic concept and production of food products: Cheese, Yoghurt, Single cell protein (SCP) and single cell oils (SCO). Mushroom and beverages. Sterilization, pasteurization, canning and packaging of different food products.
Unit – 3	Conventional and alternate sources of energy and their environmental impacts,. Methanogenic bacteria and Biogas production and its advantage. Microbial hydrogen production, Treatment of municipal waste and industrial effluents, organic compost and process of composting, vermiculture technology.
Unit – 4	Principles and applications of biosensors for detection of pollutants, Bioindicators, eutrophication, biomagnifications, phytoremidiation, metal chelation and detoxification, Biosorption. Microbes and their genetic engineering for degradation of pollutants, use of super bugs for removal of oil spills. Biofertilizers, Biopesticides.
Unit – 5	Introduction to Bioinformatics: Definition, objectives and scope, The notion of Homology. Sequence Information Sources, Understanding the structure of each source and using it on the Web, Biological databases, types (primary, secondary, composite) and examples (gene bank, prosite, swissport), Understanding the structure of each source and using it on the Web, principles of sequence similarity determinate FASTA and BLAST.

Industrial Biotechnology, Environmental Biotechnology & Bioinformatics
VBT5.5DCCP52 (Practical)

1. Isolation of industrially important microorganisms for microbial processes.
2. Isolation of pure cultures of Industrial microorganism.
3. To test the production of enzymes: Amylase, proteinases, lipases and celluloses by microorganisms.
4. Demonstration of citric acid production by *Aspergillus niger, Penicillium citrianum.*
5. Preparation of niacin by lactic acid bacteria.
6. Demonstration of fermenters.
7. Estimation of Lactic acid.
8. Preparation of Yoghurt by lactic acid bacteria.
9. Testing of milk by MBRT.
10. Test for pasteurization of milk.
11. Coliform test for milk.
12. Culture preservation.
13. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.
14. Determination of biological oxygen demand (BOD) of a sewage sample.
15. Determination of chemical oxygen demand (COD) of sewage sample.
16. Estimation of dissolved oxygen in water sample.
17. Estimation of chloride in water sample.
18. Determination of quality of water by MPN test.
19. Sequence information resources.
20. Understanding and use of various web resources: EMBL, Genbank,
21. Using various BLAST and interpretation of results.
22. Academic visit/tour to research centers/institutions/industries.

NOTE: A report on the academic visit/tour should be written and submitted along with Practical record.

SCHEME OF PRACTICAL EXAMINATION
Practical Based on Theory Paper

Time: 4hrs Maximum Marks: 40 Minimum Marks: 13

Combined Practical	**Marks**
1. Exercise of Industrial Biotechnology	[06]
2. Exercise of Environmental Biotechnology	[05]
3. Exercise of Bioinformatics	[05]
4. Spots (Four)	[08]
5. Viva-voce	[04]
6. Practical Record	[07]
7. Report on Industrial / Research center visit	[05]

References:

- Manual of industrial microbiology and Biotechnology, Demain A.L. Solomon, J.J., 1986. ASM press.
- Industrial Microbiology, Reed C., Prescott and Dann's, 1982. Macmillan publishers.
- Fundamentals of Biotechnology, Prave. P. Faust, V. Sitih. W., Sukatsh, DA, 1987. ASM press.

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- Biotechnology-fundamentals and applications. Purohit S.S., Mathur S.K.1996: Agro
- botanical Publishers, New Delhi
- Biotechnology Singh B D, Kalyani publishers, Ludhiana.
- Principle of fermentation technology, Stanbury P.F., Whitaker H . Adity booklimited.
- General Microbiology Sullia S.B and Shantaram S. 1998: Oxford and IBM publishing Co.
- Industrial Biotechnology A. H. Patel.
- A text book of Industrial Microbiology, Cruger & Cruger, Panima Publishing corporation, New Delhi
- Introduction to environmental biotechnology, Chatterji A.K Prentice Hall of India, New Delhi
- Environmental Biotechnology (3rd edition), Jogdand S. N, Himalaya publishing house Pvt. Ltd.
- Environmental Biotechnology, Foster C.F. John WAe D. A Ellis Horword Limited.
- Environmental Biotechnology, Alan Scragg, Oxford University Press
- Bioinformatics, Baxevanis Ouellette, Wiley-Less Publication
- Bioinformatics: Principles and Applications. Ghosh Z. and Bibek anand M. Oxford University Press.

SEMESTER VI

SCHEME OF EXAMINATION

Semester-VI

Paper Code	Paper Name	Code	L	T	P	Total Credits		Maximum Marks: Internal Marks	Maximum Marks: External Marks	Total marks	**Minimum Passing Marks (%)	Hours/ week
VBT5.5DCCT 62	Plant and Animal Biotechnology	DCC	3	1	0	4	6	30	80	150	36	06
VBT5.5DCCP 62	Practical	DCC	0	0	2	2			40		36	04
						Total Credits	**06**					10
						Total Marks		150				

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Pattern of Paper and Content

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- **Section A** (10 marks) shall contain 10 questions two from each Unit. Each question shall be of 1 mark. All the questions are compulsory. Section A will be prepared such that questions i through v are multiple-choice questions, while questions vi through x will be fill-in-the-blank questions.
- **Section B** (25 marks) shall contain 5 questions (two from each unit with internal choice). Each question shall be of 5 marks. The candidate is required to answer all 5 questions. The answers should not exceed 150 words.

- **Section C** (45 marks) shall contain 5 questions, one from each Unit. Each question shall be of 15 marks. The candidate is required to answer any three questions by selecting these three questions from different units. The answers should not exceed 400 words.

Plant and Animal Biotechnology VBT5.5DCCT62 (Theory)	
Unit – 1	History of Plant tissue culture, introduction to cell and tissue culture, terms and definitions. Tissue culture media, types (composition, preparation and role of different constituents). Role of growth regulators. Sterilization techniques, Initiation and maintenance of callus. Organ Culture–Anther, ovary, Embryo, endosperm cultures for *in vitro* pollination and embryo rescue.
Unit – 2	Micropropagation, shoot tip and meristem culture, somatic embryogenesis, synthetic seeds, cryopreservation. Suspension culture, single cell culture, protoplast isolation, culture and viability test, Methods of Protoplast fusion, Somatic hybridization and cybridization. Somaclonal variation and their significance.
Unit – 3	Secondary metabolites production (alkaloid) in plant tissue culture, cell selection for higher yield, optimized conditions for higher production. Biotransformation. Immobilization of cells, elicitors. Hairy root culture. Application of tissue culture in agriculture, forestry and conservation. Commercial production of transgenic plants for resistance to insects, viruses, herbicides and pesticides and stress. Production of edible vaccines.
Unit – 4	Animal cell culture: Media and its components. Primary Culture – Cell lines, and cloning, Basic technique of mammalian cell culture in vitro, disaggregation of tissue and primary culture, maintenance of cell culture. Secondary Culture – transformed animal cells and continuous cell lines. Growth factors – Promoting proliferation of animal cells EGF, FGF, PDGF, IL-1, IL-2, NGF and erythropoietin.
Unit – 5	Organ culture, whole embryo culture, Histotypic culture, transplantation of cultured cells. measurement of cell growth. Application of animal cell culture for studies on gene expression, cell culture-based vaccines. In vitro fertilization in humans, super ovulation, embryo transfer in humans and livestock. Procedure involved in patenting biotechnological inventions.

Plant and Animal Biotechnology VBT5.5DCCP62 (Practical)
1. Acquaintance with tissue culture laboratory. 2. Washing and cleaning of glass wares. 3. Sterilization of glassware by moist air. 4. Sterilization by dry heat method. 5. Observation of various developing stages of chick embryo.

6. Preparation of media for animal cell culture (Undefined media: Chick embryo extract, chick plasma, chick serum).
7. In vitro animal cell culture.
8. Preparation of single cell suspension from spleen and thymus.
9. Preparation of Hank's Balanced Salt Solution (BSS).
10. Culture of animal cells (embryo cells) on undefined media.
11. Methodology and preparation of M S media containing various plant growth regulators of different concentrations.
12. Preparation of cell suspension culture and determination of cell count by Haemocytometer.
13. To study the characteristics of callus on the basis of following parameters:
14. Colour and texture
15. Packed and volume
16. Fresh weight and dry weight
17. Cell viability test
18. Sterilization of plant material.
19. *In vitro* seed germination
20. Preparation of aseptic plant.
21. Anther culture on M.S. media under aseptic condition.
22. Shoot apical meristem culture for obtaining virus free plants.
23. Principle and working of various instrument used in plant tissue culture.
24. Test of cell viability in cell suspension culture.
25. Fusion of cells by polyethylene glycol (PEG).
26. Preliminary tests of secondary metabolites.

SCHEME OF PRACTICAL EXAMINATION
Practical Based on Theory Paper

Time: 4hrs Maximum Marks: 40 Minimum Marks: 13

Combined Practical	**Marks**
1. Exercise of Plant Biotechnology	
Major	[05]
Minor	[03]
2. Exercise of Animal Biotechnology	
Major	[05]
Minor	[03]
3. Spots (Four)	[08]
4. Viva-voce	[04]
5. Practical Record	[07]
6. Review	[05]

References:

- A test book book on Biotechnology (2nd Edition). Kumar H.D Affiliated East West Press Private Ltd. New Delhi.
- Plant Cell and Tissue Culture, Narayanaswami, Tata Mc Graw Hill
- Plant Biotechnology, K. G. Ramawat, S. Chand and Company Ltd.
- Introduction to Plant Biotechnology, H. S. Chawla, Oxford and IBH Publishing Co. Pvt. Ltd.

- Animal Biotechnology, M. M. Ranga, Agrobios India.
- Plant tissue culture, Kalyan Kumar, New central book agency
- Elements of biotechnology, Gupta P. K. Rastogi and Company.
- Biotechnology Expanding Horizons, B. D. Singh, Kalyani Publishers
- Biotechnology applications of Plant Tissue & cell culture. Ravishankar G.A and Venkataraman L.V Oxford & IBH Publishing co., Pvt Ltd.
- Animal Cell Culture, John R. W. Masters, Oxford University Press
- Culture of Animal Cell - A Manual of Basic Techniques, Freshney, Wiley-Liss Publication.