

# FACULTY OF LIFE SCIENCES

## Syllabus

For

### Pre Ph.D. Course in Molecular Biology & Bio-Chemistry (Credit Based Evaluation & Grading System)

Examinations: 2019–20



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**Guru Nanak Dev University**  
**Amritsar**

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**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
(Credit Based Evaluation & Grading System)**

**Scheme of Course**

<b>Semester-I</b>						
<b>Course No.</b>	<b>C/E/I</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Credit</b>
<b>Core Course</b>						
LSL-901	<b>C</b>	Research Methodology	<b>3</b>	1	-	<b>4</b>
MBL-902	<b>C</b>	Seminar	1	-	-	<b>1</b>
	<b>E</b>	Elective –I*	3	-	-	<b>3</b>
<b>Semester-II</b>						
	<b>E</b>	Elective –II*	3	-	-	<b>3</b>
	<b>I</b>	Interdisciplinary*	3	-	-	<b>3</b>
		Thesis	<b>Non-Credit</b>			

*List of Elective courses*

**MBL-903 Animal Tissue culture**  
**MBL-904 Molecular Microbiology**  
**MBL-905 Essentials of Transplant Immunology**  
**MBL-906 Experimental Life Science**  
**MBL-907 Protein Biochemistry**  
**MBL-908 Essentials in Developmental Biology**

*Interdisciplinary course for other Departments*

**MBL- 926 Molecular Biology of The Cell**

**\*These courses may be opted from the same department or in an allied field/s in other departments of the University (depending on their area of specialization/ research interest) and at least one of these courses should be from outside the department**

**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
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**LSL-901 - Research Methodology**

**Credits 3-1-0**

**Time: 3 Hrs.**

**Max. Marks : 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Note: The course will be numerical oriented to train the students for the analysis of research data. Use of calculators will be allowed in the examination.**

**SECTION-A**

1. **Descriptive statistics:** Statistical expressions, central tendency, dispersion of data (arithmetic and geometric), moments, skewness, kurtosis, sample size estimation.
2. **Probability:** Concept of probability, conditional probability, distributions: Normal, Poisson, binomial, 't',  $\chi^2$ , F-distributions.

**SECTION-B**

3. **Testing of hypothesis:** Central limit theorem, null hypothesis and alternative hypotheses, Z-test, Student's t-test,  $\chi$ -square, F-test, sample size, confidence intervals. odds ratio, index numbers, Probit analysis.
4. **Correlation and regression analysis:** Linear correlation and regression, exponential regression, logarithmic regression, reciprocal regression, Michael-Menten's regression, logistic regression, Gompertz regression, monomolecular regression.

**SECTION-C**

5. **Multiple correlation and regression:** MLR with 2 and 3 independent variables, quadratic and cubic polynomial regressions, Beta regression, sine curve, multiple correlation, partial correlation, path analysis, time series analysis.
6. **Experimental designs:** Experimental designs, central composite designs with 2 and 3 factors.

**SECTION-D**

7. **Analysis of Variance:** Assessing normality, one way and 2-way ANOVA, Tukey's multiple comparison test, HSD.
8. **Multivariate analysis:** Cluster analysis and dendrogram, principal component analysis, factor analysis, artificial neural networks.
9. **Non-parametric tests:** Wilcoxon's, Mann-Whitney's tests, Spearman's rank correlation, Kendall's Tau.
10. **Basic Greek and Latin words:** The students will learn Greek alphabet and more than 100 basic roots and words used in science.

**Note: The students will be asked to submit an assignment of computer softwares designed by them on the basis of the Research methodology syllabus.**

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**References:**

1. Bailey, N.T.J. (1995). Statistical Methods in Biology. Cambridge University Press, Cambridge.
2. Kothari, C.R. (2004). Research Methodology: Methods and Techniques, New Age International Publishers, New Delhi.

**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
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**MBL-902 Seminars on Current Topics**

Credit hrs.		
L	T	P
1	0	0

(Topics to be decided by the students in consultation with the teacher(s) at the start of the semester)

**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
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**MBL-903 ANIMAL TISSUE CULTURE**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four).

Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

**Introduction:** Historical Background, Advantages and Disadvantages of using cell culture, Types of tissue culture, Biology of cultured cells.

**Section-B**

**Growth and Maintenance of cells in culture:** Laboratory design and layout, Equipment for Tissue culture lab, concept and importance of aseptic techniques, Components of culture medium, Media supplements, serum-free media, Role of CO<sub>2</sub> in culture medium, Primary culture, Subculture and Cell lines, Differentiation, Transformation and Immortalization.

**Section-C**

**Techniques in Animal Tissue Culture:** Production of Monoclonal antibodies, DNA transfer techniques, Cell separation techniques, Cell counting and monitoring, Viability measurements, Cell line identification, analysis of the cell cycle, Cryopreservation, Scaling up animal cell culture: Scale up in suspension, Scale up in monolayer, Bioreactors., Modes of culture: batch, fed-batch or continuous.

**Section-D**

**Applications of tissue culture:** Mammalian cell products: Viral vaccines, Monoclonal Antibodies, Glycoproteins, Clotting factors, Plasminogen activators, Erythropoietin etc. Role of tissue culture in Gene therapy, Artificial skin, Artificial organs.

**Books Recommended:**

1. Freshney, R.I. (2010). Culture of Animal Cells, 6<sup>th</sup> ed., John Wiley and Sons, New York.
2. Butler, M. (2004). Animal Cell Technology, 2<sup>nd</sup> ed., BIOS Scientific Publishers, U. K.

**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
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**MBL–904 Molecular Microbiology**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100  
Mid Semester Marks : 20  
End Semester Marks : 80**

**Mid Semester Examination: 20% weightage  
End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

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**Section-A**

**Microbiology:** Prokaryotic and eukaryotic cell structure, Microbial nutrition, growth and control, Sterilization. Microbial metabolism (aerobic and anaerobic respiration), Chemical basis of mutations and mutagens; plasmids, transformation, transduction.

**Section-B**

Conjugation, Microbial diversity and characteristic features, Viruses. Genetics and life cycle of phages- lambda, T4, pi, Mu and M13. Microbial Genomes.

**Section-C**

**Microbial Genetics:** Molecular structure of genes and chromosomes, DNA replication and control; Transcription and its control; Translational processes; Regulatory controls in prokaryotes; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extrachromosomal inheritance; Chromosomal variation; Transposable elements.

**Section-D**

**Gene transfer in bacteria** - Modes of gene transfer and genetic analysis, phages, and yeast molecular genetics, genetic and physical mapping of bacteria.

**Books Recommended:**

1. Willey, J., Sherwood, L. and Woolverton, C. Prescott – Microbiology 9<sup>th</sup> Edition (2013) McGraw Hill - ISBN-13: 978-0073402406
2. Voet D and Voet J.G. (2010) Biochemistry, 4<sup>th</sup> Edition, John Wiley & Sons, New York
3. Genes : Lewin, 11<sup>th</sup> ed. Oxford University Press, 2014.
4. Microbial Genomes - D. A. Realman and E. Strauss - 2000 - American Academy Of Microbiology
5. Practical handbook of microbiology- II Edition- Emanuel Goldman and Lorrence H. Green. 2008

**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
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**MBL-905 ESSENTIALS OF TRANSPLANT IMMUNOLOGY**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

Overview of immune system. Elements of innate defence mechanism and adaptive immune response. Introduction to transplant immunology.

**Section-B**

Graft compatibility and Graft rejection- Hyperacute, acute and chronic rejection. Immunobiology of T cell activation.

**Section-C**

Organ transplantation-kidney, heart and bone marrow. Graft versus host disease. Strategies for avoiding transplant rejection.

**Section-D**

Tools employed in Transplant research: Flow cytometry, Enzyme Linked ImmunoSorbent Assay (ELISA)-Direct, indirect and sandwich types, ABO and HLA typing, mixed lymphocyte reaction, complement fixation test, Cross match test, animal models in transplant research.

**Books Recommended:**

1. Abbas, A.K., Litchman, A.H. (2012). Basic Immunology : Functions and disorders of the immune System, 4<sup>th</sup> ed. (updated edition), Philadelphia, Pennsylvania: W.B. Saunders Company Publishers.
2. Coico, R. and sunshine, G. (2009). Immunology: A short course, 7<sup>th</sup> ed., New York, Wiley-Blackwell.
3. Abbas, A.K., Lichtman, A.H and Pilla, S. Cellular and Molecular Immunology, 8e (2014), W.B. Saunders Company Publishers.



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**MBL-906 Experimental Life Science**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four).

Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

**Conceptual research design:** Identifying and analysing research problems, Experiment design (through discussion of selected research articles), writing scientific proposals and articles. **Advanced research techniques** (Basic concept, instrumentation & applications).

**Genomics:** Microarray technology, Next-generation sequencing, Real-time PCR.

**Section-B**

**Proteomics:** Mass spectrometry, 2D gel electrophoresis.

**Section-C**

**Structural Biology:** Cloning, expression, purification of proteins, Site-directed mutagenesis, X-Ray Crystallography, Nuclear magnetic resonance.

**Section-B**

**Cell biology techniques:** Confocal microscopy, FACS, electron microscopy (TEM & SEM).

**Books recommended:**

1. Wilson, K. and Walker, J. (2010) Practical Biochemistry: Principles and Techniques, Edition 7<sup>th</sup> Cambridge university press
2. Schena, M. ed. (1999). DNA Microarrays: a practical approach. Oxford University Press.
3. Lieblker, D.C.(2007).Introduction to Proteomic: Tools for the New Biology.
4. Sambrook, J. and Michael, R.G. (2012) Molecular Cloning: A Laboratory Manual 4<sup>th</sup> Edition
5. Rhodes, G. (1993) Crystallography Made Crystal Clear, 3<sup>rd</sup> Edition
6. Recent articles in journals

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**MBL-907 Protein Biochemistry**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four).

Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

**Protein basics:** Amino acids; Primary, secondary, tertiary & quaternary structure of proteins; post translational modifications. Structural organization of soluble & membrane proteins; structure-function relationships. **Isolation, purification & characterization of proteins:** Precipitation, fractionation & chromatographic methods; Electrophoresis: SDS-PAGE, Native PAGE, chromatofocussing & isoelectric focussing; determination of amino acid composition & sequence, assignment of disulphide bonds, molecular weight & oligomeric structure; bioinformatics tools for protein characterization, western blotting & functional characterization of proteins.

**Section-B**

**Protein engineering, folding & prediction:** Protein folding themes, folding proteins *in vitro*, protein structure prediction & modeling, prediction of protein function; Protein engineering: codon shuffling & codon optimization.

**Section-C**

**Protein interactions:** General properties of ligand binding interaction, binding affinities, rate of binding & dissociation, relationship between protein conformation & binding, allostery. Yeast-two hybrid & Yeast-three hybrid technology, surface- plasmon resonance, FRET & other methods for studying protein interactions.

**Section-D**

**Protein structure determination:** Circular dichroism, X-ray crystallography & Nuclear magnetic resonance.

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**Books recommended:**

1. Nelson, D.L. and Cox, M.M. (2012) Lehninger Principles of Biochemistry, 6<sup>th</sup> Edition, W H Freeman Publishers, New Delhi.
2. Voet, D. and Voet, J.G. (2010) Biochemistry, 4<sup>th</sup> Edition, John Wiley & Sons, New York
3. Wilson, K. and Walker, J. (2010) Practical Biochemistry: Principles and Techniques, Edition 7<sup>th</sup> Cambridge university press
4. Sambrook, J. and Michael, R.G. (2012) Molecular Cloning: A Laboratory Manual 4<sup>th</sup> Edition
5. Rhodes, G. (1993) Crystallography Made Crystal Clear, 3<sup>rd</sup> Edition
6. Recent articles in journals

**PRE-PH.D (MOLECULAR BIOLOGY & BIO-CHEMISTRY  
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**MBL-908 ESSENTIALS IN DEVELOPMENTAL BIOLOGY**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100**

**Mid Semester Marks : 20**

**End Semester Marks : 80**

**Mid Semester Examination: 20% weightage**

**End Semester Examination: 80% weightage**

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**Section-A**

**Introduction:** Principals of Developmental Biology, Life cycles and the stages of animal development, cell specification, Mitosis, Meiosis, Sex determination, cell-cell interaction, various signal transduction pathways: Wnt pathway, Notch pathway, RTK pathway, SMAD pathway, JAK-STAT pathway, Hedgehog pathway

**Section-B**

**Fertilization and Organogenesis:** Gametogenesis, Recognition of the egg by the sperm, Polyspermy, Embryo formation, cleavage, gastrula, Early vertebrate development, determination of cell fate and differentiation, cell polarity, cell migration, axis formation.

**Section-C**

**Stem Cells and Cloning:** Introduction and development of stem cells, Human Gene therapy,

**Section-D**

**Techniques used for studying Developmental Biology:** Northern Blotting, Southern Blotting, Polymerase Chain Reaction, In situ Hybridization, In situ PCR detection, FISH, Immunohistochemistry, Transgenic animals.

**References**

1. Gilbert, S.F. and Singer, S.R. (2010) Developmental Biology. Sinauer Associates, 9<sup>th</sup> Edition.
2. Carlson, B.M. (2003) Patten's Foundations of Embryology. McGraw-Hill College 6<sup>th</sup> Edition.
3. Cormack, D.H. (2001) Essential Histology. J.B. Lippincott Co. 2<sup>nd</sup> Edition.
4. Moore, K.L. (2012) The Developing Human: Clinically Oriented Embryology. Saunders Co. 9<sup>th</sup> Edition.

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**MBL- 926 - MOLECULAR BIOLOGY OF THE CELL**

Credit hrs.		
L	T	P
3	0	0

**Time: 3 Hrs.**

**Max. Marks : 100  
Mid Semester Marks : 20  
End Semester Marks : 80**

**Mid Semester Examination: 20% weightage  
End Semester Examination: 80% weightage**

**Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

**Cellular Organization:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

**Section-B**

**Membrane Components and functions:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

**Section-C**

**Cellular signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing. **Cell-Cell Communication:** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

**Section-D**

**Cell Biology techniques:** Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

**Books Recommended:**

1. Karp, G. (2013) Cell and Molecular Biology: Concepts and Experiments. 7<sup>th</sup> edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology. 8<sup>th</sup> edition. Lippincott Williams and Wilkins, Philadelphia
3. Cooper, G.M. and Hausman, R.E.(2009) The Cell: A Molecular Approach. 5<sup>th</sup> Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Lodish, H., Berk, A. and 6 more. (2007). Molecular Cell Biology. 6<sup>th</sup> edition. W. H. Freeman.