Solapur University, Solapur

B. Sc. Part – II Biotechnology Syllabus
Semester III & IV

(Credit and Grading System)

(w.e.f. June 2015)

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Science
Credit and Grading System
(w.e.f. June 2015)

- **Title of the Course:** B.Sc. Part-II
- **Subject:** Biotechnology
- **The Credit and Grading System:**

With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate degree, Solapur University has implemented Credit and grading system of Evaluation at Undergraduate level.

Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. As per present norms, there are 3 contact hours per paper (subject) per week which works out to be 45 contact hours per paper (subject) per semester.

In Solapur University, for B.Sc.-II Biotechnology, there are 6 papers and Environmental studies. For B.Sc.-II Biotechnology, there are 3 contact hours per paper (subject) per week for each paper. Therefore, total contact hours per week are 18. Each paper has 45 contact hours, which are transformed into 3 credits. As there are 4 contact hours per week for Environmental Studies, 4 credits shall be assigned for Environmental Studies.

Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 30 marks and University Evaluation for 70 marks. It is 70+30 pattern of evaluation. It is applicable for theory and practical as well. The details regarding this evaluation system are as under.

- **Conversion of marks into Grades:**

A table for the conversion of the marks obtained by a student in each paper (out of 100) to grade and grade point is as given below:

Sr. No.	Range of Marks	Grade	Grade Point
1	80 – 100	O	10
2	70 – 80	A+	9
3	60 – 69	A	8
4	55 – 59	B+	7
5	50 – 54	B	6
6	45 – 49	C+	5
7	40 – 44	C	4
8	<39	FC	0 (Failed in Term Exam)
9	<39	FR	0 (Failed in Internal Assessment)

1. **Grade Point Average at the end of the Semester (SGPA)**

$$\text{SGPA} = \frac{(G_1 \times C_1) + (G_2 + C_2) + \ldots\ldots\ldots}{\sum C_i}$$

(ΣC_i = The total number of credits offered by the student during a semester)

2. **Cumulative Grade Point Average (CGPA)**

$$\text{CGPA} = \frac{(G_1 \times C_1) + (G_2 + C_2) + \ldots\ldots\ldots}{\sum C_i}$$

(ΣC_i = The total number of credits offered by the student upto and including the semester for which CGPA is calculated.)

3. **Final Grade Point Average (FGPA)**

It will be calculated in the similar manner for the total number of credits offered for the completion of the said course.

Where: C_i = Credits allocated for the i^{th} course.

G_i = Grade point scored in the i^{th} paper (subject)

4. **Conversion of average grade points into grades:**

SGPA/CGPA/FGPA	**Letter Grade**
9.5 – 10	O
8.5 – 9.49	A+
7.5 – 8.49	A
6.5 – 7.49	B+
5.5 – 6.49	B
4.5 – 5.49	C+
4.0 – 4.49	C
<3.99	FC / F
	FR

- **Syllabus Structure:**

1. The University follows semester system.
2. An academic year shall consist of two semesters.
3. Each B.Sc. course shall consist of three years i.e. six semesters.
4. Environmental Studies paper shall remain compulsory for B.Sc. Part-II Biotechnology students in IV^{th} semester.
5. B.Sc. Part-II Biotechnology shall consist of two semesters: Semester III and Semester IV.

   In semester III, there will be six papers of 100 marks for each. Similarly in Semester IV there will six papers of 100 marks for each. There shall be six papers in subject and Environmental Studies paper compulsory for every student in semester IV.

The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below. For B.Sc. Part-II Biotechnology sem III & IV the internal assessment will be based on Unit tests, Home assignment, viva, practicals, project work etc. as given below. Practical course examination of 200 marks for each course shall be conducted at the end of IVth semester. The practical examination of 200 marks shall also consist of 140 marks for University practical assessment and 60 marks for college internal assessment.

The process of evaluation for Environmental Studies shall be based on University theory examination of 70 marks and 30 marks internal assessment. The internal assessment for environmental studies shall be based on internal test / home assignment / tutorial of 10 marks and project work for 20 marks.

For University practical examination out of two examiners, one examiner will be internal and another examiner will be External. Both examiners will be appointed by the University. The internal practical assessment shall be done as per scheme given below.

6. Scheme of Evaluation

As per the norms of the grading system of evaluation, out of 100 marks, the candidate has to appear for college internal assessment of 30 marks and external evaluation (University assessment) of 70 marks. The respective B.O.S. may decide the nature of college internal assessment after referring to scheme given below or may be used as it is.

Semester – III

Theory: (100 marks)

University Examination (70 marks): No. of theory papers: 6

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test
10 marks – Home assignment / tutorials / seminars / group discussion / viva / field visit / industry visit.

Semester – IV

Theory: (100 marks)

University Examination (70 marks): No. of theory papers: 6

Internal Continuous Assessment: (30 marks)

Scheme of marking: 20 marks – Internal test
10 marks – Home assignment / tutorials / seminars / group discussion / viva / field visit / industry visit.

Practical Examination: (200 marks)

University Examination (140 marks): No. of practical course 3

Internal Continuous Assessment: (60 marks)

Scheme of marking: 40 marks – Internal test on any four practicals
20 marks – Lab Journal / Viva, attendance, attitude etc.

For Environmental Studies there shall be theory examination of 70 marks (UA) and 30 marks (CA) internal assessment. The Internal assessment for environmental studies shall be based on internal test / home assignment / tutorial of 10 marks and project work report of 20 marks.

7. **Passing Standard**

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in Internal assessment and passed in University examination (theory) shall be given FR Grade. Such student will have to reappear for both University examination as well as internal assessment. In case of Annual pattern/old semester pattern students/candidates from the mark scheme the candidates shall appear for the same 70 marks of external examination and his performance shall be scaled to 100 marks.

8. **ATKT**

Candidate passed in all papers except 6 (six) papers combined together of semester III and IV of B.Sc. Part-II Biotechnology examination and clearly passed in B.Sc. Part-I Biotechnology shall be permitted to enter upon the course of Semester V of B.Sc. III Biotechnology

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Science

Credit System Structure for B.Sc – II Biotechnology Theory

Semester – III

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
9	Inheritance Biology	3	-	-	100	70	30	3
10	Cyto-Genetics and Population Genetics	3	-	-	100	70	30	3
11	Biophysical Instruments	3	-	-	100	70	30	3
12	Analytical Techniques	3	-	-	100	70	30	3
13	Immunology – I	3	-	-	100	70	30	3
14	Immunology – II	3	-	-	100	70	30	3
Total		**18**			**600**			**18**

Semester – IV

Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
15	Molecular Biology – I	3	-	-	100	70	30	3
16	Molecular Biology – II	3	-	-	100	70	30	3
17	Plant Tissue Culture	3	-	-	100	70	30	3
18	Animal Tissue Culture	3	-	-	100	70	30	3
19	Bioenergetics and Enzymology	3	-	-	100	70	30	3
20	Metabolism	3	-	-	100	70	30	3
	Environmental Studies	4	-	-	100	70	30	4
Total		**22**			**700**			**22**

Practical (Annual)

Practical Course No.	Title of Practical Course	Hrs/Week			Practical Marks	UA	CA	Credits
		L	T	P				
5	Techniques in Molecular Genetics	-	-	8	200	140	60	4
6	Methods in Advanced Biotechnology	-	-	8	200	140	60	4
7	Techniques in Metabolism, Enzymology and Immunology	-	-	8	200	140	60	4
Total				**24**	**600**			**12**

Summary

Class	**Semester**	**Total Marks**	**Total Credits**
B.Sc. II	III (Theory)	600	18
	IV (Theory)	700	22
	Practical	600	12
Grand Total		**1900**	**52**

Abbreviations: L: lectures, T: tutorials, P: practicals; UA: University Assessment by End Semester Examination; CA: College Assessment by Internal Continuous Examination.
UA (University Assessment): University Theory paper shall be of 70 marks for 3:00 hrs duration
CA (College Assessment): The internal examination for theory and practical course.

B. Sc. II Biotechnology Syllabus
Semester III

SEMESTER- III (THEORY)

Paper No. 9: Inheritance Biology **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Mendelism** Introduction, Mendel's experiment, Monohybrid and Dihybrid crosses, Genotypic and phenotypic ratio, Law of Dominance, Law of segregation and Law of independent Assortment, Back cross and test cross. Modifications of Mendelian ratios: Co-dominance, Incomplete dominance, Interaction of complementary genes, supplementary gene, inhibitory gene, epistasis.	10 L
II	**Genetic Linkage and Chromosome Mapping** Linkage – Definition, types of linkage, significance of linkage. Crossing-over – theories, types and mechanism. Gene Mapping – physical map and genetic map (by three-point test crosses), Mapping by tetrad analysis – the analysis of unordered and ordered Tetrads.	10 L
III	**Extra chromosomal inheritance and alleles** Genetic system in mitochondria, chloroplast, and plasmid. Definition of Alleles. Multiple alleles – ABO blood groups in human, fur colour in rabbit, self incompatibility in plants, and eye colour in *Drosophila*. Pseudo alleles, Complementation test.	10 L
IV	**Sex linked Inheritance** Structure of Sex Chromosomes. Complete and incomplete sex linked genes. Inheritance of XY linked genes, Y linked genes, X linked genes. Sex determination with examples.	07 L
V	**The Genetics of Bacteria** The Genetic Organization of Bacteria (folded fibre model), Bacterial Recombination – transformation, conjugation and transduction. F Plasmids	08 L

References

1. Genetics: Principles and Analysis; Fourth Edition; Daniel L. Hartl; Jones Bartlet Publishers.
2. Experiments in Plant Hybridization – G. Mendel; Prentice Hall, New Jersey.
3. Genetics – B. D. Singh; Kalyani Publication
4. Principles of Genetics – E. J. Gardner; John Willey & Sons, New York.
5. Molecular Biology – P. K. Gupta
6. Genetics – M. W. Strickberger; Macmillan Publication
7. Heterochromatin Science – S. W. Brown
8. The Theory of Gene – T. H. Morgan; Yale University press; New Haven, Conn.
9. Plant Breeding – Principles and Methods: B. D. Singh: Kalyani Publication.
10. Experimental studies in Physiology of Hereditary; Bateson & Punnet; Harrison's & Sons, London

Paper No. 10: Cyto-Genetics and Population Genetics (45 Lectures = 3 Credits)

Unit	Content	Lectures
I	**Chromosome** Structure, Morphology, Organization, Heterochromatin and euchromatin, Lampbrush chromosome, polytene chromosome, Sex chromosomes, Role of chromosome in heredity. Mitosis, Meiosis. Karyotyping.	08 L
II	**Mutation** Spontaneous and induced mutation. Chemical, physical and biological mutagenic agents. Effect of mutation and detection of mutants. Chromosomal abrasion – deletion, duplication, inversion, translocation. Numerical alteration in chromosome – polyploidy, aneuploidy, euploidy.	10 L
III	**Transposable elements** Terminology, insertion sequences, types of bacterial transposons. Transposition – structure of transposons and target sites, replicative and non-replicative transposition. Eukaryotic trasnsposable elements – DNA transposases, retroposes (LINES, SINES), Satellite DNA (mini & micro).	08 L
IV	**Population Genetics** Introduction, Hardy-Weinberg law, gene frequency, factors affecting gene frequency- migration, selection, genetic drift, inbreeding and Mutations. Significance of population genetics. Genetic basis of evolution, evolutions in some crop plants and animals	10 L
V	**Quantitative Genetics** Introduction, Multiple factor hypothesis, Transgressive segregation, Handling of quantitative data: mean, range, Variance, Standard deviation, Coefficient of Variation. Effects of the environment on quantitative traits.	09 L

References

1. Genetics: Principles and Analysis; Fourth Edition; Daniel L. Hartl; Jones Bartlet Publishers.
2. Genetics – B. D. Singh; Kalyani Publication
3. Principles of Genetics – E. J. Gardner; John Willey & Sons, New York.
4. Molecular Biology – P. K. Gupta
5. Genetics – M. W. Strickberger; Macmillan Publication
6. Heterochromatin Science – S. W. Brown
7. Plant Breeding – Principles and Methods: B. D. Singh: Kalyani Publication.
8. Experimental studies in Physiology of Hereditary; Bateson & Punnet; Harrison's & Sons, London
9. Gene VII; Benjamin Lewin; W. H. Freeman & Company.
10. Molecular Basis of Mutation: J. W. Drakey; Holdan Day, San Francisco

Paper No. 11: Biophysical Instruments (45 Lectures = 3 Credits)

Unit	Content	Lectures
I	**Spectroscopy** Electromagnetic wave, Electromagnetic spectrum. Introduction to molecular energy levels – excitation, absorption, emission. Instrumentation & applications of – Colorimetry, UV–Visible Spectroscopy, turbidometry, IR spectroscopy, Atomic absorption spectroscopy.	10 L
II	**pH Meter and Centrifugation** **pH meter:** - Measurements of pH – pH indicators, pH paper, pH meter glass electrode, operation and calibration of pH electrode, errors in pH measurements. **Centrifugation:-** Introduction, Sedimentation and Relative Centrifugal Force. Rotor Types**:** Swinging-Bucket Rotors, Fixed-Angle Rotors, Vertical Rotors. Types of Centrifugation – differential, rate-zonal, isopycnic, ultracentrifugation.	10 L
III	**Microscopy:** Introduction, optical principles of microscopy. Image formation in light and electron microscopy. Types of Microscopes – Darkfield, Phase contrast, Fluorescence, Compound, Inverted, Transmission Electron Microscope and Scanning Electron Microscope	09 L
IV	**Radioactivity:** Introduction, Nature of Radioactivity – atomic structure, atomic stability, types of radioactive decay, radioactive decay energy, rate of radioactive decay, units of radioactivity, Interaction of radioactivity with matter. Dosimeter – Absorbed dose (D), Dose equivalent (H) and effective dose equivalent. Radioactivity detection techniques – Ionization chamber, Proportional counters, Geiger Muller counter, Scintillation counter. Hazards biological effect of radiation, Safety measures. Biological Applications of Radioisotope.	10 L
V	**Molecular Characterization:** Introduction, Principle, working and application of the following Instruments: Circular Dichroism and Optical Rotatory Dispersion, X-ray Diffraction, Flow Cytometry, NMR	06 L

References

1. Instrumental Methods of Chemical Analysis – G. R. Chatwal, S.K.Anand
2. Handbook on Analytical Instruments –R. S. Khandpur. (Mc Graw Hill).
3. Biophysical Chemistry - Upadhyay, Nath, Upadhyay (Himalaya Publishing House).
4. Practical Biochemistry –Wilson & Walker.
5. Biophysics– Dr. Mohan P. Arora

Paper No. 12: Analytical Techniques **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Electrophoresis:** Basic principle of electrophoresis, support media, theory and application of moving boundary, starch gel, paper, agarose, native and denaturing PAGE, isoelectric focusing. Blotting techniques – Southern, Northern and Western blotting. Autoradiography.	10L
II	**Chromatography** : Introduction, Principle, instrumentation, working and applications of – paper, column, molecular exclusion, ion exchange, affinity chromatography, HPLC, GLC.	10L
III	**Protein Purification Techniques :** Cell disruption techniques – mechanical, physical and chemical methods. Ammonium sulphate and organic solvent precipitation. Dialysis, Ultrafiltration.	05L
IV	**Biomolecules Estimation**: Principles, applications with limitation and advantages of estimation methods of – 1) Carbohydrates – DNSA, anthrone, resorcinol method. 2) Protein – BCA assay, Bradford assay, Lowery's assay. 3) Lipid – acid value, saponification value, ester value and iodine number. 4) Nucleic acids – DPA method, orcinol method and spectrophotometer method.	10L
V	**Tools in Proteomics**: Introduction, Sample Taking, 2D Gel Electrophoresis, Mass Spectroscopy of Peptides and Proteins, Mass Spectrometers, Sample Preparation for MALDI, The Possibilities of MALDI – TOF. Micro sequencing – Preparing the Protein, Edman Degradation, Carboxyterminal Sequencing.	10 L

References

1. Protein purification –Robert Scoopes
2. Instrumental Methods of Chemical Analysis – Gurudeep R. Chatwal, Sham K. Anand (Himalaya Publishing House).
3. Handbook on Analytical Instruments –R. S. Khandpur. (Mc Graw Hill).
4. Biophysical Chemistry - Upadhyay, Nath, Upadhyay (Himalaya Publishing House).
5. Practical Biochemistry –Wilson & Walker.
6. Biophysics– Dr. Mohan P. Arora

Paper No. 13: Immunology – I **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Native Immunity:** Innate immunity: introduction, First line of Defense – Physical and Chemical barriers at the portal of entry. Second line of Defense – Antimicrobial substances, Cellular factors and Process.	07 L
II	**Acquired Immunity:** **Humoral immunity**: Primary and secondary immune response, antibody production against T cell dependent and independent antigens and antigen presented by antigen presenting cells, Role of B cells, T cells, antigen presenting cells, B cell receptors. B cell – maturation, activation, differentiation. **Cell mediated immunity**: T cell receptors, types of cells, their role in immunity, T cell – maturation, activation, differentiation.	15 L
III	**Abnormal Immunity:** **Hypersensitivity**: Introduction, Gell and Coombs classification, types, general mechanism and component staking part in hypersensitivity. **Autoimmunity**: Introduction, general mechanism, classification of autoimmune diseases (Hemolytic, organ specific, and non-organ specific).	07 L
IV	**Immunity to Infections:** Immunity to Bacteria, fungi, Protozoan's, Helminthes and Viruses: Regarding nonspecific Immunity, specific immunity and evasion of the immune response.	07 L
V	**Essential Immunology:** **Immuno hematology**: ABO and Rh blood group system, applications of blood group, Hemolytic diseases of new born, detection of Rh antibodies, ABO hemolytic diseases. **Vaccines**: Introduction active and passive immunization, Types of vaccines – Live-attenuated, killed, subunit, conjugate, DNA, recombinant vector vaccines. **Monoclonal antibodies**: Hybridoma Technology and its applications	09 L

References

1. Immunology - Kuby
2. Essential Immunology- Roitt
3. Cellular and Molecular Immunology- Abbas
4. Immunology and Serology- Philip Carpenter
5. Textbook of Immunology- Barrette J.T.
6. Basic and Clinical Immunology- Fundenberg H.
7. Biology of Immune response- Abramoff and Lavice
8. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
9. Immunology an Introduction- Tizard

Paper No. 14: Immunology – II **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Cells and Organs:** **Hematopoisis**: Introduction, factors involved in hematopoisis, programmed cell death and Homeostasis. **Cells of immune system**: B lymphocytes, T lymphocytes, Natural Killer Cells, Mononuclear phagocytes, Dendritic cells, Follicular dendritic cells. **Organs of immune system**: Structure and functions of primary lymphoid organs (Thymus, Bone marrow, and Lymphatic system), secondary lymphoid organs (Lymph nodes, Spleen), and Mucosa Associated Lymphoid Tissue, Cutaneous Associated Lymphoid Tissue	15 L
II	**Mediators:** **Major Histocompatibility Complex**: Introduction, classes – structure and function. **Cytokines**: Introduction, properties, function, cytokines receptors. **Complement system**: Introduction, functions, components, general account on complement activation – classical, alternative and lectin pathways.	07 L
III	**Antigen and Antibody:** **Antigen**: Introduction, immunogenicity, antigenicity, types of antigens, Haptens, properties of immunogen, role of biological system in immunogenicity (genotype of animal, immunogen dosage, route of Administration), adjuvant, epitope. **Antibody**: Introduction, basic structure and biological function of antibody classes, antigenic determinants	08 L
IV	**Antigen Processing and Presentation:** Processing of Endogenous Antigens – the Cytosolic Pathway, Processing of Exogenous Antigens – the Endocytic Pathway, Presentation of Nonpeptide Antigens.	07 L
V	**Immuno-techniques:** Antigen antibody interactions: Principles and applications of interaction, strength of interactions, cross-reactivity, features of interactions, measurement of antigen-antibody. Reactions of antigen-antibody complex – precipitation, flocculation, agglutination, complement fixation. Immunodiffussion, Immunoelectrophoresis, Electroimmunodiffussion, Complement Fixation Test, Immunofluorescence Test, Radioimmunoassay, ELISA.	08 L

References

1. Immunology - Kuby
2. Essential Immunology- Roitt
3. Cellular and Molecular Immunology- Abbas
4. Immunology and Serology- Philip Carpenter
5. Textbook of Immunology- Barrette J.T.
6. Basic and Clinical Immunology- Fundenberg H.
7. Biology of Immune response- Abramoff and Lavice
8. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
9. Immunology an Introduction- Tizard

B. Sc. II Biotechnology Syllabus
Semester IV

SEMESTER- IV (THEORY)

Paper No. 15: Molecular Biology – I **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Central Dogma** DNA as genetic element, the Central Dogma, Molecular nature of Gene, Genetic code – evidences and properties.	08 L
II	**Structure of Genetic Elements** Mischer to Watson and Crick historic perspective; DNA structure; Salient features of double helix; Types of DNA; Denaturation and renaturation of DNA; cot curves; DNA topology-linking number, topoisomerases; Organization of DNA in Prokaryotes, Viruses, Eukaryotes; RNA Structure; Organelle DNA – mitochondria and chloroplast DNA.	11 L
III	**Replication of DNA in Prokaryotes** General principles - bidirectional replication, Semiconservative, Semi discontinuous; RNA priming; Various models of DNA replication including rolling circle, Θ (theta) mode of replication, replication of linear ds-DNA; Enzyme involved in DNA replication of prokaryotes – DNA polymerases, DNA ligase, Primase, and other accessory proteins; Initiation, elongation and termination of replication.	10 L
IV	**Replication of DNA in Eukaryotes** D-loop (mitochondrial) replication model; DNA polymerases of eukaryotes; Initiation, elongation and termination of replication.	08 L
V	**Mutability and Repair of DNA** DNA damage; DNA Repair- Photoreactivation, Mismatch, Excision, Recombination, SOS repair mechanisms and disorders.	08 L

References

1. Molecular Biology; R. Weaver; 2nd Edition, McGraw Hill.
2. Molecular Cell Biology; Lodish; 6th Edition; W. H. Freeman & Company.
3. Gene VII; Benjamin Lewin; Pearson Education.
4. Genetics; B.D. Singh; Kalyani Publication

Paper No. 16: Molecular Biology – II **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Transcription** RNA polymerase and the transcription unit; Initiation, elongation and termination of transcription in Prokaryotes and Eukaryotes	08 L
II	**Transcription Regulation in Prokaryotes** Principles of transcriptional regulation; Operon concept; Repression and induction of genes; Regulation of operon : Lac operon and Trp operon.	08 L
III	**Transcription Regulation in Eukaryotes** Conserved mechanism of regulation; Eukaryotic activators; Signal integration; combinatorial control; transcriptional repressors; Signal transduction in regulation (e.g. Auxin).	08 L
IV	**RNA Modification** Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport	08 L
V	**Translation (Prokaryotes and Eukaryotes)** Ribosome structure and assembly; various steps in protein synthesis; Charging of tRNA, aminoacyl tRNA synthetases; Proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Regulation of translation- Translation-dependent regulation of mRNA and Protein Stability, Post translational modifications.	13 L

References

1. Molecular Biology; R. Weaver; 2nd Edition, McGraw Hill.
2. Molecular Cell Biology; Lodish; 6th Edition; W. H. Freeman & Company.
3. Gene VII; Benjamin Lewin; Pearson Education.
4. Genetics; B.D. Singh; Kalyani Publication
5. Life-The Science of Biology; David Sadava; 9th Edition; W. H. Freeman & Company

Paper No. 17: Plant Tissue Culture **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Introduction:** History and scope of plant tissue culture with timeline. Concept of totipotency. Aseptic techniques in preparation, packing and sterilization of glassware, laboratory fumigation, surface disinfection.	07 L
II	**Infrastructure and Organization :** General laboratory setup, maintainance of aseptic conditions and practices in plant tissue culture laboratory. Significance and importance of laboratory equipments, instruments, glassware and other requirements in plant tissue culture laboratory. Levels of safety.	08 L
III	**Culture Techniques** Culture media, media composition with significance and preparation. Culture techniques – callus, suspension, organ culture, anther and pollen culture. Organogenesis, somatic embryogenesis, factors affecting somatic embryogenesis. Plant hardening, Artificial seed production	10 L
IV	**Clonal Propagation** **Micropropagation**: Stages, Micropropagation through callus, Axillary Branching, Adventitious buds, Factor affecting, Limitations & Applications of micropropagation. **Somaclonal variation:** Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism	10 L
V	**Protoplast culture:** Protoplast isolation, gene transfer in protoplast, fusion, cell wall regeneration & culture. Production of hybrids & cybrid. Cryopreservation.	10 L

References

1. Introduction to plant tissue culture- M.K. Razdan
2. 2.Plant tissue culture-Theory & practice-S.S.Bhojwani & M.K. Razdan
3. Plant tissue culture-Kalyankumar Dey
4. Biotechnology- B.D. Singh
5. A text book of Biotechnology- R.C. Dubey
6. Biotechnology- H.S. Chawla

Paper No. 18: Animal Tissue Culture (45 Lectures = 3 Credits)

Unit	Content	Lectures
I	**Introduction:** History. Laboratory design, Characteristics of animal cell in culture, substrate for cell growth, Equipments required for animal cell culture – Laminar air flow, CO_2 incubator, Centrifuge, Inverted microscope etc. Sterilization of apparatus.	09 L
II	**Media** Culture media: – Natural media, synthetic media – serum containing media, serum free media, balanced salt solution, and complete media. Physicochemical properties of media, Sterilization of media.	09 L
III	**Culture techniques:** Primary cell culture: Cell Separation – Mechanical, Enzymatic. Criteria for subculture, Types of organs culture, **Cell synchronization-** Cell separation by physical means and chemical blockade	09 L
IV	**Establishment of cell lines-** Cell lines selection and routine maintenance of cell lines, Cell counting and monitoring, Indirect methods of cell determination – Protein, DNA, LDH, and Glucose determination. Cell line Identification: Tests of identification – Karyotyping, Isozymes, Labeled antibodies and DNA fingerprinting. Analysis of the cell cycle – Tritiated thymidine pulse method, Flow cytometry	09 L
V	**Genetic engineering & Applications of animal cell culture-** **Genetic engineering of animal cells in culture:** Gene transfer into mammalian cells – Transfer of naked DNA, DNA transfer using viruses.. **Production of animal cell in bioreactors:** purpose, production strategy, purification, Efficiency & productivity of a culture system, Cost of the process. **Applications:** Monoclonal antibodies. Viral vaccines – production of viruses & cell lines for vaccine production, Glycoprotein from mammalian cells – Interferons, Plasminogen activators, Blood clotting factors and Erythropoietin. Cells as a product – Artificial skin, Organs, Drugs screening & toxicity tests. Gene Therapy	09 L

References

1. Animal Tissue culture : J. Paul
2. Culture of animal cell 3rd edition-R Ian Freshney
3. Animal cell culture- R.W.Masters
4. Animal biotechnology-M.M.Ranga
5. Animal biotechnology-R.Sasidhara
6. Animal cell culture technique-Ed. Martin Clynes Springer
7. Cell growth & division a practical approach-Ed. R. B. Sega& R.L.Press

Paper No. 19: Bioenergetics and Enzymology (45 Lectures = 3 Credits)

Unit	Content	Lectures
I	**Principles of Thermodynamics :** Thermodynamic systems; First and second law of thermodynamics; Free energy concept; Biological standard state; Standard free energy change; Mass action ratio of reaction; Determination of free energy change of reaction; Relationship between equilibrium constant and standard free energy change (Problems based on it); Properties of standard and actual free energy change.	07 L
II	**Biochemical Reactions :** Introduction to aldol condensation, claisen condensation, internal rearrangement, isomerization, elimination, free radical reactions; Group transfer reactions (phosphate group transfer) free energy of hydrolysis of ATP, other high energy compounds, group transfer reactions by ATP, ATP as universal currency of free energy in biological system; Biological Oxidation reduction reactions, Biological half reactions, Electron transfer from biomolecules, Redox potential and measurement, Relation between standard redox potential and free energy change (derivation and numericals included); Comparison of biochemical and chemical equations	10 L
III	**Fundamentals of Enzymology :** Introduction – definition, apoenzyme, coenzymes, holoenyme, prosthetic group, cofactors; Classification of enzymes with two examples of each class; IUB nomenclature and numbering of enzymes; Enzyme catalyzed and uncatalyzed reactions; concept of activation energy in enzyme catalysed reaction; Unit of enzyme activity, specific activity and turnover number; Active site of enzyme and its features; Lock and key mechanism; Induced fit hypothesis; Types of enzyme specificity	09 L
IV	**Enzyme Kinetics :** Factors affecting enzyme activity – pH, temperature, substrate concentration, product concentration, inhibitors and activator; Derivation of Michaelis-Menten equation for single substrate; Significance of Km and Vmax; Lineweaver Burk plot and limitations; Enzyme inhibition with kinetics – irreversible, competitive, uncompetitive and non competitive inhibition.	06 L
V	**Advances in Enzymology :** Isoenzymes of LDH and their clinical importance; Allosteric enzymes – allosteric modulator; Regulation of enzyme in living system (allosteric regulation, activation of latent enzymes, compartmentation of metabolic pathways, control of enzyme synthesis, enzyme degradation, isoenzymes); Abzymes; Non protein enzymes – ribozymes; Biological role of enzymes.	08 L

References

1. Lehninger's Principles of Biochemistry –Nelson & Cox, 5th Edition, W.H. Freeman and Company, New York.
2. Fundamentals of Biochemistry – J. L. Jain, S. Chand & Company Ltd, New Delhi.
3. Fundamentals of Biochemistry – Voet & Voet, 3rd Edition, W.H. Freeman and Company, New York.
4. Biochemistry – U. Satyanarayan, 3rd Edition, Books and allied (P) Ltd.

Paper No. 20: Metabolism **(45 Lectures = 3 Credits)**

Unit	Content	Lectures
I	**Carbohydrate metabolism** Glycolysis and its energetics, gluconegenesis, reciprocal regulation both cycles, lactic acid and ethanol fermentation; TCA cycle its regulation and energetic; Glycogenesis and glycogenolysis; Reactions and physiological significance of pentose phosphate pathway.	09 L
II	**Oxidative phosphorylation** Ultra structure of mitochondria; Components of respiratory chain, membrane arrangement of respiratory chain and electron transfer; Q cycle; mechanism of oxidative phosphorylation (Chemiosmotic coupling hypothesis); ATP synthase complex and ATP generation; Stoichiometry of O_2 consumption and ATP synthesis; Inhibitors of electron transport chain and ATP synthase complex; Uncouplers; Transport of reducing potential from cytosole to mitochondria	08 L
III	**Brief overview of Photosynthesis** Location; light harvesting in green plants; Photosystem I & II; Z scheme of non-cyclic photophosphorylation; Cyclic photophosphorylation; Dark reactions – C_3 and C_4 pathway; Rubisco enzyme; Synthesis of sucrose and starch	06 L
IV	**Amino Acid and Nucleotide Metabolism** General reactions of amino acid metabolism – Transamination, deamination and decarboxylation; Urea cycle; Degradation and biosynthesis of amino acids, glycogenic and ketogenic amino acids; Nucleotide Metabolism – Sources of the atoms in the purine and pyrimidine molecules; Outline of biosynthesis and degradation of purine and pyrimidines (Structures not required). Regulation of purine and pyrimidine metabolism	09 L
V	**Lipid Metabolism** Hydrolysis of triacylglycerols; Transport of fatty acid into mitochondria; β oxidation of saturated fatty acids, ATP yield from palmitic acid oxidation; Oxidation of unsaturated and odd chain fatty acids; Biosynthesis of saturated and unsaturated fatty acids, triglyceridse, phospholipids and cholesterol; Regulation of cholesterol metabolism.	08 L

References

1. Lehninger's Principles of Biochemistry –Nelson & Cox, 5th Edition, W.H. Freeman and Company, New York.
2. Fundamentals of Biochemistry – J. L. Jain, S. Chand & Company Ltd, New Delhi.
3. Fundamentals of Biochemistry – Voet & Voet, 3rd Edition, W.H. Freeman and Company, New York.
4. Harper's Illustrated Biochemistry – R. K. Murray, 26th Edition, Lange Medical Books/McGraw-Hill, Medical Publishing Division, New Delhi.
5. Biochemistry – Lubert Stryer, 5th Edition, W.H. Freeman and Company, New York.
6. Biochemistry – U. Satyanarayan, 3rd Edition, Books and allied (P) Ltd.

B. Sc. II Biotechnology Practical Syllabus (Annual)

Practical course No. 5: Techniques in Molecular Genetics

4 Credits

(Based on Paper No. 9, 10, 15 and 16)

Sr. No.	Practical Title
1	Meiosis in Flower Buds of *Allium cepa*-Acetocarmine Stain
2	Mitosis in Onion Root Tip (*Allium cepa*)
3	Study of Mendelian Traits
4	Problem sets in Mendelian inheritance, single point, two point crosses and gene interaction & gene mapping
5	Induction of Polyploidy
6	Identification of mutant phenotypes- Body shape / nature of wings / eye colour in *Drosophila*.
7	Sex-Linked Inheritance in *Drosophila melanogaster*
8	Preparation of Salivary Gland Chromosomes
9	Culture maintenance of *Drosophila*
10	Spontaneous mutation: Fluctuation test – StrR
11	Examples based on Hardy Weinberg Equilibrium
12	Isolation of bacterial DNA
13	Isolation of Plasmid DNA
14	Isolation of DNA from animal cell / plant cell / yeast cells
15	Isolation of DNA from yeast cells
16	Isolation of RNA from yeast
17	Isolation of RNA from plant cells / tissue
18	Separation of nucleotides by column chromatography.
19	Isolation of coliphages
20	Transfer of genetic material - Transformation
21	Transfer of genetic material – Conjugation
22	Transfer of genetic material - Transduction
23	Visit to Molecular Biology Laboratory

Practical Course No. 6: Methods in Advanced Biotechnology

4 Credits

(Based on Paper No. 11, 12, 17 and 18)

Sr. No.	Practical Title
1	Measurement of pH of any biological sample
2	Cell disruption by SDS/ Lysozyme
3	Ammonium sulphate precipitation of proteins
4	Purification of proteins by dialysis
5	Immobilization of enzymes / cells.
6	Maltose calibration curve by using colorimeter
7	Growth curve by turbidimetry
8	Electrophoresis of RNA/DNA.
9	UV spectra of protein and nucleic acid
10	SDS-PAGE for protein mol. Wt. Determination
11	Gel permeation chromatography
12	Protein estimation by Lowery Method
13	Separation of leaf pigment by paper chromatography
14	Amino acids separation by TLC.
15	Washing of glassware, Sterilization techniques
16	Plant Tissue Culture Media preparation
17	Isolation of explants, establishment of Callus
18	Aseptic seed germination
19	Initiation and establishment of cell suspension culture
20	Establishment of Ovule culture
21	Establishment of Anther culture
22	Protoplast isolation
23	Separation of serum and plasma from blood by using centrifugation technique
24	Animal Cell culture media preparation
25	Cell separation by Trypsinization
26	Cell counting
27	Visit to a Tissue Culture Laboratory

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Practical Course No. 7: Techniques in Metabolism, Enzymology and Immunology

4 Credits

(Based on Paper No. 13, 14, 19 and 20)

Sr. No.	Practical Title
1	To determine the relative strength of any known redox couple by titration method
2	To study the factors affecting the amylase enzyme (from any source) activity: a) Presence and absence of activator (chloride ion) & inhibitors (Hg & Cu metal), b) Substrate concentration, c) Temperature, and d) pH
3	To study induction of invertase enzyme in green gram seeds
4	To separate the isoenzymes of lactate dehydrogenase by polyacrylamide gel electrophoresis
5	To estimate the glucose in blood by Folin-Wu method
6	To isolate the Cytochrome C from goat heart
7	To isolate chloroplast from spinach leaves and assay of Hill's reaction by spectrophotometer
8	To estimate chlorophyll from spinach leaves and to separate photosynthetic pigment by paper chromatography
9	To estimate the blood urea by DAM method
10	To determine the acid value of fat
11	To estimate the blood cholesterol by Zak's method
12	Determination of blood clotting time
13	Estimation of Hemoglobin
14	Total RBC counting
15	Total Leucocytes counting
16	Study of differential Leucocytes counting
17	Latex agglutination test
18	Coomb's test
19	Ouchterlony procedure
20	Counter current immunoelectrophoresis
21	Rocket immunoelectrophoresis
22	Widal Test
23	VDRL Test
24	Study of malaria parasite
25	Visit to any recognized research institute to understand working in Biochemistry and Microbiology (or Pathology lab) laboratory

Examination Pattern (UA - University assessment)

The examination for theory (70 marks) is conducted semester wise by university as per University Time Table.

Nature of Theory question paper for each theory paper.

Solapur University, Solapur
Nature of Question Paper for Semester Pattern
(New C. G. P. A.)
Faculty of Science
B.Sc. II Biotechnology

Time:- 3 hrs **Total Marks-70**

Q. 1) Multiple choice questions **(10)**

i) ----------

a) b) c) d)

ii)
iii)
iv)
v)
vi)
vii)
viii)
ix)
x)

Q. 2) Answer any five (out of seven) of the following **(15)**

i)
ii)
iii)
iv)
v)
vi)
vii)

Q. 3) Answer any three (out of four) of the following **(15)**

i)
ii)
iii)
iv)

Q. 4) Answer any three (out of four) of the following **(15)**

i)
ii)
iii)
iv)

Q. 5) Answer any three (out of four) of the following **(15)**

i)
ii)
iii)
iv)

The examination for Practical (140 marks) is conducted annually at the end of second term of academic year by university as per University Time Table.

Nature of Practical question paper for each practical course.

Solapur University, Solapur

Nature of Question Paper for Practical
(New C. G. P. A.)
Faculty of Science
B.Sc. II Biotechnology

Duration:- 2 Days (Each day of 6 hours) **Total Marks-140**

Q. 1)	**A)** Major Practical performance	**(20)**
	B) Major Practical performance	**(20)**
Q. 2)	**A)** Major Practical performance	**(15)**
	B) Major Practical performance	**(15)**
Q. 3)	**A)** Minor Practical performance	**(10)**
	B) Minor Practical performance	**(10)**
	C) Minor Practical performance	**(10)**
Q. 4)	**A)** Principle / approach writing (two experiment)	**(10)**
	B) Spotting (five spot)	**(10)**
Q. 5)	Visit report	**(10)**
Q. 6)	**a)** Journal	**(05)**
	b) Viva-voce	**(05)**