MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA 686 666

NAAC Accredited 'A^{+}' Grade Institution

Email: mac@macollege.in

www.macollege.in

SCHEME AND SYLLABUS

FOR

POST GRADUATE PROGRAMME

UNDER CREDIT SEMESTER SYSTEM

MAC-PG-CSS 2020

IN

M.Sc. BIOTECHNOLOGY

EFFECTIVE FROM THE ACADEMIC YEAR 2020-2021

BOARD OF STUDIES IN BIOTECHNOLOGY (PG)

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BOARD OF STUDIES IN BIOTECHNOLOGY (PG)

Academic Council

COMPOSITION – With Effect From 01-06-2020

Chairperson : **Dr. Shanti. A. Avirah**
Principal
Mar Athanasius College (Autonomous), Kothamangalam

Experts/Academicians from outside the college representing such areas as Industry, Commerce, Law, Education, Medicine, Engineering, Sciences etc.

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   Mar Athanasius College Association
   Kothamangalam

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   Former Vice-Chairman
   University Grants Commission,
   New Delhi.

3. **Dr. R.K. Chauhan**
   Former Vice-Chancellor, Lingaya's University,
   Faridabad, Haryana -121002

4. **Dr. Sheela Ramachandran**
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   Atmiya University
   Rajkot.

5. **Prof. Kuruvilla Joseph**
   Senior Professor and Dean,
   Indian Institute of Space Science and Technology (IIST),
   Department of Space, Govt. of India, Valiyamala, Thiruvananthapuarm

6. **Dr. M.C. Dileep Kumar**
   Former Vice Chancellor
   Sree Sankaracharya Sanskrit University
   Kalady, Kerala, India

7. **Dr. Mathew. K.**
   Principal
   Mar Athanasius College of Engineering,
   Kothamangalam, Kerala - 686 666

8. **Adv. George Jacob**
   Senior Advocate
   High Court of Kerala
   Ernakulam

Nominees of the university not less than Professors

9. **Dr. Biju Pushpan**
SAS SNDP Yogam College
Konni

10. **Dr. Suma Mary Sacharia**
UC College
Aluva

11. **Dr. V.B. Nishi**
Associate Professor
Sree Shankara College, Kalady.

Member Secretary

12. Dr. M.S.Vijayakumary

Dean – Academics

Mar Athanasius College (Autonomous)

Kothamangalam

Four teachers of the college representing different categories of teaching staff by rotation on the basis of seniority of service in the college.

13. **Dr. Bino Sebastian. V** (Controller of Examinations)

14. **Dr. Manju Kurian,** Asst. Professor, Department of Chemistry

15. **Dr. Smitha Thankachan**, Asst. Professor, Department of Physics

16. **Dr. Asha Mathai**, Asst. Professor, Department of Malayalam

Heads of the Departments

17. Dr. Mini Varghese, Head, Department of Hindi

18. Dr. Jayamma Francis, Head, Department of Chemistry

19. Dr. Igy George, Head, Department of Economics

20. Ms. Shiny John, Head, Department of Computer Science

21. Dr. Deepa. S, Head, Department of Physics

22. Dr. Rajesh. K. Thumbakara, Head, Department of Mathematics

23. Dr. Aji Abraham, Head, Department of Botany
24. Dr. Selven S., Head, Department of Zoology
25. Dr. Diana Ann Issac, Head, Department of Commerce
26. Ms. Sudha. V, Head, Department of Statistics
27. Dr. Aswathy Balachandran, Head, Department of English
28. Dr. Diana Mathews, Head, Department of Sociology
29. Dr. Jani Chungath, Head, Department of History
30. Dr. Seena John, Head, Department of Malayalam
31. Mr. Haary Benny Chettiamkudiyil, Head, Department of Physical Education
32. Ms. Shari Sadasivan, Head, Department of M. Com. International Business
33. Ms. Sheeba Stephen, Head, Department of B. Com Tax Procedure and Practice
34. Dr. Julie Jacob, Head, Department of Biochemistry
35. Ms. Nivya Mariyam Paul, Head, Department of Microbiology
36. Ms. Jaya Vinny Eappen, Head, Department of Biotechnology
37. Ms. Shalini Binu, Head, Department of Actuarial Science
38. Prof. Dilmol Varghese, Head, Department of M. Sc Zoology
39. Ms. Simi. C.V, Head, Department of M.A. History
40. Ms. Bibin Paul, Head, Department of M. A. Sociology
41. Ms. Sari Thomas, Head, Department of M.Sc Statistics

BOARD OF STUDIES FOR M.Sc BIOCTECHNOLOGY PROGRAMME

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Dr. P.N. Rangarajan	Professor Department of Biochemistry Indian Institute of Sciences, Bengaluru
Dr. Tapas Manna	Associate Professor and Head Department of Biology, Indian Institue of science Education and Research, Thiruvananthapuram

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	CMLRE, Kochi
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	CIFT, Kochi

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	Mar Athanasius College, Kothamangalam
Mr. Paul George	Assistant Professor
	Department of Biotechnology
	Mar Athanasius College, Kothamangalam
Dr. Jithin Thomas	Assistant Professor
	Department of Biotechnology
	Mar Athanasius College, Kothamangalam
Dr. Julie Jacob	Assistant Professor and Head
	Department of Biochemistry
	Mar Athanasius College, Kothamangalam
Dr. Asha Gangadharan	Assistant Professor
	Department of Biochemistry
	Mar Athanasius College, Kothamangalam
	Assistant Professor

Mrs. Elizabeth Jacob	Department of Biochemistry
	Mar Athanasius College, Kothamangalam
	Assistant Professor and Head
Mrs. Nivya Mariyam Paul	Department of Microbiology
	Mar Athanasius College, Kothamangalam
Mrs. Elza John	Assistant Professor
	Department of Microbiology
	Mar Athanasius College, Kothamangalam
Dr. Nayomi John	Assistant Professor
	Department of Microbiology
	Mar Athanasius College, Kothamangalam

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PREFACE

Education in India has always been valued more than mere considering it as a means towards earning a good living. Right from pre-historic days, Education, especially higher education, has been given a predominant position in the Indian society. Ancient India considered knowledge as the third eye that gives insight into all affairs of life. Indian Higher Education Structure is traced back to Nalanda and Takshashila Institutions. Nevertheless, Gurukulas, Agrahars, Viharas and Madarasas were the nerve centres of knowledge and wisdom. The great universities flourished in India even centuries back, when most of the western world was groping in the dark. Those were the halcyon days when India led the world in scientific knowledge and philosophical speculations. Great scholar Max Muller has narrated in his own words: "If I were asked under what sky the human mind has most fully developed some of its choicest gifts, has most deeply pondered on the greatest problems of life, and has found solutions to some of them which well deserve the attention of even those who have studied Plato and Kant, I should point to India".

Mar Athanasius College has been instrumental in providing knowledge to thousands and thousands of students in the realm of Higher Education. The educational framework of the institution creates an atmosphere to flourish arts, science and research. The institution has crossed another milestone on its path towards academic excellency when the autonomy was conferred on it in March 2016. In order to fulfill the dreams of academic autonomy, the institution had resolved to constitute Board of Studies for all PG Programmes for restructuring the Curriculum and Syllabi, subject to the Regulations and Guidelines of the Parent University, i.e, Mahatma Gandhi University, Kottayam and also in accordance with the UGC rules. This regulation is the accomplishment of the task of imparting knowledge and wisdom to the students at the higher education level, so as to prepare them to live with dignity and noble thoughts.

The task of restructuring was done by the proposals and recommendations of the members of Board of Studies constituted by the institution for each PG Programme. The duration of the programme, examination pattern, method of valuation and number of credits assigned to each course remain on par with that of the parent university.

LIST OF POST GRADUATE PROGRAMMES IN MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

SL. NO.	PROGRAMME	DEGREE	FACULTY
1	ENGLISH	MA	LANGUAGE AND LITERATURE
2	ECONOMICS	MA	SOCIAL SCIENCES
3	SOCIOLOGY	MA	SOCIAL SCIENCES
4	HISTORY	MA	SOCIAL SCIENCES
5	MATHEMATICS	M.Sc	SCIENCE
6	CHEMISTRY	M.Sc	SCIENCE
7	PHYSICS	M.Sc	SCIENCE
8	BOTANY	M.Sc	SCIENCE
9	STATISTICS	M.Sc	SCIENCE
10	ZOOLOGY	M.Sc	SCIENCE
11	BIOCHEMISTRY	M.Sc	SCIENCE
12	BIOTECHNOLOGY	M.Sc	SCIENCE
13	MICROBIOLOGY	M.Sc	SCIENCE
14	ACTUARIAL SCIENCE	M.Sc	SCIENCE
15	FINANCE AND TAXATION	M.Com	COMMERCE
16	MARKETING AND INTERNATIONAL BUSINESS	M.Com	COMMERCE

REGULATIONS OF THE POSTGRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM MAC-PG-CSS2020 (2020 Admission onwards)

1. SHORT TITLE

1.1 These Regulations shall be called "Mar Athanasius College (Autonomous) Regulations (2020) governing Postgraduate Programmes under the Credit Semester System (MAC-PG-CSS2020)".

1.2 These Regulations shall come into force from the Academic Year 2020-2021.

2. SCOPE

2.1 The regulations provided herein shall apply to all Regular Postgraduate (PG) Programmes, M.A. /M.Sc. /M.Com. conducted by Mar Athanasius College (Autonomous) with effect from the academic year 2020-2021 admission onwards.

3. DEFINITIONS

3.1 **'Academic Committee'** means the Committee constituted by the Principal under this regulation to monitor the running of the Post-Graduate programmes under the Credit Semester System (MAC-PG-CSS2020).

3.2 **'Academic Week'** is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day. A sequence of 18 such academic weeks constitutes a semester.

3.3 '**Audit Course**' is a course for which no credits are awarded.

3.4 **'CE' means Continuous Evaluation (Internal Evaluation)**

3.5 **'College Co-ordinator'** means a teacher from the college nominated by the Principal to look into the matters relating to MAC-PG-CSS2020 for programmes conducted in the College.

3.6 **'Comprehensive Viva-Voce'** means the oral examinations conducted by the appointed examiners and shall cover all courses of study undergone by a student for the programme.

3.7 **'Common Course'** is a core course which is included in more than one programme with the same course code.

3.8 '**Core Course**' means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

3.9 '**Course**' means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork / seminar / project /practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

3.10 **'Course Code'** means a unique alpha numeric code assigned to each course of a programme.

3.11 '**Course Credit**' One credit of the course is defined as a minimum of one-hour lecture /minimum of 2 hours lab/field work per week for 18 weeks in a Semester. The course will be considered as completed only by conducting the final examination.

3.12 **'Course Teacher'** means the teacher of the institution in charge of the course offered in the programme.

3.13 **'Credit (Cr)'** of a course is a numerical value which depicts the measure of the weekly unit of work assigned for that course in a semester.

3.14 '**Credit Point(CP)**' of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course **CP=GP x Cr**.

3.15 '**Cumulative Grade Point Average(CGPA)**' is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places. CGPA determines the overall performance of a student at the end of a programme.

(CGPA = Total CP obtained/ Total credits of the programme)

3.16 '**Department**' means any teaching Department offering a programme of study in the institution.

3.17 '**Department Council**' means the body of all teachers of a Department in a College.

3.18 'Dissertation' means a long document on a particular subject in connection with the project /research/ field work etc.

3.19 '**Duration of Programme**' means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be 4 semesters spread over two academic years.

3.20 '**Elective Course**' means a course, which can be substituted, by equivalent course from the same subject.

3.21 **'Elective Group'** means a group consisting of elective courses for the programme.

3.22 **'ESE' means End Semester Evaluation (External Evaluation).**

3.23 **'Evaluation'** is the process by which the knowledge acquired by the student is quantified as per the criteria detailed in these regulations.

3.24 **External Examiner** is the teacher appointed from other colleges for the valuation of courses of study undergone by the student in a college. The external examiner shall be appointed by the college.

3.25 '**Faculty Advisor**' is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.

3.26 '**Grace Grade Points**' means grade points awarded to course(s), recognition of the students' meritorious achievements in NSS/ Sports/ Arts and cultural activities etc.

3.27 '**Grade Point**' (GP) Each letter grade is assigned a Grade point (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

3.28 '**Grade Point Average (GPA)**' is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade point obtained in the course by the sum of the weights of Course. **(GPA= ∑WGP / ∑W)**

3.29 '**Improvement Course**' is a course registered by a student for improving his performance in that particular course.

3.30 **'Internal Examiner'** is a teacher nominated by the department concerned to conduct internal evaluation.

3.31 '**Letter Grade**' or '**Grade**' for a course is a letter symbol (A+, A, B+, B, C+, C, D) which indicates the broad level of performance of a student for a course.

3.32 **MAC-PG-CSS2020 means Mar Athanasius College Regulations Governing Post Graduate programmes under Credit Semester System, 2020.**

3.33 '**Parent Department**' means the Department which offers a particular postgraduate programme.

3.34 '**Plagiarism**' is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

3.35 '**Programme**' means the entire course of study and Examinations.

3.36 **'Project'** is a core course in a programme. It means a regular project work with stated credits on which the student undergoes a project under the supervision of a teacher in the parent department/ any appropriate research centre in order to submit a dissertation on the project work as specified. It allows students to work more autonomously to construct their own learning and culminates in realistic, student-generated products or findings.

3.37 '**Repeat Course**' is a course to complete the programme in an earlier registration.

3.38 '**Semester**' means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days each.

3.39 '**Seminar**' means a lecture given by the student on a selected topic and expected to train the student in self-study, collection of relevant matter from various resources, editing, document writing and presentation.

3.40 '**Semester Grade Point Average (SGPA)**' is the value obtained by dividing the sum of credit points (CP) obtained by the student in the various courses taken in a semester by the total number of credits for the course in that semester. The SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester (SGPA = Total CP obtained in the semester / Total Credits for the semester).

3.41 '**Tutorial**' means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

3.42 '**Weight**' is a numeric measure assigned to the assessment units of various components of a course of study.

3.43 **University** means Mahatma Gandhi University Kottayam to which the college is affiliated.

3.44 '**Weighted Grade Point (WGP)**' is grade points multiplied by weight. **(WGP=GPxW)**

3.45 'Weighted Grade Point Average (WGPA)' is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade points by the sum of the weights. WGPA shall be obtained for CE (Continuous Evaluation) and ESE (End Semester Evaluation) separately and then the combined WGPA shall be obtained for each course.

4. ACADEMIC COMMITTEE

4.1. There shall be an Academic Committee constituted by the Principal to

Manage and monitor the working of MAC-PG-CSS2020.

4.2. The Committee consists of:

1. Principal
2. Dean, Administration
3. Dean, Academics
4. IQAC Coordinator
5. Controller of Examinations
6. One Faculty each representing Arts, Science, Commerce, Languages, and Self Financing Programmes

5. PROGRAMME STRUCTURE

5.1 Students shall be admitted to post graduate programme under the various Faculties. The programme shall include three types of courses, Core Courses, Elective Courses and Common core courses. There shall be a project with dissertation and comprehensive viva-voce as core courses for all programmes. The programme shall also include assignments / seminars/ practical's etc.

5.2 No regular student shall register for more than 25 credits and less than16

credits per semester unless otherwise specified. The total minimum credits, required for completing a PG programme is 80.

5.3. Elective Courses and Groups

5.3.1 There shall be various groups of Programme Elective courses for a Programme such as Group A, Group B etc. for the choice of students subject to the availability of facility and infrastructure in the institution and the selected group shall be the subject of specialization of the programme.

5.3.2 The elective courses shall be either in fourth semester or distributed among third and fourth semesters. There may be various groups of Elective courses (three elective courses in each group) for a programme such as Group A, Group B etc. for the choice of students, subject to the availability of facility and infrastructure in the institution.

5.3.3 The selection of courses from different elective groups is not permitted.

5.3.4 The elective groups selected for the various Programmes shall be

intimated to the Controller of Examinations within two weeks of commencement of the semester in which the elective courses are offered. The elective group selected for the students who are admitted in a particular academic year for various programmes shall not be changed.

5.4 P roject Work

5.4.1. Project work shall be completed in accordance with the guidelines given in the curriculum.

5.4.2 Project work shall be carried out under the supervision of a teacher of the department concerned.

5.4.3. A candidate may, however, in certain cases be permitted to work on the project in an Industrial/Research Organization on the recommendation of the supervising teacher.

5.4.4 There shall be an internal assessment and external assessment for the project work.

5.4.5. The Project work shall be evaluated based on the presentation of the project work done by the student, the dissertation submitted and the viva-voce on the project.

5.4.6 The external evaluation of project work shall be conducted by two external examiners from different colleges and an internal examiner from the college concerned.

5.4.7 The final Grade of the project (External) shall be calculated by taking the average of the Weighted Grade Points given by the two external examiners and the internal examiner.

5.5 Assignments: Every student shall submit at least one assignment as an internal component for each course.

5.6 **Seminar Lecture:** Every PG student shall deliver one seminar lecture as an Internal component for every course with a weightage of two. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the various resources, editing, document writing and presentation.

5.7 **Test Papers (Internal):** Every PG student shall undergo at least two class tests as an internal component for every course with a weight one each. The best two shall be taken for awarding the grade for class tests.

5.8. **No courses shall have more than 5 credits unless otherwise specified.**

5.9. **Comprehensive Viva-Voce** -Comprehensive Viva-Voce shall be conducted at the end of fourth semester of the programme and its evaluation shall be conducted by the examiners of the project evaluation.

5.9.1. Comprehensive Viva-Voce shall cover questions from all courses in the Programme.

5.9.2. There shall be an internal assessment and an external assessment for the Comprehensive Viva-Voce.

6. ATTENDANCE

6.1. The minimum requirement of aggregate attendance during a semester for appearing at the end-semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 15 days in a semester subject to a maximum of two times during the whole period of the programme may be granted by the University.

6.2 If a student represents his/her institution, University, State or Nation in Sports, NCC, or Cultural or any other officially sponsored activities such as college union/ university union etc., he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum 15 days in a Semester based on the specific recommendations of the Head of the Department or teacher concerned.

6.3 Those who could not register for the examination of a particular semester due to shortage of attendance may repeat the semester along with junior batches, without considering sanctioned strength, subject to the existing University Rules and Clause 7.2.

6.4. A Regular student who has undergone a programme of study under earlier regulation/ Scheme and could not complete the Programme due to shortage of attendance may repeat the semester along with the regular batch subject to the condition that he has to

undergo all the examinations of the previous semesters as per the MAC-PG-CSS2020 regulations and conditions specified in 6.3.

6.5 A student who had sufficient attendance and could not register for fourth semester examination can appear for the end semester examination in the subsequent years with the attendance and progress report from the principal.

7. REGISTRATION/ DURATION

7.1 A student shall be permitted to register for the programme at the time of admission.

7.2 A student who registered for the Programme shall complete the Programme within a period of four years from the date of commencement of the programme.

7.3 Students are eligible to pursue studies for additional post graduate degree. They shall be eligible for award of degree only after successful completion of two years (four semesters of study) of college going.

8. ADMISSION

8.1 The admission to all PG programmes shall be done through the Centralised Allotment Process of Mar Athanasius College (Autonomous), Kothamangalam (MAC-PG CAP) as per the rules and regulations prescribed by the affiliating university and the Government of Kerala from time to time.

8.2 The eligibility criteria for admission shall be as announced by the Parent University from time to time.

9. ADMISSION REQUIREMENTS

9.1 Candidates for admission to the first semester of the PG programme through CSS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of Mahatma Gandhi University as eligible thereto.

9.2 Students admitted under this programme are governed by the Regulations in force.

10. PROMOTION:

10.1 A student who registers for the end semester examination shall be promoted to the next semester

10.2 A student having 75% attendance and who fails to register for examination of a particular semester will be allowed to register notionally and is promoted to the next semester, provided application for notional registration shall be submitted within 15 days from the commencement of the next semester.

10.3 The medium of Instruction shall be English except programmes under faculty of Language and Literature.

11. EXAMINATIONS

11.1 **End-Semester Examinations**: The examinations shall be at the end of each Semester of three-hour duration for each centralised and practical course.

11.2 Practical examinations shall be conducted at the end of each semester or at the end of even semesters as prescribed in the syllabus of the particular programme. The number of examiners for the practical examinations shall be prescribed by the Board of Studies of the programmes.

11.3 A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different weightage.

12. EVALUATION AND GRADING

12.1 **Evaluation:** The evaluation scheme for each course shall contain two parts; (a) End Semester Evaluation(ESE) (External Evaluation) and (b) Continuous Evaluation(CE)(Internal Evaluation). 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both End Semester Evaluation(ESE) and Continuous Evaluation(CE) shall be carried out using direct grading system.

12.2 **Direct Grading: The direct grading for CE (Internal) and ESE(External Evaluation) shall be based on 6 letter grades (A+, A, B, C, D and E) with numerical values of 5, 4, 3, 2, 1 and 0 respectively.**

12.3 **Grade Point Average (GPA):Internal and External components are separately graded and the combined grade point with weightage 1 for internal and 3 for external shall be applied to calculate the Grade Point Average (GPA) of each course. Letter grade shall be assigned to each course based on the categorization provided in 12.16.**

12.4 **Internal evaluation:** The internal evaluation shall be based on predetermined transparent system periodic written tests, assignments, seminars, lab skills, records, viva-voce etc.

12.5 Components of internal (CE) and External Evaluation (ESE): Grades shall be given to the evaluation of theory / practical / project / comprehensive viva-voce and all internal evaluations are based on the Direct Grading System.

Proper guidelines shall be prepared by the BOS for evaluating the assignment, seminar, practical, project and comprehensive viva-voce within the framework of the regulation.

12.6 There shall be no separate minimum grade point for internal evaluation.

12.7 **The model of the components and its weightages for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are shown in below:**

a) For Theory (CE) (Internal)

	Components	Weightage
i.	Assignment	1
ii.	Seminar	2
iii.	Best Two Test papers	2(1 each)
Total		**5**

(Average grade of the best two papers can be considered. For test paper all the Questions shall be set in such a way that the answers can be awarded A+, A, B, C, D, E grades)

b) For Theory (ESE) (External)

Evaluation is based on the pattern of Question specified **in 12.15.5**

c) For Practical(CE) (Internal)

Components	Weightage
Written / Lab Test	2
Lab Involvement and Record	1
Viva	2
Total	**5**

(The components and weightage of the practical(Internal) can be modified by the concerned BOS without changing the total weightage 5)

d) For Practical(ESE) (External)

Components	Weightage
Written / Lab Test	7
Lab Involvement and Record	3
Viva	5
Total	**15**

(The components and weightage of the practical (External) can be modified by the concerned BOS without changing the total weightage 15)

e) For Project(CE) (Internal)

Components	Weightage
Relevance of the topic and analysis	2
Project content and presentation	2
Project viva	1
Total	**5**

(The components and the weightage of the components of the Project (Internal) can be modified by the concerned BOS without changing the total weightage 5)

f) For Project (ESE) (External)

Components	Weightage
Relevance of the topic and analysis	3
Project content and presentation	7
Project viva	5
Total	**15**

(The components and the weightage of the components of the Project (External) can be modified by the concerned BOS without changing the total weightage 15)

g) Comprehensive viva-voce (CE) (Internal)

Components	Weightage
Comprehensive viva-voce(all courses from first semester to fourth semester)	5
Total	**5**

(Weightage of the components of the Comprehensive viva-voce(Internal) shall not be modified.)

h)Comprehensive viva-voce (ESE) (External)

Components	Weightage
Comprehensive viva-voce(all courses from first semester to fourth semester)	15
Total	**15**

(Weightage of the components of the Comprehensive viva-voce(External) shall not be modified.)

12.8 **All grade point averages shall be rounded to two digits.**

12.9 To ensure transparency of the evaluation process, the internal assessment

grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination.

12.10 **There shall not be any chance for improvement for Internal Grade.**

12.11 The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course and a copy should be kept in the college for verification for at least two years after the student completes the programme.

12.12 **External Evaluation.** The external examination in theory courses is to be conducted by the College at the end of the semester. The answers may be written in English or Malayalam except those for the Faculty of Languages. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination.

12.13 Photocopies of the answer scripts of the external examination shall be made available to the students on request as per the rules prevailing in the University.

12.14 The question paper should be strictly on the basis of model question paper set and directions prescribed by the BOS.

12.15. **Pattern of Questions**

12.15.1 **Questions shall be set to assess knowledge acquired, standard, and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. Due weightage shall be given to each module based on content/teaching hours allotted to each module.**

12.15.2 The question setter shall ensure that questions covering all skills are set.

12.15.3 A question paper shall be a judicious mix of short answer type, short essay type /problem solving type and long essay type questions.

12.15.4 The question shall be prepared in such a way that the answers can be awarded A+, A, B, C, D, E grades.

12.15.5 Weight: Different types of questions shall be given different weights to quantify their range as follows:

Sl.No.	Type of Questions	Weight	Number of questions to be answered
1	Short Answer type questions	1	8 out of 10
2	Short essay / problem solving type questions	2	6 out of 8
3	Long Essay Type questions	5	2 out of 4

12.16**Pattern of question for practical**. The pattern of questions for external evaluation of practical shall be prescribed by the Board of Studies.

12.17**DirectGradingSystem**

Direct Grading System based on a 6- point scale is used to evaluate the Internal and External examinations taken by the students for various courses of study.

Grade	Grade point(G)	Grade Range
A+	5	4.50 to 5.00
A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

12.18 **Performance Grading**

Students are graded based on their performance (GPA/SGPA/CGPA) at the examination on a 7-point scale as detailed below.

Range	Grade	Indicator
4.50 to 5.00	**A+**	**Outstanding**
4.00 to 4.49	**A**	**Excellent**
3.50 to 3.99	**B+**	**Very good**
3.00 to 3.49	**B**	**Good(Average)**
2.50 to 2.99	**C+**	**Fair**
2.00 to 2.49	**C**	**Marginal**
up to 1.99	**D**	**Deficient(Fail)**

12.19 No separate minimum is required for Internal Evaluation for a pass, but a minimum grade is required for a pass in an External Evaluation. However, a minimum C grade is required for pass in a Course

12.20 A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch.

12.21 **Improvement of Course**- The candidate who wish to improve the grade/grade point of the external examination of the of a course/ courses he/ she has passed can do the same by appearing in the external examination of the semester concerned along with the immediate junior batch. This facility is restricted to first and second semester of the programme.

12.22 **One Time Betterment Programme**- A candidate will be permitted to improve the **CGPA** of the programme within a continuous period of four semesters immediately following the completion of the programme allowing only once for a particular semester. The **CGPA** for the betterment appearance will be computed based on the **SGPA** secured in the original or betterment appearance of each semester whichever is higher.

If a candidate opts for the betterment of **CGPA** of a programme, he/she has to appear for the external examination of the entire semester(s) excluding practical /project/comprehensive viva-voce. One time betterment programme is restricted to students who have passed in all courses of the programme at the regular (First appearance)

12.23 **Semester Grade Point Average(SGPA) and Cumulative Grade Point Average (CGPA) Calculations.** The SGPA is the ratio of sum of the credit point of all courses taken by a student in a semester to the total credit for that semester. After the

successful completion of a semester, Semester Grade Point Average(SGPA) of a student in that semester is calculated using the formula given below.

Semester Grade Point Average -SGPA (S_j) = $\sum(C_i \times G_i) / \sum C_i$

(SGPA= Total credit Points awarded in a semester / Total credits of the semester)

Where 'S_j' is the j^{th} semester, 'G_i' is the grade point scored by the student in the i^{th} course 'C_i' is the credit of the i^{th} course.

12.24 Cumulative Grade Point Average (CGPA) of a programme is calculated using the formula:-

Cumulative Grade Point Average (CGPA) = $\sum(C_i \times S_i) / \sum C_i$

(CGPA= Total credit Points awarded in all semester / Total credits of the programme)

Where 'C_i' is the credit for the i^{th} semester, 'S_i' is the SGPA for the i^{th} semester. The **SGPA** and **CGPA** shall be rounded off to 2 decimal points.

For the successful completion of semester, a student shall pass all courses and score a minimum **SGPA** of 2.0. However a student is permitted to move to the next semester irrespective of her/his **SGPA**

13. GRADE CARD

13.1 The Institution under its seal shall issue to the students, a consolidated grade card on completion of the programme, which shall contain the following information.

a) Name of the University.

b) Name of college

c) Title of the PG Programme.

d) Name of Semesters

e) Name and Register Number of students

f) Code, Title, Credits and Max GPA(Internal, External & Total) of each course (theory &practical), project, viva etc in each semester.

g) Internal, external and Total grade, Grade Point (G), Letter grade and Credit point (P) in each course opted in the semester.

h) The total credits and total credit points in each semester.

i) Semester Grade Point Average (SGPA) and corresponding Grade in each semester

j) Cumulative Grade Point Average (CGPA), Grade for the entire programme.

k) Separate Grade card will be issued.

l) Details of description of evaluation process- Grade and Grade Point as well as indicators, calculation methodology of SGPA and CGPA as well as conversion scale shall be shown on the reverse side of the grade card.

14. AWARD OF DEGREE - The successful completion of all the courses with 'C' grade within the stipulated period shall be the minimum requirement for the award of the degree.

15. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluations conducted.

16. RANK CERTIFICATE

Rank certificate shall be issued to candidates who secure positions 1st and 2nd . Candidates shall be ranked in the order of merit based on the CGPA secured by them. Grace grade points awarded to the students shall not be counted for fixing the rank. Rank certificate shall be signed by the Principal and the Controller of Examinations.

17. **GRIEVANCE REDRESSAL COMMITTEE**

17.1 Department level: The College shall form a Grievance Redressal Committee in each Department comprising of the course teacher and one senior teacher as members and the Head of the Department as Chairperson. The Committee shall address all grievances relating to the internal assessment grades of the students.

17.2. College level: There shall be a college level Grievance Redressal Committee comprising of faculty advisor, college co-ordinator, one senior teacher and one staff council member and the Principal as Chairperson.

18. FACTORY VISIT / FIELD WORK/VISIT to a reputed research institute/ student interaction with renowned academicians may be conducted for all Programmes before the commencement of Semester III.

19. Each student may undertake INTERNSHIP/ON THE JOB TRAINING for a period of not less than 15 days. The time, duration and structure of internship/on the job training can be modified by the concerned Board of Studies.

20. **TRANSITORYPROVISION**

Notwithstanding anything contained in these regulations, the Principal shall, for a period of three year from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

21. **REPEAL**

The Regulations now in force in so far as they are applicable to programmes offered by the college and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Credit Semester System in their application to any course offered in a College, the latter shall prevail.

22. **Credits allotted for Programmes and Courses**

22.1 Total credit for each programme shall be **80**.

22.2 Semester-wise total credit can vary from 16to25

22.3 The minimum credit of a course is 2 and maximum credit is 5

23. **Common Course:** If a course is included as a common course in more than one programme, its credit shall be same for all programmes.

24. **Course Codes:** The course codes assigned for all courses (Core Courses, Elective Courses, Common Courses etc.) shall be unique.

25. **Models of distribution of courses, course codes, type of the course, credits, teaching hours for a programme are given in the following tables**

Programmes with practical -Total Credits 80- Scheme of the syllabus

0 **Semester**	**Course-Code**	**Course Name**	**Type of the Course**	**Teaching Hours Per Week**	**Credit**	**Total Credits**
I	PG20BS101	Biochemistry	core	4	4	19
	PG20BS102	Cell Biology & Genetics	core	4	4	
	PG20BS103-BT	Instrumentation & Biostatistics	core	4	4	
	PG20BS104-BT	Biophysics & Bioinformatics	core	3	3	
	PG20BSP1-BT	Laboratory Course I	core	10	4	
II	PG20BS205	General Microbiology	core	4	4	19
	PG20BS206	Immunology	core	4	4	
	PG20BS207-BT	Molecular Biology	core	4	4	
	PG20BS208-BT	Enzymology and Metabolism	core	3	3	
	PG20BSP2-BT	Laboratory Course II	core	10	4	
III	PG20BS309-BT	Bioprocess Technology	core	4	4	19
	PG20BS310-BT	Recombinant DNA technology	core	4	4	
	PG20BS311-BT	Environmental Biotechnology	core	4	4	
	PG20BS312-BT	Plant and Animal Biotechnology	core	3	3	
	PG20BSP3-BT	Laboratory Course III	core	10	4	
IV	PG20BSP4-BT	Laboratory Course IV	core	10	4	23
	PG20BS4P-BT	Project	core		4	
	PG20BS4V-BT	Viva Voce	core		3	
	PG20BS413-BT	Elective -1	Elective	4	4	
	PG20BS414-BT	Elective -2	Elective	4	4	
	PG20BS415-BT	Elective -3	Elective	4	4	
	Total					**80**

Appendix

1. Evaluation first stage – Both internal and external to be done by the teacher)

Grade	Grade Points	Range
A+	5	4.50 to 5.00
A	4	4.00 to 4.49
B	3	3.00 to 3.99
C	2	2.00 to 2.99
D	1	0.01 to 1.99
E	0	0.00

The final Grade range for courses, SGPA and CGPA

Range	Grade	Indicator
4.50 to 5.00	A+	Outstanding
4.00 to 4.49	A	Excellent
3.50 to 3.99	B+	Very good
3.00 to 3.49	B	Good
2.50 to 2.99	C+	Fair
2.00 to 2.49	C	Marginal
Upto1.99	D	Deficient(Fail)

Theory-External-ESE

Maximum weight for external evaluation is 30. Therefore Maximum Weighted Grade Point (WGP) is 150

Type of Question	Qn. No.'s	Grade Awarded	Grade Point	Weights	Weighted Grade Point
Short Answer	1	A+	5	1	5
	2	-	-	-	-
	3	A	4	1	4
	4	C	2	1	2
	5	A	4	1	4
	6	A	4	1	4
	7	B	3	1	3
	8	A	4	1	4
	9	B	3	1	3
	10	-	-	-	
Short Essay	11	B	3	2	6
	12	A+	5	2	10
	13	A	4	2	8
	14	A+	5	2	10
	15	-	-	-	-
	16	-	-	-	-
	17	A	4	2	8
	18	B	3	2	6
Long Essay	19	A+	5	5	25
	20	-	-	-	-
	21	-	-	-	-
	22	B	3	5	15
			TOTAL	**30**	**117**
Calculation : **Overall Grade of the theory paper = Sum of Weighted Grade Points /Total Weight = 117/30 = 3.90 = Grade B**					

Theory-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25.

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Assignment	1	A	4	4	**WGP/Total Weight= 24/5 =4.8**
Seminar	2	A+	5	10	
Test Paper 1	1	A+	5	5	
Test Paper 2	1	A+	5	5	
Total	**5**			**24**	**A+**

Practical-External-ESE

Maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75

Components	Weight(W)	Grade Awarded	Grade Point(GP)	WGP=W*GP	Overall Grade of the Course
Written/Lab Test	7	A	4	28	**WGP/Total Weight= 58 / 15 = 3.86**
Lab involvement & record	3	A+	5	15	
Viva	5	B	3	15	
Total	**15**			**58**	**B**

Practical-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Written/ Lab Test	2	A	4	8	**WGP/Total Weight=17/5 =3.40**
Lab involvement & record	1	A+	5	5	
Viva	2	C	2	4	
Total	**5**			**17**	**B**

Project-External-ESE

Maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP= W*GP	Overall Grade of the Course
Relevance of the topic & Analysis	3	C	2	6	**WGP/Total Weight = 56/15= 3.73**
Project Content &Presentation	7	A+	5	35	
Project Viva- Voce	5	B	3	15	
Total	**15**			**56**	**B**

Project-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Relevance of the topic & Analysis	2	B	3	6	**WGP/Total Weight= 21/5 = 4.2**
Project Content & Presentation	2	A+	5	10	
Project Viva-Voce	1	A+	5	5	
Total	**5**			**21**	**A**

Comprehensive viva-voce-External-ESE

Maximum weight for external evaluation is 15. Therefore Maximum Weighted Grade Point (WGP) is 75

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W*GP	Overall Grade of the Course
Comprehensive viva-voce	15	A	4	60	**WGP/Total Weight = 60 / 15 = 4**
Total	**15**			**60**	**A**

Comprehensive viva-voce-Internal-CE

Maximum weight for internal evaluation is 5. Therefore Maximum Weighted Grade Point (WGP) is 25

Components	Weight (W)	Grade Awarded	Grade Point(GP)	WGP=W *GP	Overall Grade of the Course
Comprehensive viva-voce	5	A+	5	25	**WGP/Total Weight = 25/ 5 = 5**
Total	**5**			**25**	**A+**

2. Evaluation Second stage-(to be done by the College)

Consolidation of the Grade(GPA) of a Course PC-1

The End Semester Evaluation (ESE) (External evaluation) grade awarded for the course PC-1 is A and its Continuous Evaluation (CE) (Internal Evaluation) grade is A. The consolidated grade for the course PC-1 is as follows

Evaluation	Weight	Grade awarded	Grade Points awarded	Weighted Grade Point
External	3	A	4.20	12.6
Internal	1	A	4.40	4.40
Total	**4**			**17**
Grade of a course.	GPA of the course =Total weighted Grade Points/Total weight= **17/4 =4.25 = Grade A**			

3. Evaluation Third stage-(to be done by the College)

Semester Grade Point Average (SGPA)

Course code	Titleof the course	Credits (C)	Grade Awarded	Grade Points(G)	Credit Points (CP=C X G)
01	**PC-1**	**5**	**A**	**4.25**	**21.25**
02	**-----**	**5**	**A**	**4.00**	**20.00**
03	**-----**	**5**	**B+**	**3.80**	**19.00**
04	**-----**	**2**	**A**	**4.40**	**8.80**
05	**-----**	**3**	**A**	**4.00**	**12.00**
TOTAL		**20**			**81.05**
SGPA	**Total credit points / Total credits = 81.05/20 = 4.05= Grade- A**				

4. Evaluation Third stage-(to be done by the College)

Cumulative Grade Point Average (CGPA)

If a candidate is awarded three **A+** grades in semester 1(SGPA of semester 1), semester 2(SGPA of semester 2), semester 4(SGPA of semester 4) and **B** grades in semester 3(SGPA of semester 3). Then CGPA is calculated as follows:

Semester	Credit of the Semesters	Grade Awarded	Grade point (SGPA)	Credit points
I	20	A+	4.50	90
II	20	A+	4.60	92
III	20	B	3.00	60
IV	20	A+	4.50	90
TOTAL	**80**			**332**
CGPA= Total credit points awarded / Total credit of all semesters = 332 / 80= 4.15 **(Which is in between 4.00 and 4.49 in 7-point scale)** **Therefore the overall Grade awarded in the programme is A**				

ELIGIBILITY FOR PG ADMISSION

Academic eligibility should be satisfied as on the last date of submission of academic data. No candidate shall be admitted to the PG programme unless he/she possess the qualifications and minimum requirements thereof, as prescribed by Mahatma Gandhi University from time to time.

If an applicant for admission is found to have indulged in ragging in the past or if it is noticed later that he/she had indulged in ragging, admissions shall be denied or he/she will be expelled from Mar Athanasius College (Autonomous), Kothamangalam.

Candidates should have passed the corresponding Degree Examination under the 10 + 2 + 3 pattern with one core/main subject and two complementary/subsidiary subjects from any of the Universities in Kerala or of any other University recognized by Mahatma Gandhi University as equivalent thereto for admission, subject to the stipulation regarding marks.

OR

Candidates who have passed Degree examination with Double or Triple main subject and candidates who have passed the Degree Examination in Vocational or Specialized Programmes are also eligible for admission. However, they have to submit copy of the Equivalency/Eligibility Certificate from Mahatma Gandhi University, stating that, their Qualifying Examination is recognized for seeking admission to the relevant P.G. Degree Programme(s) as applicable, at the time of admission. This provision is not applicable in the case of those applicants who have passed their qualifying examination from MG University.

The minimum requirements for admission to PG Degree Programmes are:

1. M.Sc. Biotechnology (SF)

Graduates who have passed qualifying examination in CBCS (2017)/CBCSS (2013) pattern	**Graduates who have passed qualifying examination in CBCSS (2009) pattern**	**Graduates who have passed qualifying examination in other patterns**
Graduation in Biological Sciences viz. Zoology, Botany, Biochemistry, Biophysics, Biotechnology, Biological Techniques & Specimen Preparation and Microbiology or Chemistry or MLT with not less than CGPA/CCPA of 5.00 out of 10.00 in the Core Group (Core + Open + Complementary).	Graduation in Biological Sciences viz. Zoology, Botany, Biochemistry, Biophysics, Biotechnology, Biological Techniques & Specimen Preparation and Microbiology or Chemistry or MLT with not less than CGPA of 2.00 out of 4 in the Core Group (Core + Open +Complementary).	Graduation in Biological Sciences viz. Zoology, Botany, Biochemistry, Biophysics, Biotechnology, Biological Techniques & Specimen Preparation and Microbiology or Chemistry or MLT with not less than 50% marks in the Part III subjects (Main/Core + subsidiaries/Complementaries).
Weightage of 10% of marks, scored by the candidate in Part III (Core/Main), shall be added to the total of Part III subjects, for those candidates who have studied B Sc. Biotechnology (Core/Main), after standardizing the marks secured for the same to 600.		

The Open course under core group is taken only for reckoning the eligibility for applying for the PG programmes concerned. But a candidate cannot apply for the respective PG programmes solely on the basis of the open course selected under core group.

Relaxation in Marks in the qualifying examination:

(i) Kerala Scheduled Caste/Scheduled Tribe Category: The minimum grade in the qualifying examination for admission to the PG Degree programmes is 'C' in the seven point scale for CBCSS and a pass for pre CBCSS applicants.

(ii) SEBC Category: A relaxation of 3% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.7 for CBCS (2017),CCPA of 4.7 for CBCSS (2013), CGPA of 1.88 for CBCSS (2009)applicants and 47% marks for pre-CBCSS applicants for

admission to M Sc. programmes and CGPA of 4.2 for CBCS (2017), CCPA of 4.2 for CBCSS (2013), CGPA of 1.68 for CBCSS (2009) applicants and 42% marks for pre-CBCSS applicants for admission to M.A/M.Com programmes

(iii) OEC Category: A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.5 for CBCS (2017), CCPA of 4.5 for CBCSS (2013), CGPA of 1.80 for CBCSS (2009) applicants and 45% marks for pre - CBCSS applicants for admission to M Sc. programmes and CGPA of 4.0 for CBCS (2017), CCPA of 4.0 CBCSS (2013), CGPA of 1.60 for CBCSS (2009)applicants and 40% marks for pre CBCSS applicants for admission to MA/M Com programmes.

(iv) Persons with Disability category: A relaxation of 5% marks in the qualifying examination from the prescribed minimum is allowed i.e. CGPA of 4.5 for CBCS (2017), CCPA of 4.5 for CBCSS (2013), CGPA of 1.80 for CBCSS (2009)applicants and 45% marks for pre – CBCSS applicants for admission to M Sc. Programmes and CGPA of 4.0 for CBCS (2017), CCPA of 4.0 for CBCSS (2013), CGPA of 1.60 for CBCSS (2009)applicants and 40% marks for pre CBCSS applicants for admission to for admission to MA/M Com programme.

M.Sc BIOTECHNOLOGY PROGRAMME

Aim of the Program :

- Understanding various disciplines in biotechnology and acquire methodological knowledge in them.
- Application of this knowledge in a suitable manner in required fields.

Programme Outcomes:

PO1	Basic understanding about various precepts of the discipline, in synchronic and diachronic manner.
PO2	Critical thinking about what they learn, that prompts them to research about its technical and philosophical nuances
PO3	Inter-personal skills enabling them to work in teams, facilitating effective interaction in their respective work places.
PO4	Environmental and social consciousness, leading to a sustainable living.
PO5	An urge for lifelong learning towards professional advancement and kindle the spirit of entrepreneurship.
PO6	A holistic view regarding life and a self-disciplined learning ability for becoming a valuable person to the institution a well as the society.

Programme Specific Outcomes:

Upon completion of the M.Sc. Biotechnology Programme, the students will be able to:

PSO 1	Analyse the Structure function relationships of biomolecules, interaction between macro molecules and cellular processes at the molecular level.	PO.1,2
PSO 2	Apply Tools and techniques used in biological analysis	PO 2
PSO 3	Relate the Metabolic pathways, Clinical aspects, Bioenergetics and Catalysis.	PO 1,2
PSO 4	Understand the concepts of molecular biology and applications in genetic engineering	PO 1,2
PSO 5	Understand the concepts of microbiology and immunology and their application	PO 1,2
PSO 6	Students will be able to conduct experiments, analyse and interpret for various problems in the field of Biotechnology and its allied fields	PO 2,5
PSO 7	Awareness of Environmental policies, problems and ethical issues related to Bioscience research.	PO 2,3 4
PSO 8	Apply Research methodology, Promote scientific discoveries	PO 2,3,4
PSO 9	Students can go for Higher studies, can become Production officers or technical assistants in various Biotech companies, can start entrepreneurship ventures like training centres, consultancy, and they also have got ample opportunities in academics.	PO 3,4,5

M.Sc BIOTECHNOLOGY PROGRAMME STRUCTURE

SEMESTER	COURSE CODE	COURSE TITLE	CREDITS
Ist Semester	PG20BS101	Biochemistry	4
	PG20BS102	Cell Biology & Genetics	4
	PG20BS103-BT	Instrumentation & Biostatistics	4
	PG20BS104-BT	Biophysics & Bioinformatics	3
	PG20BSP1-BT	Laboratory Course I	4
IInd Semester	PG20BS205	General Microbiology	4
	PG20BS206	Immunology	4
	PG20BS207-BT	Molecular Biology	4
	PG20BS208-BT	Enzymology and Metabolism	3
	PG20BSP2-BT	Laboratory Course II	4
IIIrd Semester	PG20BS309-BT	Bioprocess Technology	4
	PG20BS310-BT	Recombinant DNA technology	4
	PG20BS311-BT	Environmental Biotechnology	4
	PG20BS312-BT	Plant and Animal Biotechnology	3
	PG20BSP3-BT	Laboratory Course III	4
IVth Semester	PG20BSP4-BT	Laboratory Course IV	4
	PG20BS4P-BT	Project	4
	PG20BS4V-BT	Viva Voce	3
	PG20BS413-BT	Elective -1	4
	to	Elective -2	4
	PG20BS41-BT	Elective -3	4
		TOTAL CREDITS	**80**

LIST OF ELECTIVES

ELECTIVE GROUPS	COURSE CODE	ELECTIVE COURSES	CREDITS
Elective Group I	PG20BS413-BT	Advanced Molecular Techniques	4
	PG20BS414-BT	Molecular biology of Development	4
	PG20BS415-BT	Cancer Biology	4
Elective Group II	PG20BS416-BT	Physiology and Biotechnology	4
	PG20BS417-BT	Microbial Food Technology	4
	PG20BS418-BT	IPR and Biotechnology	4
Elective Group III	PG20BS419-BT	Environment and Biotechnology	4
	PG20BS420-BT	Food Biotechnology	4
	PG20BS421-BT	Genomics: Techniques and Applications	4

First Semester

PG20BS101	**General Biochemistry**
PG20BS102	**Cell Biology and genetics**
PG20BS103-BT	**Instrumentation and Biostatistics**
PG20BS104-BT	**Biophysics and Bioinformatics**
PG20BSP1-BT	**Lab course I**

PG20BS101- BIOCHEMISTRY

Number of Hours / Week: 4 **Credits: 4**

Course Objective

- **To gain deep understanding of the structures of biological macromolecules and their structure function relationship.**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Illustrate the basic concepts of biomolecules	**K2**
2	Analyze the structure – function relationship of biomolecules	**K4**
3	Explain about the interactions between macromolecules	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(9 hours)**

Brief Review of Basic Biochemistry

Role of Water in biological systems; physiological buffers; importance of Carbon, hydrogen, oxygen, nitrogen and phosphorus in biological systems.

Chemical bond and interactions: Covalent bonds; Ionic bonds; Disulfide linkages; Non-covalent interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction.

Introduction to Biomolecules: Composition; basic structure and function of biomolecules: carbohydrates, lipids, proteins, nucleic acids and vitamins, hormones. Charge properties of biological molecules; Isoelectric pH.

Module 2 **(15 hours)**

Complex Carbohydrates

Oligosaccharides: Glycosidic bonds; Classification: glycoproteins (O-linked and N-linked), glycolipids; Nature of carbohydrate moiety attached; Functions: as cell recognition factors, in intracellular targeting; Purification and Characterization of oligosaccharides from cell membranes

Polysaccharides: Classification: Homopolysaccharides (Cellulose, Starch, Chitin and Glycogen), Heteropolysaccharides (bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and

heparin); Structural characteristics and functions of above mentioned polyasaccharides; Exopolysaccharides from bacterial systems and their uses; Purification and Characterization of Polysaccharides from biological systems.

Module 3 **(14 hours)**

Complex Lipids: Glycerophospholipids: Structure and function of (Phosphatic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl glycerol, Phosphatidyl choline, Phosphatidyl inositol), CDP-diacylglycerol, Lung surfactants.

Glycosphingolipids: Structure and function of Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides .

Eicosanoids: Prostaglandins, Leukotrienes and Thromboxanes: Chemistry, formation and physiological function.

Steroids: Steroids in animal system: Glucocorticoids, mineralocorticoids and Sex hormones (Site of biosynthesis, functions); Sterols in Plant system: Phytohormones: Brassinosterroids (functions); Sterols in microbial system.

Module 4 **(14 hours)**

Protein structure and function: Primary, Secondary, Tertiary and Quaternary structure of Proteins w.r.t: Globular protein (eg: Hemoglobin and Myoglobin), Fibrous protein (Collagen), Membrane Protein (ATP synthetase); Structural implication of the peptide bond: rigid planar peptide unit; cis and trans configuration; conformations of a pair of linked peptide units; torsion angles: phi and psi; steric hindrance; allowed and disallowed conformation – Ramachandran diagram: conformational maps of glycine and other natural amino acids. Protein families, alpha domain, beta domain, Protein structure and molecular approach to medicine: introduction, Sickle cell anaemia. Protein –DNA interaction helix turn helix, helix loop helix, zinc fingers, homeo box.

Protein –RNA interaction RNA recognition motif. Protein-protein interaction-leucine zippers, bHLH, bZip motifs, PTB SH2, SH3 domains.

Protein lipid interaction – PH domain. ,Protein drug interaction.

Module 5 **(12 hours)**

Nucleic acid structure and function: Discovery of nucleic acid structure, Contribution of Indian Scientists in the elucidation of structure, Types of DNA -A, B and Z. GC content, Denaturation kinetics, cot curve, Supercoiling of the DNA molecule; topoisomers and superhelixes; Higher

orders of DNA Structure: Chromatin Structure: Histones and Nucleosomes; histone modifiacation and their importance, Conformation of Chromatin fibers.

Organization of the DNA Sequence: Genes, pseudogenes, extragenic regions (beta globin gene and gene family) duplicated genes; Repetitive DNA sequences:Tandem repeats (Satellites, minisatellites, and microsatellites), Interspersed repeats (LINE,SINEs) Single copy genes; RNA Structure: Types of RNA; structure of mRNA, tRNA, SiRNA, micro RNA with emphasis on importance of structure to its function, non –coding RNAs, Regulatory RNAs.

REFERENCES

1. Biochemistry: A Students survival Guide by Hiram.F.Gilbert(2002) Publishers: McGraw-Hill ISBN 0-07-135657-6
2. Introduction to Biophysics by Pranab Kumar Banerjee(2008) Publishers: S.Chand & Company Ltd ISBN:81-219-3016-2
3. Lehninger, Principles of Biochemistry, Fourth Edition by David L.Nelson Michael. M Cox Publisher: W.H.Freeman; Fourth Edition (April 23,2004) ISBN-10:0716743396 ISBN-13:978-0716743392
4. Biochemistry(2011) by Donald Voet, Judith G Voet Publisher: JohnWiley & SonsInc ISBN: 978-1-1180-25024
5. Principles of Biochemistry,4/e(2006)by Robert Horton H, Laurence A Moran, GrayScrimgeour K Publisher Pearsarson ISBN:0131977369,
6. Biochemistry 6th Edition (2007)by Jeremy M. Berg John L.tymoczko LubertStryer Publisher:B.I Publications Pvt.Ltd ISBN:071676766X ISBN-13:9780716767664, 978716767664
7. Biochemistry (2008) by Rastogi, Publisher: Mcgraw Hill ISBN: 0070527954 ISBN-13:9780070527959, 978-0070527959
8. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson ,JulianLewis, MartinRaff, KeithRoberts, Peter Walter Publisher: Garland Science; 5 edition ISBN-10: 0815341059 ISBN-13: 978-0815341055
9. Genes IX by Benjamin Lewin(2008)Publisher: J&b ISBN:07637

52223ISBN-13: 9780763752224, 978-0763752224

10. Molecular Biology of the Gene 5/e(s)by James D Watson, Tania A Baker, Stephen P Bell (2008) Publisher: Dorling Kindersley (India) Pvt Ltd ISBN: 8177581813 ISBN-13: 9788177581812, 978-8177581812

11. Cell and Molecular Biology by S. SundaraRajan (2003) Publisher: Anmol Publications ISBN: 8126113553 ISBN-13: 9788126113552, 978-8126113552

PG20BS102 - CELL BIOLOGY AND GENETICS

4hours/week **Credit: 4**

Course Objective

- **To have an overview of various cellular organelles**
- **To understand the significance of cell signaling pathways**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the various organelles of a cell and its functions	**K2**
2	Know about the different cellular receptors and signal transduction pathways	**K3**
3	Understand the etiology of cancer	**K2**
4	Understand fundamental principles of heredity and deviations from mendelian behavior. AnalyzeThe effect of mutations and mutational analysis.	**K2, K4**
5	Understand the principles of behavioural and population genetics.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(12 Hours)**

Cell: An Introduction. Membrane proteins, lipids. Fluid mosaic model, membrane fluidity, membrane asymmetry, lipid raft. Functions of the membrane. Membrane transport: Passive transport- Diffusion, facilitated diffusion- glucose porter molecules. Channel proteins- aquaporins. Ionic channels- voltage gated and ligand gated channels. Transmission of electrical impulses- resting and action potential. Active transport: Features, Na^+ K^+ pump. Cell junctions: Adherens junctions, desmosomes, tight junction, gap junction.

Module 2 **(17 hours)**

Extracellular matrix: composition and functions. Cell signaling- G protein coupled receptors, Ion channel coupled receptors- synaptic transmission. Enzyme coupled receptors- ras pathway. cAMP as second messengers- glycogen breakdown by epinephrine.ca ions as second messenger. ER: structure and function, Golgi complex: structure, types, protein sorting and trafficking, exo and endocytosis, coated pits and vesicles. Lysosomes and peroxisomes: enzymatic components and functions, Mechanism of autophagy. Cytoskeleton: Microtubule, assembly and organization, microfilaments: actin structure and assembly, filament based movement in muscle, sliding filament model. Intermediate filaments-types and functions.

Module 3 **(17 hours)**

Mitochondrion: structural features and functions, Chemiosmotic coupling, Chloroplast - structural features and functions, LHC, rubisco . Nucleus, nuclear pore complex, structure of chromosomes, chromosome banding, mitosis and meiosis, Model organisms in cell biology. Cell cycle: G1, S,G2, M phases, MPF, cyclins, checkpoints, Role of Rb & p53. Cell cycle inhibitors, Aging- significance of glutathione. Apoptosis and necrosis, apoptotic pathways. Types of tumor, induction of cancer, properties of cancer cells, oncogenes and c oncogenes, tumor suppressors, Molecular pathways- PIP3 Akt, JAK STAT .

Module 4 **(20 hours)**

Mendel's laws, dominance, epistasis, pleiotropic interactions, multiple alleles-ABO blood groups, pseudoalleles, atavism, linkage, sex linkage, , linkage groups, two point and three point test crosses, determination of gene order, chromosome mapping, sex influenced genes, sex limited genes, inherited disorders in metabolism-maple syrup urine disease,Lesch Nyhan syndrome, Down's syndrome, polyploidy, aneuploidy , Cytoplasmic inheritance, cytoplasmic male sterility. .

Module 5 **(10 hours)**

Behavioral genetics, Hardy Weinberg principle- natural selection, genetic drift, Genetic variation, Allele frequencies and its changes, mutation , gene flow, random mating, inbreeding, outbreeding, assortive mating, hybrid vigour. Mutational analysis using principles of probability-Chi square test.

Reference:

1. Principles of Genetics, Snustad D P, Simmons and Jenkins, John Wiley And Sons Inc ***ISBN***-13: 978-1118129210
2. Genetics, Robert Weaver and Philip Hendricks, WH.C. Brown Publishers, Iowa
3. Fundamentals of Genetics, B D Singh, Kalyani Publishers
4. Introduction to Genetic Analysis, Griffiths, Wessler, Lewontin, Gelbart,Suzuki and Miller, Freeman's and Co, New York
5. Principles of Genetics: M J Gardner, John Wiley and sons.
6. Cell Bilogy, Smith and Wood
7. Cell and Molecular Biology by Gerald Karp, Academic Press
8. Cell and Molecular Biology Cooper, Hausman, ASM Press. ISBN: 9781605351551
9. World of the Cell , Becker, Reece, Poenie, The Benjamin/Cumming's Pub. ***ISBN***-10: 0134145798
10. Cell Biology , Lodish et al, W H Freeman and Co.,NewYork. ISBN-13: 978-1429234139
11. Cell Biology , Thomas D Pollard and W.C.Earnshaw, Saunder's PublishersISBN: 9780323341264.
12. Cell BiologyOrganelle, structure and function: David E Sadava. Jones and Barlette series in Biology. ***ISBN***-10: 9780867202281
13. Cell and Molecular biology: C S Rastogi NEW Age International Pub.. ***ISBN***-13: 978-8122416886

PG20BS103-BT - INSTRUMENTATION AND BIOSTATISTICS

Number of Hours / Week: 4 **Credits: 4**

Course Objective

- **To gain an understanding of the principle and working of various instruments and tools for biological anlaysis.**
- **An brief overview of different statistical tools in biology.**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the techniques used in the visualization of cellular components and macromolecules.	**K2**
2	Analytical techniques used in detection and quantification of biological compounds and the separation techniques used in biology.	**K5**
3	The application of statistical principles in biological studies.	**K3**
4	The research methodology and documentation.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1. **(15 hours)**

Microscopy: Light, Scanning and Transmission electron, phase contrast, polarization, confocal, Flourescence and interference microscopy, Application of immunofluorescence in microscopy, Microscopy for detecting chromosomal aberations. Spectroscopy: Beer-Lamberts law, Principle, Instrument Design, methods and Applications of UV-Visible spectra, IR spectra, Raman Spectra, Fluorescence spectra, NMR and ESR spectra.

Module 2 **(12 hours)**

Principle, methods and Applications of ORD, CD, Flow cytometry, X-ray diffraction by crystals, Electron diffraction, Application of radioactive and non-radioactive methods: GM counter, Liquid scintillation counting, phosphoimager, Autoradiography.

Module 3 **(18 hours)**

Principle, methods and Applications of Chromatography, ion exchange, molecular sieve, affinity chromatography, TLC, GC-MS, HPLC, Centrifugation and Ultra centrifugation, PAGE, SDS PAGE, 2D Gel Electrophoresis, Capillary Electrophoresis, isoelectric focusing.

Module 4 **(15 hours)**

Introduction to Biostatistics. Scope of Biostatistics, Design of experiments, Concepts of sampling, probability and probability distribution analysis. Variables in biology- collection, classification and tabulation of data- graphical and diagrammatic representation- scatter diagrams, histograms- frequency polygon- frequency curve-logarithmic curves. Descriptive statistics- measures of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic mean. Measures of dispersion, Standard Deviation, Standard error, Variance, coefficient of variation. Correlation and Regression.

Module 5 **(12 hours)**

Test of significance. Basic idea of significance test- hypothesis testing, levels of significance, Chi-square test and goodness of fit, comparison of means of two samples, three or more samples. Statistical packages.

Reference

1. Practical biochemistry Keith Wilson and John Walker Cambridge edn.
2. Modern experimental Biochemistry- Rodney Boyer, Pearson education.
3. Statistical methods in Biology- Briley N.J.T
4. Biostatistics PN Arora and P K Malhan Himalaya Pub.
5. Biophysics- R N Roy, New Central Agency.

PG20BS104-BT – BIOPHYSICS AND BIOINFORMATICS

Hours/week-3 Credits-3

Course objective

- **To generate an awareness in bioenergetics of the cell and role of bioinformatics in analysing the biological data.**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the bioenergetics of cell and the basic architecture of macromolecules.	**K2**
2	Analyse the interaction between macromolecules.	**K4**
3	Evaluate the role of bioinformatics in biological data storage.	**K5**
4	The applications of bioinformatic tools in analysing biological data.	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(12 hours)**

Laws of thermodynamics, the concept of enthalpy, entropy and free energy, thermodynamic equilibrium, redox potential, high energy molecules, examples of redox potential in biological system, Nernst equation.

Module 2 **(10 hours)**

Lambda repressor and cro binding to DNA. Interactions of transcription factors, Leucine Zipper, Cys-His, Zinc fingers. Histone-DNA interaction, RNA protein interactions, DNA-drug Interaction .

Module 3 **(10 hours)**

Mass Spectrometry: Principle, Applications; Peptide mass finger printing using MALDI-TOF, MASCOT database.

Module 4 **(12 hours)**

Introduction to Bioinformatics, data mining Online databases and search tools, data organization, Biological data bases, structural data bases, derived and specialized data bases, DNA and RNA

sequence data bases, genomic sequences, protein sequence data bases, Distance matrix methods and parsimony. Multiple sequence alignments-tree alignments, star alignments, pattern in pair wise alignment, genetic algorithm.

Module 5 **(10 hours)**

Sequence analysis softwares, SS search, BLAST, FASTA, CLUSTAL, Phylogenetic analysis, construction of phylogenetic tree, evolutionary changes in nucleotide and protein sequences, structure prediction, structural alignment tools, homology modeling, drug design, Energy minimization in molecular docking. Applications of Bioinformatics: pharmaceutical industry, immunology, agriculture, forestry, basic research, chemiinformatics in biology, geoinformatics, legal ethical and commercial considerations.

REFERENCE

1. *Introduction to Protein structure*: Branden and Tooze1.
2. *Biophysics*-Hoope W etal
3. *Molecular Biophysics*- Volkenstain M.V
4. *Introduction to Thermodynamics Of Irreversible Process*-Joh Wiley
5. *Statistical Methods In Biology*- Briley N.J.T
6. *Introduction to Biophysics*-Sokal R.R & Rohl F.J
7. *Bioinformatics: Sequence and Genome Analysis*- David Mount, Cold Spring Harbour Lab Press, New York.
8. *Bionformatics and Molecular Evolution*: Paul G Higgs, Teresa K Attwood. Blackwell pub.
9. *Introduction to Bioinformatics*; Attwood T K and Parry-Smith D J Pearson Education Ltd.
10. *Bioinformatics Seuqence, structure and database*; Des Higins, Willie Taylor.

PG20BSP1-BT-LABORATORY COURSE –I

Hours/week-10 Credits-4

Course objective

- **To make student understand the basic principles of assays and instruments in biochemistry and cell biology.**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the basic principles of preparation of solutions.	**K2**
2	Analyse and purify the biological compunds.	**K4**
3	The applications of bioinformatic tools in analysing biological data.	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Biochemistry

1. **Preparation of Solutions:**
   - Percentage solutions,
   - Molar solutions,
   - Normal solutions
   - Dilution of Stock solutions
2. **Preparation of buffers using the Henderson Hasselbach equation**
3. **Spectrophotometric experiments:**
   - Determination of UV-Visible spectrum of compounds
   - Determination of Concentration of molecules from Molar Extinction coefficient values.
4. **Quantitative Analysis-Any five from plant or animal source**
   - Extraction and Quantitative estimation of reducing sugars by Dinitrosalicylic acid method/ Nelsons Somogyi method/
   - Extraction and Quantitative Estimation of fructose by Roe and Papadopaulose method
   - Estimation xylose by orcinol method

- Extraction of polysaccharide Anthrone method (starch,glycogen) and quantification.
- Quantitative estimation of tyrosine by Folinscio calteumethod
- Quantitative estimation of Methionine by Nitroprusside method
- Extraction and Quantitative Estimation of protein by biuret method./ Lowry's method/ BCG method
- Estimation of Cholesterol by Zak's method
- Estimation of DNA by Diphenylamine and estimation of RNA by Orcinol method
- Determination of Saponification value, acid value,iodine number of oils or fats.

5. Seperation techniques

- Separation of amino acids by Paper chromatography(Descending or Ascending)
- Separation of Plant pigments/lipids/sugars by Thin layer chromatography
- Separation of any biomolecule by column chromatography (gel filtration/ ion exchange chromatography)
- SDS PAGE

Cell Biology and Genetics

- Study of various stages of mitosis using cytological preparations of onion root tips.
- Karyotype study using cytological preparation of dividing root tip cells of onion /photographs /permanent slides
- Study in the ultra structure of cell organelles using electron microphotographs pics.
- Solving genetic problems related to monohybrid, dihybrid ratio and interaction of genes

Bioinformatics

- Familiarizing with the different data bank mentioned in the syllabus.
- Retrieve a document reporting recent work on a genomic analysis of human disease.
- Retrieve one sequence both DNA and protein from database retrieval systems.
- Retrieve nucleotide sequences and construct a distance tree.
- Online sequence analysis, BLAST.
- Phylogenetic analysis.

Biostatistics

- Problems on Arithmetic mean, Standard deviation,Correlation,regression, Chi square test
- Visit a research Institute to familiarize with the Instrumentatin . Submit a report

REFERENCES

1. Introductory Practical Biochemistry, S .K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, P195-303
2. Standard Methods of Biochemical Analysis, S.K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12-18
3. Hawk's Physiological Chemistry, Bernard L.Oser(ed) TATA McGraw Hill Publishing Company LTD, New Delhi, p 60-127, 1317-1334
4. Practical Clinical Chemistry, Harold Varley, CBS Publishers and Distributors, New Delhi,
5. Medical Laboratory Technology – A procedure manual for routine diagnostic tests Volume 1, K.L. Mukherjee, Tata McGraw-Hill Publishing company LTD, New Delhi

Second Semester

PG20BS205	**General Microbiology**
PG20BS206	**Immunology**
PG20BS207-BT	**Molecular Biology**
PG20BS208-BT	**Enzymology and Metabolism**
PG20BSP2-BT	**Lab course II**

PG20BS205 -GENERAL MICROBIOLOGY

Number of Hours / Week: 4 **Credits: 4**

Course Objective

- **To gain an understanding of the general properties and identification of bacteria, virus and fungus**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Illustrate the diversity of microbial world and their interactions with the environment.	**K2**
2	Cultivation and identification of microorganisms	**K5**
3	Explain the genetic materials and mechanisms in bacteria and their role in the transmission of genetic characters	**K2**
4	Tools and techniques used in microbiology.	**K3**
5	Microbial metabolism and molecular processes..	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(16 hours)**

Introduction: The historical foundations and development of microbiology. Outline classification of microorganisms- Haeckel three Kingdom classification, Whittaker five Kingdom classification and Woese three domain classification.

Principles of bacterial taxonomy: Numerical taxonomy, Identification characters-morphological, staining, physiological, biochemical and molecular (mol % G+C, nucleic acid hybridization, 16SrRNA sequencing) characters. Bacterial classification as per latest edition of Bergey's Manual of systematic Bacteriology. Archaebacteria and Bacteria.

Module 2 **(15 hours)**

General properties of bacteria: Morphology and structure of bacteria-size, shape and arrangement. Surface structures and inclusions of bacteria-Capsule, pili, fimbriae, flagella, cell wall, cell membrane, cell organelles, genetic material, plasmid, spore, inclusion bodies. Microbial locomotion - flagellar motility, gliding motility and amoeboid motion. Chemotaxis.

General properties of viruses: Morphology and structure of viruses, Bacteriophages, viroids, prions. Genetic modification of viruses. Virus multiplication. Cultivation of viruses.

General properties of fungi: Classification of fungi, Reproduction in fungi. Methods for the study of fungi. Cultivation of fungi.

Module 3 **(15 hours)**

Bacterial growth and nutrition: Factors influencing bacterial growth – nutritional and environmental factors. Bacterial growth at different temperature, pH and oxygen level. Nutritional types of bacteria. Binary fission. Bacterial growth curve. Batch, fed-batch and continuous culture. Measurement of bacterial growth.

Cultivation of bacteria: Culture media - Composition and preparation of culture media. Types of culture media – Solid, semi-solid, liquid and bi-phasic media, simple media, differential media, special media, enriched media, enrichment media, auxanographic and anaerobic media. Culture methods- Aerobic and anaerobic.

Identification of bacteria: Staining reactions- Principles of staining. Types of staining- Simple staining, Differential staining, Special staining- capsule, spore, flagella and volutin granule. Cultural, morphological and biochemical properties. Molecular methods for identification - Isolation of bacterial DNA, electrophoresis, amplification of DNA -PCR technique, 16SrRNA sequencing. Phylogenetic tree.

Module 4 **(15 hours)**

Sterilization: Principles and methods, physical and chemical methods. Disinfectants - modes of action. Testing of disinfectants.

Antibiotics: Antibacterial, antifungal, antiviral, mechanism of action. Classification of antibiotics based on mechanism of action. Drug resistance in bacteria. Antibiotic sensitivity tests.

Module 5 **(15 hours)**

Bacterial genetics: Genetic materials in bacteria. Bacterial chromosome. Extrachromosomal genetic elements. Plasmid- copy number and incompatibility, Replication of plasmid. Episomes. Transposable element-IS element and transposon, Integrons and Antibiotic resistance cassettes, Multiple antibiotic resistant bacteria, Mutation- types of mutations, DNA repair-Photolysis, Excision repair, NER, SOS repair, Mutant selection. Mechanism of gene transfer - transformation,

transduction and conjugation. Recombination- types, mechanism and enzyme involved. Gene mapping. Metagenomics.

REFERENCES

1. Russell AD, Hugo WB, & Ayliffe GAJ (1999) *Principles and practice of disinfection, preservation, and sterilisation* (Blackwell Science, Oxford) 3rd ed
2. Bryan LE (1984) *Antimicrobial Drug Resistance* (Academic Press, Orlando
3. Topley WWC, Wilson GS, Parker T, & Collier LH (1990) *Topley and Wilson's Principles of Bacteriology, Virology and Immunology* .Edward Arnold, London. 8th ed.
4. Davis BD (1990) *Microbiology* (Lippincott, Philadelphia) 4th ed
5. Zinsser H & Joklik WK (1992) *Zinsser Microbiology* (Appleton & Lange, Norwalk, CT) 20th Ed
6. Gerhardt P (1994) *Methods for General and Molecular Bacteriology*. American Society for Microbiology, Washington, D.C.
7. Pelczar MJ, Chan ECS, & Krieg NR (1993) *Microbiology : concepts and applications* .McGraw-Hill.5th ed.
8. Prescott LM, Harley JP, & Klein DA (2005) *Microbiology* (McGraw-Hill, Boston ; London) 6th ed.
9. Paul De Kruif (1926) Microbe Hunters [Honghton Mifflin Harcourt publishing Company] ISBN 0-15-602777-1.

PG20BS206 - IMMUNOLOGY

Number of Hours / Week: 4 **Credits: 4**

Course Objective

- **To have an understanding of the immune system and their function**

Course Outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Illustrate the cellular and molecular basis of the immune system	**K2**
2	Demonstrate the adaptive immune responses coordinate to fight against invading pathogens	**K3**
3	Describe the structure and functions of MHC molecules and Immunoglobulins	**K2**
4	Explain the complement system, its activation and biological consequences of complement activation	**K1 & K2**
5	Illustrate the use of vaccines and analyze the strategies for future vaccines	**K2 & K4**
6	Explain the genetic defects that lead to immunodeficiency diseases and their treatment as well as the current status of gene therapy	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(15 hours)**

Introduction to the immune system: Infection, Source of infection, Methods of transmission. Immunity, Types of immunity. Mechanisms of innate immunity- barriers, inflammation, phagocytosis-mechanisms, Pattern recognition receptors - Scavenger receptors and the Toll-like receptors etc. Organs and cells with immune functions. Lymphocytes and lymphocyte maturation.

Module 2 **(15 hours)**

Antigen, antibody and immunological techniques: Antigens, Antigenicity, Epitopes, Antibodies, Immunoglobulin – structure, classes and functions Fc receptors. Monoclonal antibodies – production and application, Antibody engineering. Antigenic determinants on Ig- Isotype, Allotype, Idiotype. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, V(D)J

rearrangements; somatic hypermutation and affinity maturation, Class-switching, Antigen-antibody reactions, Agglutination, Precipitation, Complement fixation, Immunodiagnosis: Radioimmuno assay, Immunoflourescence, ELISA, lateral flow assay, Western blotting, Flow cytometry, FACS.

Module 3 **(15 hours)**

Cell and humoral Immune response: Receptors on T and B cells for antigens, MHC, Antigen processing and presentation, Complement system, Complement activation, regulation, Biological effects of complements, B cell- generation, activation, differentiation, Humoral Immune response- Antibody formation, Primary and secondary immune response, Clonal selection theory. T-cell maturation, activation and differentiation, Cell mediated Immune response, Cytokines, Primary and secondary Immune modulation, Antibody engineering.

Module 4 **(15 hours)**

Transplantation and immunotherapy: Immunology of organ and tissue transplantation- Allograft reaction and GVH reaction, Factors influencing allograft survival, Immunology of malignancy- Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohematology- ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born.

Module 5 **(15 hours)**

Hypersensitivity, Autoimmunity and vaccines: Immunological Tolerance, Autoimmunity- Mechanisms of autoimmunity, Autoimmune diseases. Inflammation, Hypersensitivity– immediate and delayed reactions, Clinical types of hypersensitivity, Immunodeficiency diseases, Immunoprophylaxis- Vaccines –types of vaccines: 1) Conventional vaccines-Attenuated, live; 2) recombinant vaccines- carbohydrate, protein and DNA based vaccines, Combination vaccines, Edible vaccines. Recent trends in vaccine development. Role of Adjuvants. Immunoregulation

REFERENCES

1. Roitt IM & Delves PJ (2001) *Roitt's essential Immunology*.Blackwell Science, Oxford. 10th ed.
2. Kindt TJ, Goldsby RA, Osborne BA, & Kuby J (2006) *Kuby Immunology*.W.H. Freeman, New York. 6th ed
3. Murphy K, Travers P, Walport M, & Janeway C (2008) *Janeway's Immunobiology*. Garland Science, New York. 7th ed
4. Chapel H (2006) *Essentials of clinical Immunology* .Blackwell, Malden, Mass. ; Oxford. 5th ed
5. Kimball JW (1986) *Introduction to Immunology*.Macmillan, London 2nd ed
6. Paniker CKJ (2006) *Ananthanarayan & Paniker's Textbook of microbiology*. Orient Longaman.

PG20BS207-BT – MOLECULAR BIOLOGY

Number of Hours / Week: 4 **Credits: 4**

Course objective

- **To gain an understanding of molecular biology of the cell**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the structural and functional organization of genome.	**K2**
2	Describe the molecular phenomena of DNA copying and transmission of information.	**K3**
3	The regulation of gene function and associated phenomena.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(17 hours)**

Structural and Organisation of genome: chromatin , nucleosome, chromosomes. Functional organization: genes, controlling sequence, split gene concept, exons, introns, intergenic DNA-repetitive sequences-interspersed repeats- SINE, LINE transposons- types (IS elements, replicative transposons, retroposons) &significance, tandem repeats-micro,minisatellites, DNA ReplicationModels of DNA Replication, Conservative, Semiconservative and discontinuous, Messelson and Stahl experiment, Steps in initiation of replication, Enzymatic factors involved, Ori site , Okazaki fragments, Termination of replication, DNA polymerases in eukaryotes and prokaryotes, Klenow fragment, Primosome, SSB, Ligase, modes of replication, theta, rolling circle, d-loop replication, end problem of replication, telomerase-structure and functions, Inhibition of replication. Role of enzymes in proof reading, Repair mechanisms: Photolyase, Excision Repair- BER, NER. Mismatch repair, SOS repair, Recombination repair systems.

Module 2 **(17 hours)**

Process of transcription, promoters, Enhancers, stages in initiation, RNA polymerases in prokaryotes and eukaryotes, sigma factor in prokaryotes, elongation, Rho dependant and Rho independent termination, Transcription factors in Eukaryotes, CpG islands, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications, Polyadenylation, capping, r-RNA processing, Splicing-Spliceosome, lariat structure, Group I, II and III Introns, catalytic RNA Importance of ribozyme, properties, application, RNase P, RNAse III, RNAse H. monocisrtonic and polysistronic m-RNA, Joint transcript of r-RNA and t-RNA in prokaryotes and their processing, Transplicing, alternate splicing, inhibitors of Transcription, mRNA stability and degradation.

Module 3 **(10 hours)**

Genetic code, properties, wobble hypothesis. Eukaryotic and prokaryotic ribosomes,, t-RNAs, aminoacyl t-RNA synthatases, Steps of translation. protein factors- initiation complex, peptidyl transferase, releasing factors, differences between prokaryotic and eukaryotic translation systems, inhibition of translation, post translational modifications.Protein folding, chaperones.

Module 4 **(15 hours)**

Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system, positive & negative regulation; Operon concept, structure of operon, Lac, Trp, Catabolic repression, Atteunation, Multiple levels of eukaryotic gene regulation: Histone acetylation and deacetylation, methylation and demethylation, chromosome remodeling complex, Gene amplification,transcription level:differential transcription,Translational control, Intein splicing. Role of Hormones in gene regulation.

Module 5 **(15 hours)**

RNA interference, Antisense RNA, SiRNA, MicroRNA, long noncoding RNA, Ribozwitches & their applications; Nucleic acid as therapeutic agent, prions, prion disease in mammals – CJD, scrapie. Human genome project and its implications. Molecular mechanism of differentiation: maternal, segmentation and homeotic genes,hox genes, gene interactions bicoid- nanos system. Differentiation in plants, floral development-apetalous, pistillate, agamous interactions. Stem cells and Induced pluripotent stem cells.

Reference

1 REA's Problem Solvers in Genetics, Research Education Association,61, Ethel Roadwest, New Jersey

2. Modern Genetic Analysis, Griffiths, Lewontin, Gelbart, and Miller, Freeman's and Co, New York
3. Genes X: Benjamin Lewin
4. Cell and Molecular Biology by Gerald Karp, Academic Press
5. Genomes: T A Brown, John Wiley & Sons
6. Molecular Biology: David P Clark, Elsevier.
8. Principles of gene manipulation – Old, Twyman and Primrose
9. Gene cloning and DNA analysis – T. A. Brown
10. Genes-Benjamin Lewin

PG20BS208-BT – ENZYMOLOGY AND METABOLISM

Number of Hours / Week:3 Credits: 3

Course Objective

- **To gain an understanding of the various metabolic pathways in the body and their regulation**
- **To have a in depth knowledge of the properties and functions of enzymes**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Explain the metabolism of carbohydrates, proteins, lipids and nucleic acids	**K2**
2	Illustrate the structure, functions and mechanism of action of enzymes	**K2**
3	Demonstrate the classification of enzymes based on the reactions catalysed	**K3**
4	Explain the kinetics of enzyme catalysed reactions and enzyme inhibitory and regulatory processes	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 **(10 hours)**

Metabolism of carbohydrates: Glycolytic pathway, substrate level phosphorylation, significance of the mitochondrial respiratory chain and oxidative phosphorylation, Electron transport chain: structural components of the chain, complexes, free elements; Generation of the electrochemical proton gradient: Chemiosmosis ATP synthesis: structural and functional properties of ATP synthesis; Inhibitor agents and decoupling agents of the respiratory chain and ATP synthesis; Regulation of glycolytic pathway, Etner Dudoruff pathway, Gluconeogenesis and Glycogenesis. Synthesis of bacterial peptidoglycan, Bacterial photosynthesis- photosynthetic and accessory pigments

Module 2 **(10 hours)**

Metabolism of Proteins, lipids and nucleic acids: Synthesis and degradation of aromatic and aliphatic amino acids with two examples each, deamination, transamination, urea cycle, β oxidation, synthesis of fatty acids, FAS, synthesis of cholesterol, degradation of cholesterol. Synthesis of bacterial LPS, Synthesis of purines and pyrimidines, salvage pathway, degradation regulation of pathways.

Module 3 **(14 hours)**

Enzymes and Enzyme kinetics : Holoenzyme, apoenzyme, and prosthetic group; Interaction between enzyme and substrate- Features of active site, activation energy, Rate Enhancement Through Transition State Stabilization, Enzyme specificity and types; Enzyme Commission system of classification and nomenclature of enzymes, ribozymes, abzymes measurement and expression of enzyme activity, enzyme assays. Definition of IU, katals, enzyme turnover number and specific activity, Isolation of enzymes and the criteria of purity; Characterization of enzymes, Order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction-Derivation of Michaelis -Menten equation and Km value determination and its significance, Definition of V_{max} value of enzyme and its significance, Lineweaver- Burk plot; Bi-substrate reactions: Classification.

Module 4 **(12 hours)**

Enzyme inhibition and regulation: Reversible and irreversible – examples. Reversible-competitive, non-competitive and uncompetitive inhibition;; Dose—Response Curves of Enzyme Inhibition; Structure—Activity Relationships and Inhibitor Design; Application of inhibitors as therapeutic agents for HIV, Cancer. Covalently modulated enzymes with examples of adenylation and phosphorylation; Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; Allosteric enzymes: Examples, Effects of Co-operativity on Velocity Curves, Sigmoidal Kinetics for Nonallosteric Enzymes Allosteric regulation: example Aspartate trascarbamoylase, Isoenzymes-Lactate dehydrogenase and creatine phosphokinase

Module 5 **(8 hours)**

Application of enzymes: Immobilisation of enzymes, Industrial uses of enzymes: production of glucose from starch, cellulose and dextrans, use of lactase in diary industry, production of glucose fructose syrup from sucrose, use of proteases in food, leather and detergent industry. Diagnostic and therapeutic enzymes, Enzymes as drug targets.

REFERENCES

1. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis Stevens (2000) Publisher: Oxford University Press, USA ISBN: 019850229X ISBN-13: 9780198502296, 978-0198502296
2. Enzyme Kinetics: A Modern Approach Book: Enzyme Kinetics: A Modern Approach by Alejandro G. Marangoni (2003) Publisher: Wiley-Interscience ISBN: 0471159859 ISBN-13: 9780471159858, 978-0471159858
3. Enzyme Kinetics and Mechanisms by Taylor Publisher: Spring ISBN: 8184890478 ISBN-13: 9788184890471, 978-8184890471

4. Enzyme Mechanism by P.K. Shivraj Kumar (2007) Publisher: RBSA Publishers ISBN: 8176114235 ISBN-13: 9788176114233, 978-8176114233
5. Enzymes and Enzyme Technology by Kumar (2009) Anshan Pub ISBN: 1905740875, ISBN-13: 9781905740871, 978-1905740871
6. Enzymes in Industry: Production And Applications by Aehle W (2007) Publisher**:** John Wiley & Sons Inc ISBN: 3527316892 ISBN-13: 9783527316892, 978-3527316892
7. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (second Edition) by Trevor Palmer, Philip Bonner (2007) Publisher: Horwood Publishing Limited ISBN: 1904275273 ISBN-13: 9781904275275, 978-1904275275
8. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson Michael M. Cox Publisher: W. H. Freeman; Fourth Edition edition (April 23, 2004) ISBN-10: 0716743396 ISBN-13: 978-0716743392
9. 9.E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974

PG20BSP2-BT - LABORATORY COURSE-II

Number of Hours/week:10 **Credits: 4**

Course Objective

- **To make the student efficient in handling various microbiological, immunological and enzymological assays.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the cultivation, observation and identification of microorganisms	**K2**
2	Learn to design various immunological experiments	**K2**
3	Understand the detection of compounds of interest in biological samples	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Microbiology And Immunology

- Microscopic examination of bacteria in living conditions
- Testing of motility
- Staining procedures- Gram, Volutin, Spore, Capsule, Negative, Acid Fast, Fungal staining etc.
- Cultivation of bacteria and fungi
- Sterilization methods
- Study of cultural characteristics and biochemical reaction of bacteria
- Testing of disinfectants
- Bacterial growth curve
- Antibiotic sensitivity tests- disc diffusion, MIC
- Sterility testing of solution, vaccines, drugs and surgical methods
- Serological tests for the diagnosis of microbial infections-RPR, RF, ASO
- Agglutination and precipitation tests
- Immunodiffusion in gel
- ELISA

Metabolism and Enzymology

- Estimation of enzyme activity ALP , SGOT, SGPT
- Determination of Km and Vmax
- Effect of pH, Effect of temperature on enzyme activity
- Enzyme inhibition studies- estimation of KI.
- Purification of the enzyme-
  - Ammonium sulphate precipitation
  - Dialysis
  - Gel Filtration
  - Ion Exchange chromatography

Reference

1. An Introduction to Practical Biochemistry. David T Plummer *ISBN*-13: 978-0070841659.
2. Biochemical Methods. S. Sadasivam and A Manickam. New Age International Publishers
3. Biochemical Calculations: Irwin H Segel. Wiley Pub. *ISBN*-13: 978-0471774211
4. Practical Enzymology Hans Bisswanger Wiley and Blackwell Pub.
5. Practical immunology. Frank C Hay, Olwin M R Westwood. Wiley pub.
6. Practical Microbiology. Maheswari D K. S Chand Pub.
7. Microbiological Applications.Laboratory manual in General Microbiology. Harold J Benson. Mc Graw hill Pub.

Third Semester

PG20BS309-BT	**Bioprocess Technology**
PG20BS310BT	**Recombinant DNA Technology**
PG20BS311-BT	**Environmental biotechnology**
PG20BS312-BT	**Plant and Animal biotechnology**
PG20BSP3-BT	**Lab Course III**

PG20BT309-BT BIOPROCESS TECHNOLOGY

Number of Hours / Week: 4 **Credits: 4**

Course Objective:

- **To have an overview of bioprocess technology in industrial applications.**
- **Understand control and designing of bioreactor.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Explain the Screening for microbial strains from different samples	**K2**
2	Illustrate the Types of Bioprocess and standard lab practices	**K2**
3	Demonstrate the Bioreactor designing and control	**K3**
4	Explain the Industrial production conditions through fermentation	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1. **(8 hours)**

Isolation of Industrially important microorganism, Primary and secondary screening methods. Single cell sequencing in detecting microbiome. Methods of strain improvement. Preservation and maintenance.

Module 2 **(20 hours)**

Batch culture- characteristics, specific growth rate, substrate saturation constant, yield coefficient, Monod kinetics, substrate affinity. Continuous culture- characteristics, dilution rate, washing out. Fed batch culture, Product yield, solid state and submerged fermentations, Immobilisation of microbial cells- Methods, advantages and disadvantages. Media preparation- C, N, energy sources, minerals, vitamins, buffers, chelators, growth factors, buffers and antifoams. Examples of Industrial media- Molasses, Cornsteep liquor, GLP.

Module 3. **(16 hours)**

Bioreactor Design- desirable features, aseptic manipulation, probes, valves- , gate valve, globe valve, piston valve, butterfly valve. Agitators, aerators, baffles. Types of bioreactors: CSTR, Pneumatically driven fermentors, Airlift fermentor, Packed Bed reactor , Fluidized Bed reactor, Reactor

performance. Oxygen transfer in reactor system , KLa, Determination of KLa- sulphite oxidation technique. Reynold's number, types of fluids- Newtonian and Nonnewtonian fluids.

Module 4. (18 hours)

Bioreactor- online and offline control. pH probe, temperature probe, DO probe, Tacchometer, Load cells Control of Bioreactor, Downstream processing: filtration, centrifugation, celldisruption, liquid/liquid extraction, dialysis, Purification, Drying, Packing and labelling. Good Manufacturing Practices, Biosafety- laws and concerns at different levels- individual, institution and society. Forms of IPR and process of patenting.

Module 5 (14 hours)

Industrial production of Primary metabolites and secondary metabolites-shikimic acid,flavanoids Fermentative production of alcohol, acetone- butanol, citric acid, acetic acid, lactic acid. Amino acids- lysine and phenyl alanine, Vitamins.- riboflavin and ascorbic acid. Antibiotics- penicillin, streptomycin, tetracycline. Microbial production of enzymes- amylase, protease, cellulase. SCP production. Bread manufacturing, beer manufacturing, Production of Cheese and other fermented dairy products -acidophilus milk, paneer, yogurt, butter milk.

Reference

1. Principles of Fermentation Technology, P.F.Stanbury, A Whitaker and S.J.Hall, , 2008. Elsevier. ISBN 976-81-8147-406-5.
2. Bioprocess Technology, P.T. Kalichelvan and I Arul Pandi, , 2009,MJP Publishers, Chennai.
3. Bioprocess Engineering, M.Shuler & F.Kargi (2002). Prentice Hall (I) Ltd., N.Delhi.
4. Bioprocess Technology- Kinetics and reactors ,Antan Moser and Philip Manor,.1998, Springer
5. Fermentation Microbiology and Biotechnology ,E.M.T. Mansi, C.F.A . Bryce. A.L..Dmain, A.R.Alliman. ,2009, Taylor and Francis. New York
6. Comprehensive Biotechnology. Second edition, Elsevier, 2011, Murray Mor. Young (Editor in chief). ISBN-978-0-08-088504-9
7. Industrial Microbiology, Cassida L.E. 1968.John Wiley and Sons Publishers.

PG20BS310-BT RECOMBINANT DNA TECHNOLOGY

Number of Hours / Week: 4 **Credits: 4**

Course Objective:

- **To have an in-depth knowledge in Recombinant DNA technology and its applications in various fields.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Explain the basic requirements to perform genetic engineering experiments.	**K2**
2	Illustrate the techniques involved in the preparation and introduction of rDNA to the host.	**K2**
3	Regulations in carrying out rDNA experiments	**K3**
4	Explain the applications of rDNA technology	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I **(14 hours)**

Histroy. Isolation of genetic material. Modification of genetic material for the preparation of r DNA- Enzymes for in vitro modification of nucleic acids– Kinases, Phosphatases, Exonucleases, Endonucleases, Restriction Endonucleases, Site specific recombinases, topoisomerases, Ligases and Terminal Transferases. Types and properties of restriction enzymes. Modification of Ends - Adapters, Linkers, Homopolymer Tailing. Genomic and c DNA library construction.

Module II **(15 hours)**

Cloning Vectors- Plasmids and their desirable properties, E coli based vectors- pBR, pSC, pUC, pGEM3Z. M13vectors mp7, Bacteriophages λ EMBL Cosmids, Phasmid , Phagemids with special reference to pBluescript, pLITMUS. In vitro packaging, phage display. Gateway Cloning, TA cloning. Shuttle Vectors -pCAMBIA,Vectors for Yeast (YEP, YIP, YRP, YCP,YAC) Artificial Chromosomes- BAC, AC. Viral and virus derived vectors for animal cells- SV40, Adenovirus vectors, Baculovirus, lentivirus, poxvirus. Plant vectors - geminivirus, Ti plasmid .

Module III **(16 hours)**

Introduction of r DNA to host cells-micro injection, electroporation, biolistics, Gene transfer by Chemical transfection: Calcium phosphate mediated, Polyplexes mediated, Liposomes and lipoplexes mediated. Markers in prokaryotes. Selection of recombinants. Blue white screening, screening for

Antibiotic resistance. Genetic markers in plants- Kanamycin, neomycin, Hygromycin B, Bromoxynil, Methotrexate, chloramphenicol. Animal markers: Maximizing protein expression in Bacteria, fungi and animal cells – Promoters- Ca MV promoter, Maize actin 1 gene. Reporter systems- lux genes, GFP. Expression vectors, Fusion tagged expression system, affinity tag. Studying the translation product- hybrid arrest and hybrid release translations, immunochemical methods. Nuclear transfer technology, Inducible expression system and control of transgene expression through naturally inducible promoters – lac and tet. Steroid hormones as heterologous Inducers. Chemically induced dimerisaion (CID) as inducible transgene regulation. Site specific recombination for efficient gene targeting.

Module IV **(16 hours)**

Chemical synthesis of DNA, Blotting techniques: Southern, Northern, Southwestern, Far western. colony hybridization PCR types and applications. DNA foot printing, finger printing, gel shift analysis, DNA microarray, RFLP, RAPD, advanced molecular markers, chromosome walking, jumping and landing. DNA sequencing- Maxam and gilbert, enzymatic method, pyrosequencing, New generation sequencing- Site directed Mutagenesis: methods.

Module V **(15 hours)**

Applications of recombinant DNA technology- Production and purification of recombinant proteins- insulin and somatostatin. Gene therapy. Metabolite engineering. Imparting new agronomic traits to plants to improve quality and quantity. Gene Silencing through RNA interference and antisense therapy. CRISPR system. Gene Knockout. Animal pharming, nanoparticles for labeling, delivery of drugs, DNA and RNA.synthetic microorganisms, Metabolic engineering, semisynthetic production of artimisin against malaria. RNA Sequencing. Bioethics: laws, possible hazards and merits to society or nature.

Reference

1. Principles of gene manipulation – Old and Primrose, Blackwell Scietific publishers, Edns 5th , 6th and 7th.
2. Molecular Biotechnology – Glick and Pasternac
3. From gene to genomes – Dale and Shantz
4. Gene cloning :An Introduction, T A Brown, Chapman and Hall Pub.
5. Biotechnology: An Introduction, Susan R Barnum. Pub: Thomson, Brooks/Cole
6. Molecular cloning : A laboratory Manual, Sambrook and Russel, Cold spring Harbor Lab Pub.
7. DNA science : A first course in rDNA Technology: David Mickols, Carolina Biological Supply.

PG20BS311-BT ENVIRONMENTAL BIOTECHNOLOGY

Hour/ week: 4 **Credits: 4**

Course Objective:

- **To have an in-depth knowledge of biotechnological applications in prevention pollutions.**
- **To have an idea on green energy and technologies.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the role of biotechnology in environmental applications.	**K2**
2	Illustrate the degradation of recalcitrant compounds by biological agents	**K2**
3	Demonstrate the treatment technologies involved in the processing of solid and liquid waste.	**K3**
4	Explain the Alternate green energy sources and green technologies.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module1 **(16 hours)**

Xenobiotics, biological impacts of polychlorinated biphenyls and dioxans, synthetic polymers, alkylbenzyl sulphonates, hydrocarbons, chlorinated pesticides, heavy metals- Mercury, lead. Biomagnification of recalcitrant molecules Microbial infallibility, types of biodegradation, factors affecting biodegradation, enzymes involved in biodegradation, catabolic plasmids, super bugs, Biodegradation of Hydrocarbons, cellulose, lignin, and pesticides. Bioremediation strategies.

Module II **(12 hours)**

Bacillus thuringiensis as a pesticide, viral pesticides. Biological fertilizers- biological nitrogen fixation: Mycorrhizae, AM, cyanobacteria, molecular mechanism of nitrogen fixation in root nodules, nonsymbiotic nitrogen fixation- C*lostridium*sp. Nif gene data base. Biosurfactants, Biofouling, Bioleaching**.**

Module III **(20 hours)**

Types of industrial effluents, characterization of the wastewater- Chemical Oxygen Demand, Biological Oxygen Demand, Total organic carbon, Nitrogen contents, Suspended solids. Total heterotrophic bacterial population. Bacteriological analysis of drinking water, E. coli as a water quality indicaror. Presumptive, completed, and confirmed test. Treatment strategies: Preliminary and primary phases. Secondary treatment: Aerobic biological treatment methods- Floc based and film based strategies. Activated sludge process and its different stages, Types. Trickling filter process, Rotating Biological contactor, Submerged aerobic filters, Fluidized Bed Reactor, Packed bed reactor, Oxidation lagoons. UASB**.**

Module IV **18**

Tertiary treatment methods: Columns of activated and granulated charcoal, ion exchange methods, reverse osmosis, Nitrogen removal- air stripping, break point chlorination biological denitrification. Removal of phosphate- biological and other methods. Ultra and nanofiltration. Disinfection,- Chlorination, chlorination derived byproducts, chloramines, Copper- silver method, ozone, UV methods. Solid waste- Characterization and sorting of wastes. Treatment methods- Land fills, incineration, pyrolysis. Composting- stages in composting, Types of composting .Vermicomposting. DRANCO. .Anaerobic reactors -Stages in anaerobic digestion, methanogens . Biogas generation. Household treatment strategies- septic tank, small scale composting using pot, pipe etc.

Module V **10**

Introduction to: Biofuels- biogas, syngas, biodiesel, ethanol. Bioelectricity, biocementation and biocement, Bioplastics- PHB, PLA, cellulose and protein based plastics. Green composite – starch based. Concept of green patent. Advantages of bioprocessing in space. Biological indicators, DNA barcoding, Contaminant facilities: Biosafety I, II and III. Role of GEAC and IBCs in environmental clearance for r-DNA products.

Reference

1. Environmental Biotechnology, Christopher. F Forster, D.A.John Wase, 1987 Ellis Harwood.
2. Comprehensive Biotechnology. Second edition, Elsevier, 2011, Murray Mor. Young (Editor in chief). ISBN-978-0-08-088504-9

3. Waste water Microbiology, Gabriel Bitton, 2005, John Wiley and Sons, Wiley series in Ecological and Applied Microbiology.

4. Microbial Ecology. Fundamentals and Applications. Atlas and Bartha, Pearson Education, Benjamin Cummings publishing company.Inc. New Jersy

5. Environmental Biotechnology, sries in Handbook of Environmental Engineering.Vol.10.Wang, L.K., Ivanov V.,Tayi,J.H and Hung Y.T (eds),2010, Humana Press.

PG20BS312-BT PLANT AND ANIMAL BIOTECHNOLOGY

Number of Hours / Week: 3 **Credits: 3**

Course Objective:

- **To have an overview in Animal and Plant cell culture techniques and its applications in various areas.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the fundamental requirements and design of lab to carry out plant and animal cell culture experiments	**K2**
2	Illustrate the approaches and techniques involved in creating recombinant plant and animals.	**K2**
3	Demonstrate the applications and demerits of genetic modification in plants and animals.	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (10 hours)

History of animal cell culture; Laboratory setup and equipments; Types of cell culture media, media constituents, CO2 incubation & bicarbonate Buffering. Sterilization of cell culture media; Isolation of tissue. Disaggregation of tissue – Mechanical and Enzymatic methods. Different culture techniques, Secondary culture. Passaging number; characteristics of animal cells in cultures; Suspension culture; Histotypic cultures; Embryonic and Adult stem cell culture. Continuous cell lines, Maintenance of cell Lines- Cryopreservation and Germplasm storage.

Module II (10 hours)

Vectors for animal cells- adeno based vectors, SV 40, baculovirus. Measurement of viability & cytotoxicity; Cell cloning and selection; Cell synchronization; Hybridoma technology and its application; Application of animal cell culture technology: Production of human and animal vaccines and pharmaceutical protein. Animal bioreactors. Three dimensional culture and tissue engineering for organ replacement.; *In vitro* testing of drugs, Testing of toxicity of environmental pollutants and carcinogens; As model systems for basic research; Foetal cell culture to detect genetic abnormalities. Transgenesis, transgenic mice and cattle. Artificial cells.

Module III **(14 hours)**

Conventional plant breeding. Introduction to cell and tissue culture; Requirements of tissue culture lab, Tissue culture media: Composition and Preparation. Sterilization and agents of sterilization used in tissue culture labs. Initiation and maintenance of callus and suspension cultures. Somaclonal variation. Shoot tip culture; micropropagation, Rapid clonal propagation and production of virus-free plants. Organ culture , Embryo culture and embryo rescue; Single cell clones. Organogenesis; Somatic embryogenesis; Transfer and establishment of whole Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Bulbosum technique , triploid production, Hardening, synthetic seeds.

Module IV **(8 hours)**

Agrobacterium mediated DNA transfer- Features and Use of *Ti* and *Ri* plasmids; Mechanism of DNA transfer; triparental mating, Binary vectors. Methods of nuclear transformation, Viral vectors and their applications; Multiple gene transfers, Vector-less or direct DNA transfer, Transformation of monocots- Gemini virus, Plant promoters: Ca MV35Spromoter, Rice actin 1 promoter, Maize ubiquitin1 promoter. Transgene stability and gene silencing.

Module V **(10 hours)**

Protoplast isolation, culture and fusion; Selection of hybrid cells and regeneration of hybrid plants; Symmetric and asymmetric hybrids, cybrids. Chloroplast transformation; Cryopreservation; Slow growth cultures and DNA banking for germplasm conservation.

Application of plant transformation for enhanced quality: Herbicide resistance, insect resistance, Bt genes, Non Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated disease resistance, Pathogen identification by SCAR. Movement protein mediated disease resistance, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stresses; marker aided breeding –an introduction.– Advantages, Plantibodies. Metabolic engineering and industrial products – Plant secondary metabolites.

Reference

1. Freshney, culture of Animal cell, 5th edition

2. Ed. John R.W Masters Animal cell culture- Practical approach 3rd edition, Oxford university press-2000
3. In Vitro cultivation of Animal cells. Elsevier India PVT LTD-17-A/1 Main Ring Road, New Delhi-110024
4. R.Sasidhara, Animal Biotechnology MJP publishers-Chennai.
5. Plant biotechnology – J Hammond, et. al., Springer Verlag.
6. Biotechnology in crop improvement – H S Chawla.
7. Practical application of plant molecular biology – R J Henry, Chapman & Hall.
8. Elements of biotechnology – P K Gupta.
9. An introduction to plant tissue culture – M K Razdan.
10. Cell culture and somatic cell genetics of plants (Vols. 1 to 3) – A K Vasil, A. Press.
11. Principles of plant biotechnology: An introduction to genetic engineering in plants – SH Mantell,

PG20BSP3-BT LABORATORY COURSE III

Number of Hours / Week: 4 **Credits: 4**

Course Objectives:

- **To train students in plant tissue culture, lab scale aspects of bioprocess technology and waste water analysis.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the fundamentals of plant tissue culture	**K2**
2	Illustrate the approaches and techniques in bioprocess technologies	**K2**
3	Understand the various procedures in waste water treatment plants	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

1. Bacteriological examination of water. MPN Method
2. Bacteriological examination of food and milk sample

3. Methylene blue reductase test for milk quality

3. Fermentative production of wine and estimation of alcohol content
4. Fermentative production through Solid state fermentation
5. Immobilisation of microbial cells for enzyme production
6. Estimation of COD
7. Estimation of BOD
8. Bioreactor studies for waste management
9. Biogas production
10. Composting techniques
11. Mushroom cultivation
12. Fermentative production of industrially useful enzyme
13. Plant tissue culture techniques
14. Surface sterilization
16. Callus culture
17. Anther culture
18. Embryo culture

19. Protoplast isolation
20. Somatic Hybridization

Reference :

1.. Practical Microbiology. Maheswari D K. S Chand Pub.

2. . Microbiological Applications.Laboratory manual in General Microbiology. Harold J Benson. Mc Graw hill Pub.

3. Plant tissue culture: Theory and Practice - S.S Bhojwani and M.K. Razdan. Elsevier

4. Plant, Cell, Tissue and Organ Culture Fundamental Methods - Gamborg and Phillips, Narosa Publishers.

5. Experiments in Microbiology, Plant Pathology and Biotechnology. K R Aneja. New Age International

FOURTH SEMESTER

PG20BSP4-BT	**Lab Course IV**
PG20BS4P-BT	**Project**
PG20BS4V-BT	**Course Viva**
	Elective 01
	Elective 02
	Elective 03

PG20BSP4-BT Laboratory Course IV

Number of Hours / Week: 4 **Credits: 4**

Course Objectives:

- **To train students in various molecular and rDNA technologies used in various fields**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the fundamentals molecular biology techniques	**K2**
2	Illustrate the approaches and techniques in rDNA technology	**K2**
3	Understand the various procedures in Biotech industries and research industries	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

1. DNA isolation
2. RNA isolation
3. Conjugation
4. cDNA preparation
5. Competent cell preparation
6. Transformation
7. Plasmid isolation
8. Restriction enzyme digestion
9. Ligation
10. Screening of recombinants
11. Expression and purification of recombinant proteins
12. Blotting techniques
13. RFLP,

14 Amplification of selective gene by PCR

15. Molecular marker studies: RAPD, SCAR, AFLP, SNP

16. Basics of Bioinformatics

Reference:

1. Molecular cloning : A laboratory Manual, Sambrook and Russel, Cold spring Harbor Lab Pub

2. Experiments in Microbiology, Plant Pathology and Biotechnology. K R Aneja. New Age International

3. Biotechnology: Procedures and Experiments Hand book: S. Harisha. Infinity Science Press. *ISBN*:9788170088790

4. PRACTICAL HANDBOOK OF BIOCHEMISTRY AND MOLECULAR BIOLOGY. ED. FASMAN. CRC PRESS.ISBN0-8493-3705-4

LIST OF ELECTIVES

Elective Groups	Elective courses	Credit
Elective Group I	Advanced Molecular Techniques	**4**
	Molecular biology of Development	**4**
	Cancer Biology	**4**
Elective Group II	Physiology and Biotechnology	**4**
	Microbial Food Technology	**4**
	IPR and Biotechnology	**4**
Elective Group III	Environment and Biotechnology	**4**
	Food Biotechnology	**4**
	Genomics: Techniques and Applications	**4**

PG20BS413-BT ADVANCED MOLECULAR TECHNIQUES

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To understand various molecular techniques employed in the research studies.**
- **To have an overview of the applications of these molecular techniques in the area of biotechnology.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Summarize the different DNA extraction and visualization methods	**K5**
2	Illustrate different PCR techniques for various analysis	**K3**
3	Illustrate various DNA sequencing methods	**K2**
4	Demonstrate various applications of DNA analysis in Forensic and diagnostic areas	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (10 hours)

DNA Extraction: Phenol-chloroform method. Representational Difference Analysis (RDA), Serial Analysis of Gene Expression (SAGE), Differential Display. Electrophoretic Methods for mutation detection: SSCP (Single-Strand Conformational Polymorphism), Heteroduplex analysis, DGGE (Denaturing Gradient Gel Electrophoresis), Chemical Cleavage of mismatched nucleotides, Ribonuclease cleavage of mismatched DNA: RNA duplexes.

Module II (12 hours)

Modifications of PCR: Gene amplification and Analysis-PCR, Multiplex Amplification, Labeling PCR, Allele-Specific PCR, Real-Time PCR, Quantitative fluorescent PCR, Rolling-Circle Amplification (RCA) and Multiple Displacement Amplification (MDA), ARMS-PCR (Amplification-Refractory Mutation System-PCR), Oligonucleotide Ligation Assay, Primer Extension. IsothermalAmplification: TMA (Transcription-Mediated ***Amplification***), NASBA (Nucleic Acid Sequence-Based ***Amplification***), SDA (Strand Displacement Amplification), Multiple Thermal Amplification: Linked Linear Amplification, LCR (Ligase Chain Reaction)

Module III (12 hours)

Next-Generation Sequencing: Massively Parallel Sequencing Platforms: 454/Roche GS FLX : Technology Overview, Research Application. Illumina Genome Analyzer II: Library Preparation, Cluster Creation, Data Analysis, Paired-End Sequencing. Solid 3 System: Solid (Sequencing By Oligonucleotide Ligation And Detection) Platform, Solid System Application.

Module IV (12 hours)

DNA Profiling in forensic analysis : Concept of sequence variation - VNTR, STRs (Short Tandem Repeat), Mini STRs , SNPs. Detection techniques - RFLP, PCR amplifications, Amp-FLP (Amplified Fragment Length Polymorphism), Y-STR (Short Tandem Repeat on Y-chromosome), Evaluation of results, frequency estimate calculations and interpretation, Allele frequency determination, Match probability – Database, Quality control, Certification and Accreditation. Mitochondrial DNA analysis.

Module V (8 hours)

DNA profiling applications in disputed paternity cases, child swapping, missing person's identity, civil immigration, veterinary, wild life and agriculture cases. Legal perspectives – legal standards for admissibility of DNA profiling – procedural & ethical concerns. Status of development of DNA profiling in India & abroad. Limitations of DNA profiling.

Reference

1. Anolles, G. C. and Gresshoff, P.M., DNA markers – protocols, applications and overviews. Wiley – Liss, NewYork, 1997
2. Clark, D. P., Molecular Biology, Elsevier, USA, 2005.
3. Henry R. J., Plant Genotyping: The DNA fingerprinting of plants. CABI, New Delhi, 2005.
4. Patterson, Molecular dissection of complex traits, CRC Publications, Washington, 1998.
5. Purohit, S. S., Biotechnology – Fundamentals and Applications, 8th Edition, Agrobios, India, 2007.

PG20BS414-BT MOLECULAR BIOLOGY OF DEVELOPMENT

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To have an overview of the molecular pattern and mechanisms of development process in animals and plants.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Summarize the cellular processes leading to organogenesis and development.	**K5**
2	Illustrate the Significance of molecular patterns and molecular mechanisms of development in plants and animals	**K3**
3	Illustrate the Basic mechanism of senescence and cell death.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module 1 (10 hours)

Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development .

Module II (12 hours)

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Module III (12 hours)

Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Module IV (12 hours)

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum* . Introduction to B chromosomes in plants.

Module V (8 hours)

Programmed cell death, aging and senescence

Necrosis, Apoptosis, caspases, Extrinsic and intrinsic pathway, aging, theories of aging mitochondrial stress, senescence

Reference

1. Lewin's Cells. Lynne Cassimeris,Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London
2. The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.
3. Scott F. Gilbert,Developmental Biology, Seventh Edition,2003,Sinauer Associates, Inc., Sunderland, MA,ISBN 0-87893-258-5
4. John Gerhart and Marc Kirschner,Cells, Embryos, And Evolution,1997,Blackwell Science,ISBN 0-86542-574-4,
5. Fred H. Wilt & Sarah C. Hake,Principles of evelopmental Biology,2004,W.W. Norton & Company, Inc., New York, NY,ISBN 0-393-97430-8
6. Sally A. Moody, Editor,Cell Lineage and Fate Determination**,**October 1998,Academic Press, Inc.,ISBN 0-12-505255-3
7. Lewis Wolpert, Rosa Beddington, Thomas Jessell, Peter Lawrence, Elliot Meyerowitz, Jim Smith, **Principles of Development**, Second Edition,2002,Oxford University Press, ISBN 0-19-924939-3

PG20BS415-BT CANCER BIOLOGY

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To gain an understanding of mechanisms of carcinogenesis.**
- **To know the various diagnostic techniques and therapeutic measures in cancer treatment.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the basic aspects of cancer pathology	**K5**
2	Illustrate the mechanisms of Carcinogenesis and metastasis.	**K3**
3	Illustrate the diagnostic techniques and treatment approaches.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (15 hours)

Fundamentals of cancer biology: Introduction to Cancer Biology, Different forms of cancers, Cancer screening and early detection, Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer.

Module II (15 hours)

Principles of carcinogenesis: Theory of Carcinogenesis, Chemical carcinogenesis, principles of physical carcinogenesis, X-ray radiation-mechanisms of radiation carcinogenesis, Diet and cancer.

Module III (15 hours)

Principles of molecular cell biology of cancer: Signal targets and cancer, activation of kinases; Oncogenes, identification of oncogenes, retroviruses and oncogenes, detection of oncogenes, Oncogenes/proto oncogene activity, Growth factors related to transformation, Telomerases. Tumor suppressor genes, modulation of cell cycle in cancer.

Module IV (12 hours)

Principles of cancer metastasis : Clinical significances of invasion, Metastatic cascade, Basement membrane disruption, proteinase and tumor cell invasion.

Module V (15 hours)

New molecules for cancer therapy: Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer; Gene therapy.

Reference

1. Maly B.W.J, "Virology A Practical Approach", IRLl Press, Oxford, 1987.
2. Dunmock N.J And Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, Oxford, 1988.
3. Biotechnology- Applying genetic revolution. David P Clark , Nanette J Pazdernik.Elsevier, New York
4. Lewin's Cells. Lynne Cassimeris,Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London

The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.

PG20BS416-BT PHYSIOLOGY AND BIOTECHNOLOGY

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To understand the metabolic pathways in the plants.**
- **To have an idea of the various application of biotechnology in cell culture.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the functional significance of organ systems	**K5**
2	Illustrate the role of plant metabolic pathways and their steps.	**K3**
3	Illustrate the applications of biotechnology in human cell and organ culture.	**K2**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (12 hours)

Composition and functions of blood. Haemopoiesis . Plasma and formed elements. Plasma - function, Clotting factors- production through r DNA technology. Role of Haemoglobin. Thalassemia – genetic diagnosis and gene therapy. Haemostasis– mechanisms. Blood groups: ABO system, determination, importance, Rh. Culture of blood cells. Cardiac cycle, blood pressure, Neural and chemical regulation.

Module II (12 hours)

Physiology of excretion, Kidney, Urine formation, Urine concentration, Micturition, Regulation of water balance, electrolyte balance, acid-base balance. Functional anatomy, Phases of respiration transport of gases, Neural and chemical regulation of respiration. Organ culture and its applications

Module III: (12 hours)

Nervous system - Neurons, Action potential, Gross neuro – anatomy of the brain and spinal cord, Central and peripheral nervous system, Neural control of muscle tone and posture. Neural circuit. Flourescent labeling and detection of neurons. Culture of neuronal cells. Endocrinology and reproduction - Endocrine glands, Basic mechanism of hormone action, Hormones and diseases

Module IV: (10hours)

Photosynthesis - Light harvesting complexes, mechanisms of electron transport, photo protective mechanisms, CO2 fixation-C3, C4 and CAM pathways. Citric acid cycle; plant mitochondrial electron transport and ATP synthesis, photorespiration. Transpiration. Reverse photosynthesis- production of biofuels.

Module V: Plant Physiology (8 hours)

Absorption and transport of water, Macro &micro nutrients, Plant hormones, plant movements, photoperiodism, vernalization, **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.Strees tolerant plant production through biotechnology.

Reference

1. Vander's Human Physiology- The Mechanism of Body function. Widmaier, Raff, Strang
2. Text book of Medical Physiology. Arthur. C. Guyton & John. E. Hall
3. Physiological basis of Medical Practice. John. B. west
4. Review of Medical Physiology. William. F. Ganong
5. Essentials of Medical Physiology. K. Sembulingam & Prema Sembulingam
6. Freshney, culture of Animal cell, 5th edition
7. Ed. John R.W Masters Animal cell culture- Practical approach 3rd edition, Oxford university press-2000
8. In Vitro cultivation of Animal cells. Elsevier India PVT LTD-17-A/1 Main Ring Road, New Delhi-110024
9. R.Sasidhara, Animal Biotechnology MJP publishers-Chennai.
10. Plant biotechnology – J Hammond, et. al., Springer Verlag.
11. Biotechnology in crop improvement – H S Chawla.

PG20BS417-BT MICROBIAL FOOD TECHNOLOGY

Number of Hours / Week: 4 **Credit-4**

Course Objectives:

- **To gain an idea of how fermentation helps in production of food.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the role of microbial fermentation in food production and factors affecting it.	**K5**
2	Illustrate the role of biotechnology in food production and modification.	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I **(14 hours)**

Primary Sources of microbes in food, Intrinsic parameters of food that affect microbial growth: pH,water activity, oxidation reduction potential, nutrient content, antimicrobial constituents & biological structures. Extrinsic parameters of food that affect microbial growth: relative humidity, storage temperature, gaseous environment. Cross contamination. Role of microbes in bread making, cheese production, acidophilus milk, yoghurt, sauerkraut, beer and wine. Single cell protein. Definition & mechanism- probiotics, prebiotics & synbiotics. Functional foods-from plant sources: tomatoes & oats; animal sources: fish. Nutraceuticals, Methods of food preservation, food borne illness and quality control.

Module II **(10 hours)**

Spoilage of fish- mechanism of meat spoilage. Spoilage of dairy products. Principles offood preservation- commercially sterile, pasteurization, pickling, drying, canning, curing. Food preservation with chemicals. Radiation preservation of food.

Module III **(12 hours)**

Foodborne diseases: infections, food-poisoning, toxico-infections; Microbiological hazards in food: *Salmonella, Clostridium botulinum, Vibrio, Hepatitis A*, *Campylobacter jejuni, Listerimonocytogenes, Bovine Spongiform Encephalopathy*; Fungal Toxins. Emerging foodborne pathogens: *E. coli* O157.

Module IV **(10 hours)**

Microbial indicators of food safety and quality: coliforms- detection & enumeration, coliform criteria & standards. Aerobic Plate Count, Methylene blue reductase test& phosphatase test. Risk associated with ready to eat food(RTF). Microbiological examination of food: Detection of *Salmonella*in food.

Food Safety and standards authority of India, United StatesFood and Drug Administration US-FDA, *Codex alimentarius*; Microbiological safety of food: HACCP concepts in ensuring food safety.

Module V **(8 hours)**

GM food: Risks, possible danger to individuals, society or nature, labeling of GM food. Safety assessment of GM food. Transgenic tomato; Methionine-enriched oil; Frost-resistant food; Bt. maize; beta-carotene in rice. Edible vaccines. Transgenic Animals: Growth hormone gene in pigs; Transgenic salmon; Bovine Somatotropin in Milk.

References:

1. Potten N.M. "Food Science" The AVL Publishing Co. 2002
2. Piefzer F.M. "Food Microbiology" Academic Press, 1989
3. Roger A., Gorden B., and John T., " Food Biotechnology", 1989
4. Bioprocess Technology: P T Kalaichelvan, I Arul Pandy : MJP Publishers.
5. James M.Jay. "Modern Food Microbiology", CBS Publishers & Distributors, 1987.
6. James M.Jay. "Modern Food Microbiology", CBS Publishers & Distributors, 1987 pp17-20
7. James M.Jay. "Modern Food Microbiology", CBS Publishers & Distributors, 1987 chapter 3.
8. James M.Jay. "Modern Food Microbiology", CBS Publishers & Distributors, 1987 pp221-225
9. James M.Jay. "Modern Food Microbiology", CBS Publishers & Distributors, 1987 pp237-239.
10. Bacteriological Analytical Manual Chapter 3*Reference: Bacteriological Analytical Manual, 8th Edition, Revision A, 1998. Chapter 4; Microbiological analysis –Manual FSSAI, India - pp28-36; Reference: Bacteriological Analytical Manual, 8th Edition, Revision A, 1998. Pp51-62.
11. Review- The Role of Functional Foods, Nutraceuticals, and Food Supplements in Intestinal Health 2010, A. Cencic and W. Chingwaru*Nutrients* 2010, 2, 611-625 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257668/pdf/nutrients-02-00611.pdf.

PG20BS418-BT IPR and BIOTECHNOLOGY

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **Understand the various aspects of IPR**
- **To know the biosafety guidelines and ethical issues associated with genetic modification.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the National and international approaches to protect the IPR	**K2**
2	Illustrate the guidelines for biosafety and Genetic modification of food crops and animals and the ethical issues. .	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (12 hours)

Introduction to Intellectual Property. Types of IP: Patents, Trademarks, Trade dress, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. WTO regime - consumer protection and plant genetic resources-GATT and TRIPS. Patent protection to GMO. Objects of Intellectual property law.

Module II (12 hours)

Types of patents; Indian Patent Act 1970; Recent Amendments; Patent application- forms and guidelines, fee structure, time frames; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Types of patent applications: provisional and complete specifications; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.). Rights of patent holder. Basmati rice patent issue: a Case study.

Module III (10 hours)

Introduction to Biosafety levels. Primary Containment for Biohazards; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines. Regulatory bodies of India-RCGM and GEAC.

Module IV (12 hours) GM crops- versus organic and traditional crops, global status of GM crops, genetic engineering of Btbrinjal and Bt cotton , Golden rice, edible vaccines,. Advantages and disadvantages of GM foods, Biosafety and environmental safety concerns, Public perceptions, Environmental release of GMOs; Genetically modified Organisms in India. Labeling of GM foods;

Module V (8 hours)

Ethical and legal implications of Human genome project, genetic testing and screening, stem cell research , Bioweapons and bioterrorism. Patenting of gene, Patenting of microbes- International Microorganism Deposit system of WIPO.

Reference

1. P. Narayanan, Intellectual Property Laws, Eastern Law House.2001
2. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.2009
3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.
4. John E. Smith,Biotechnology,3rdEd.Cambridge University Press.
5. Molecular Biotechnology – Glick and Pasternac
6. Gene cloning :An Introduction, T A Brown, Chapman and Hall Pub
7. Principles of gene manipulation – Old and Primrose, Blackwell Scietific publishers

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http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html
https://www.wipo.int/treaties/en/registration/budapest/

PG20BS419-BT ENVIROMENTAL SCIENCE

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To have a knowledge on the importance to conserve the environment.**
- **To know the various environmental issues and biotechnological approaches towards it.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the structure of the environment	**K2**
2	Illustrate the role of other organisms in the survival of man as a species, the global environmental issues, the necessity to conserve environment and strategies for conservation, the Biotechnological approaches in environmental studies.	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (12 hours)

Principles and scope of environmental science, autecology, synecology, habitat, niche, fundamental and realized niches, trophic levels, food chains, foodweb, ecosystem, biotic and abiotic components, pyramid of numbers ,pyramid of biomass, energy transfer in ecosystem.

Module II (10 hours)

Biogeochemical cycles- nitrogen, sulfur, phosphorus cycles and their significance. Micro organisms in extreme environment.Biological indicators of environmental quality- lichen, frogs and toads.

Module III (18 hours)

Biomes: Types. Tropical rain forest as a typical example of biome. ,Ecological succession – xerosere and hydrosere, Edge effect and ecotones, Endangered and Threatened Species. Sentinel species, Environmental genomics: High throughput sequencing in the detection of unknown DNA from environment, DNA barcoding.

Module IV (16 hours)

Environmental issues and problems: Ozone depletion, global warming and climatic change, acid rain, pollution by oil spillage, desertification, eurtrophication, underground water pollution, heavy

metal poisoning- mercury, lead, arsenic, cadmium, hazards of radio activity, bioweapons, pollution in extreme environment., carbon foot print.

Module V (16 hours)

International and national efforts for environment Protection.and Conservation of biodiversity: Biodiversity status, monitoring and documentation Biodiversity management approaches, principles of conservation and wild life management, ex situ and in situ methods of conservation , biological parks, nature reserves, sanctuaries, cryopreservation, gene bank,germplasm conservation, Hotspots of biodiversity.

Reference

1. Ecology principles and applications. Chapman and Reiss,Cambridge University.
ISBN-13: 978-0521588027
2. Environmental biology, Jobes A. M., Routledge, London.
3. Fundamentals of ecology. Odum E. P and Barret G W,W. B Saunders company, Philadelphia.
4. Odum E. P. Basic ecology. Saunders College.
5. A textbook of environmental sciences, Arvind kumar.
6. Basics of environmental science. Alleby M. Routledge, Newyork
7. Cunningham, W. P and Siago, B. W ,Environmental science.
8. Kewin T. P and Owen C. A., Introduction to global environmental issues. Routledge, London.Chiras,D.D, Environmental science
9. Microbial Ecology. Fundamentals and Applications. Atlas and Bartha, Pearson Education, Benjamin Cummings publishing company.Inc.New Jersy

PG20BS420-BT FOOD BIOTECHNOLOGY

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To gain an idea on various biotechnological applications in food industry.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the applications of biotechnology in food production. Enhancing the quality and quantity of food materials through genetic engineering,	**K2**
2	Illustrate the rules and regulations in genetic modification of food	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (15 hours)

Food production through fermentation- Bread making, cheese production-process, starter culture, types of cheese. Other fermented dairy products- buttermilk, acidophilus milk, yogurt, butter, paneer, kefir, marine fermented foods, koji, tempeh. Fermented bevarages- beer and wine. Enzymes in food processing: amylase, protease,chymosin, lipase, cellulase, hemicellulase, pectinase, pectin lyase, catalase, glycosidase, invertase, glucose oxidase, glucose isomerase

Module II (12 Hours)

Single cell protein- from bacteria and algae, probiotics, prebiotics, Edible mushrooms, Steps of mushroom production, microbial production of vitamins-riboflavin, vitamin C, lite beer, HFCS(High Fructose corn syrup). Buffalo cloning in India.

Module III (15 hours)

Transgenic plants-Flavr savr tomato; Methionine-enriched oil; Frost-resistant food; - Starlink corn, Bt maize; Fungal Resistant potatoes; Transgenic Fish -Atlantic salmon. Plant Pharmaceuticals, Biopharming -beta -carotene in rice; Edible vaccines -Hepatitis B vaccine in maize-Cholera vaccine in potatoes; Bovine Somatotropin in Milk; Chymosine and mycoproteins. Growth hormone gene in pigs - alpha-lactalbumin and lactoferrin in milk

Module IV (15 hours)

Food preservation:, contamination of milk, Preservation of milk, microbial contamination and spoilage of food, foodborne illness- salmonellosis, listeriosis, botulism, staphylococcal infection, preservation methods: Effect of low temperature, freezing, effect of heat, drying, concentration, fermentation, canning, radiation, chemical preservatives.

Module V (15 hours)

Significance of food safety assessments & surveillance. GM food: Regulations, Risks, possible danger to individuals, society or nature- Terminator genes and loss of biodiversity. HACCP concepts and risk assessment. Government regulatory agencies and food policies -Food and Drug Administration, The Centers for Disease Control and Prevention, The Environmental Protection Agency.

Reference:

1. Biotechnological innovations in foodprocessing: Editor : Dr. J Green, Butterworth-Heinman Pub.
2. Food-Facts and PrinciplesII Ed: N Shakuntala Manay, M. Shadakshara Swamy. New Age International Pub:
3. Bioprocess Technology: P T Kalaichelvan, I Arul Pandy : MJP Publishers.
4. George J.B., "Basic Food Microbiology", CBS Publishers & Distributors, 1987
5. Roger A., Gorden B., and John T., " Food Biotechnology", 1989

PG20BS421-BT GENOMICS: TECHNIQUES AND APPLICATIONS

Number of Hours / Week: 4 **Credit-4**

Course Objective:

- **To gain an indepth knowledge on organization of human genome.**

Course outcome

CO No.	Upon completion of this course, the students will be able to:	Knowledge Level
1	Understand the structural and functional organization of genome. Human genomic structure and implications of HGP.	**K2**
2	Illustrate the Techniques involved in genomics and their applications	**K3**
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.		

Module I (15 hours)

Overview: Genomes of Bacteria, Archaea, and Eucarya; chromatin, supercoiling and packaging; karyotype. Genetic mapping: linkage map and gene association analysis. Genome signature. Coding sequences- Genes and gene families. Noncoding sequences- pseudogenes, Regulatory sequences, repetitive sequences. Transposable elements.

Module II (15 hours)

Human Genome Project- brief history, techniques and outcomes. LINE(L1)sequences in human genome. Human mitochondrial genome - A structural outline. mitochondrial eve. Mitochondrial gene deletion related syndrome- Kearns sayre syndrome, Mitochondrial Diabetis and Deafness(MIDD). Human gene data base- OMIM.

Module III (15 hours)

European Genome-phenome archive(EGA) European Nucleotide Archive(ENA), Techniques in functional genomics: Genetic interaction mapping, ENCODE. Gene finding and annotation; sequence annotation and bioinformatics tools for genomics – Phred, RAST. Analyzing gene expression-DNA microarray-design, analysis and visualization of data. Application of DNA microarrays, SAGE. RNA sequencing. Spliceman, EST, SNP, RFLP's.

Module IV (15 hours)

Pharmacogenomics- basic principles and benefits. Cytochrome p 450 in drug metabolism. Predictive prescribing. Molecular medicine. gene medicine- Gene therapy- Types, methods and applications. Guidelines of gene therapy. DNA vaccines, Antisense therapy, Nucleic acid drugs.

Module V (12 hours)

Synthetic biology- artificial gene synthesis(DNA printing) and its applications. Genome editing- role of TALEN, CRISPR and meganucleases. Peptide Nucleic Acid, Threose nucleic acid. Human artificial chromosome(HAC).

Reference

1. Genomes. Brown, T.A., Wiley - Lis Publications, 2002.
2. Mount David W. Bioinformatics Sequence and Genome Analysis. Cold Spring Harbor Lab Press, CSH New York, 2002.
3. Stephen Misener and S. A. Krawetz. Bioinformatics Methods and Protocols. Humana Press. 2000.
4. Rastogi, S.C, N. Mendiratta, P. Rastogi. Bioinformatics Methods and Applications. Prentice Hall of India, 2004.
5. Krebes, J E, GoldsteinE. S and Kilpatrick ST. B Lewin's Genes XI. Jones and Bartlett learning.
6. Lewis D. Solomon (Editor). Synthetic Biology: Science, Business, and Policy. 2017 . Routeledge Pub.
7. https://www.ncbi.nlm.nih.gov/pmc/articles
8. https://www.genome.gov/
9. https://www.ebi.ac.uk/training/online/course/genomics-introduction-ebi-resources/european-genome-phenome-archive-ega

Model Question Papers

QP Code **Reg. No……**

Name ……

MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

First Semester M.Sc. Biotechnology Examination - 2019
PG20BS101 –Biochemistry (Model question paper)

Time: Three hours Max. Weight: 30

Section- A (Answer any **eight** questions. Each question carries a weight of 1)

1. Glycosidic bonds
2. Glycolipids
3. PHOSPHATIDYL ETHANOLAMINE
4. Chitin
5. Watson and crick base pairing
6. Epinephrine
7. Ascorbic Acid
8. ATP Synthase
9. FAD
10. Glutathione

Section B (Answer any **six** questions. Each question carries a weight of 2)

11. Glycoprotein
12. Heteropolysaccharides
13. Bacterial peptidoglycans
14. Coenzymes and co factors
15. Insulin
16. Night Blindness
17. Sphingomyelin
18. Sequencing of proteins

Section C (Answer any **two** questions. Each question carries a weight of 5.)

19. With a suitable example explain the mechanism of action of steroid hormones
20. Compare the structure and function of Hb and myoglobin
21. Structure and function of glycerophospholipids
22. Classification and structure of carbohydrates.

QP Code **Reg. No……**

Name ……

MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

First Semester M.Sc. Biotechnology Examination - 2019
PG20BS102 –Cell Biology and Genetics (Model question paper)

Time: Three hours Max. Weight: 30

Section- A(Answer any **eight** questions. Each question carries a weight of 1)

1. Fluid Mosaic model of membranes
2. Oncogene
3. Tumor suppressor gene
4. Ribosome
5. Histones
6. Monohybrid ratio
7. Down's syndrome
8. Chloroplast
9 . Apoptosis
10. Facilitated diffusion

Section- B(Answer any **six** questions. Each question carries a weight of 1)

11. Chromosome mapping
12. Cytoplasmic inheritance
13. Hardy Weinberg principle
14. Multiple alleles
15. Regulation of cell cycle
16. Inherited disorders in metabolism
17. Comment on the different theories of aging
18. Cell cycle check points

Section C(Answer any **two** questions. Each question carries a weight of 5.)

19. Membrane transport
20. With the help of a labeled diagram describe a typical cell and its constituents.
21. What are the causes of cancer? Describe the different stages of cancer development. Add a note on diagnosis and treatment.
22. Mitochondrion: structural features and functions

QP Code **Reg. No……**

Name ……..

MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

First Semester M.Sc. Biotechnology Examination - 2019

PG20BS103-BT –Instrumentation and Biostatistics (Model question paper)

Time: Three hours Max. Weight: 30

Section- A (Answer any **eight** questions. Each question carries a weight of 1)

1. Beer- Lambert's law.
2. Arithmetic mean
3. Resolving power of a microscope
4 . State the use of cantilever in AFM
5. What is cation exchange resin
6. Define Isoelectric point
7. What is Ultrafiltration
8. What is Freeze fracture technique.
9. Define standard deviation
10. Principle of interference microscope.

Section- B(Answer any **six** questions. Each question carries a weight of 2)

11. Agarose as support matrix in electrophoresis
12. GM Counter
13. Tests of significance
14. Density gradient centrifugation.
15. Pulsed field gel electrophoresis.
16. immunoaffinity chromatography
17. Describe the different methods used for collection classification and tabulation of data.
18. Explain the working mechanism of HPLC.

Section- C(Answer any **two** questions. Each question carries a weight of 5)

19. Give an account of the different chromatographic techniques used for separation
20. What is SDS PAGE? Add a note on its working principles and significance.
21. Describe the. different spectroscopic techniques you have studied
22. Describe in detail the principle and working of confocal microscopy.

QP Code **Reg. No……**

Name ……..

MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

First Semester M.Sc. Biotechnology Examination - 2019
PG20BS104-BT – Biophysics and Bioinformatics (Model question paper)

Time: Three hours Max. Weight: 30

Section- A (Answer any **eight** questions. Each question carries a weight of 1)

1. State the advantages of Rasmol
2. Z DNA
3. Define Enthalpy
4. Leucine zipper motif
5. SWISSPROT
6. World wide web
7. Similarity search
8. What are histones
9. State the application of Ramachandran plot
10. High energy molecules

Section- B (Answer any **six** questions. Each question carries a weight of 2)

11. Zinc fingers
12. BLAST
13. Biological databases
14. Globin fold
15. Construction of phylogenetic tree
16. Laws of thermodynamics
17. Give an account of the different protein structural data bases
18. Applications of Bioinformatics in genetic research

Section- C (Answer any **two** questions. Each question carries a weight of **5**)

19. Comment on DNA- Protein interactions you have studied
20. What is DNA polymorphism?
21. Describe the Applications of Bioinformatics in drug designing. different spectroscopic techniques you have studied
22. Describe in detail sequencing of DNA principle and working of confocal microscopy.

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Name ……

MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Second Semester M.Sc. Biotechnology Examination - 2019

PG20BS205 –Microbiology (Model question paper)

Time: Three hours Max. Weight: 30

Section A: (Answer any **eight** questions. Each question carries a weight of 1)

1) Insertion sequences
2) Enrichment media
3) Fermentation
4) Transformation
5) Lyophilization
6) Photo-reactivational repair
7) Blood agar
8) Dry heat Sterilization
9. Lophotrichous bacteria
10. Catalase test

Section B(Answer any **six** questions. Each question carries a weight of 2)

11) Conjugation
12) Hexokinase
13) Transposons
14) Phenol Coefficient Test
15) Ribotyping
14) Growth curve of a typical bacteria in culture.
15) Explain Flagellar Structure with a note on difference between prokaryotic & eukaryotic flagella.
16) Viral Classification
17. Elaborate on Generalized & Specialized transduction.
18. Purple sulfur bacteria

Section C(Answer any **two** questions. Each question carries a weight of 5.)

19) Elaborate on the structure of bacterial cell wall with a note on peptidoglycan synthesis.
20) Explain the mechanism of drug resistance in Bacteria
21) Write in detail about the glycolytic pathway.
22) Classify fungi, with a note on economic importance of fungi.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Second Semester M.Sc. Biotechnology Examination - 2019
PG20BS206 –Immunology (Model question paper)

Time: Three hours Max. Weight: 30

Section A(Answer any **eight** questions. Each question carries a weight of 1.)

1) Adjuvants
2) Abzymes
3) Immunofluorescence
4) Chimeric antibody
5) Superantigens
6) Idiotype and Isotype
7) Dendritic cells
8) SCID
9) Active & Passive Immunization
10. Erythroblastosis foetalis

Section B(Answer any **six** questions. Each question carries a weight of 2.)

11) Describe the process of Inflammation
12) T- Cell Receptor Complex
13) MHC Molecules
14) ABO blood grouping
15) Mechanism involved in Graft Rejection
16) Mitogens
17) Classical pathway of complement.
18) B cell maturation

Section C(Answer any **two** questions. Each question carries a weight of 5.)

19) Elaborate on the molecular basis of Antibody Diversity. Write a note on class switching.
20) Describe the various Antigen- Antibody reactions in detail.
21) Describe the different types of Hypersensitivity reactions.
22) What is autoimmunity? Describe the various autoimmune diseases.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Second Semester M.Sc. Biotechnology Examination - 2019
PG20BS207-BT – Molecular Biology (Model question paper)

Time: Three hours Max. Weight: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1.)

1. Release factors
2. Looping in Ara operone
3. DNA polymerase I
4. Scaffold DNA
5. C-value paradox
6. Ribozymes
7. Okazaki fragments
8. Topoisomerase
9. SINE
10. Promoters

Section B (Answer any **six** questions. Each question carries a weight of 2.)

11. Post transcriptional modification of eukaryotic mRNA
12. RNA polymerases in prokaryotes and eukaryotes
13. Wobble hypothesis
14. Attenuation.
15. Human genome project
15. Difference between prokaryotic and eukaryotic replication
16. Lac operon
17. Types of transposons
18. Ara Operon

Section C (Answer any **two** questions. Each question carries a weight of 5.)

19. Write in detail about repetitive sequences and their importance.
20. Explain the DNA repair mechanisms
21. Explain the different stages in transcription. Add a note on regulation of transcription.
22. Describe in detail the role of enzymes in DNA replication.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Second Semester M.Sc. Biotechnology Examination - 2019

PG20BS208-BT –Enzymology and Metabolism (Model question paper)

Time: Three hours Max. Weight: 30

Section- A(Answer any **eight** questions. Each question carries a weight of 1)

1. Enzyme specificity
2. Specific activity
3. Activation energy
4. Time dependent inhibition
5. Glycogenesis
6. Redox potential
7. Amphibolic pathway
8. Criteria of purity of enzymes
9. Chemiosmosis
10. substrate level phosphorylation

Section B(Answer any **six** questions. Each question carries a weight of 2)

11. Allosteric regulation of enzymes
12. Application of enzymes
13. Bisubstrate reactions
14. Biosynthesis of sulphur containing aminoacids
15. Oxidation of fatty acids
16. TCA cycle and its energetics
17. Acyl carrier protein and fatty acid synthesis
18. Michaelis Menten equation and its significance

Section C (Answer any **two** questions. Each question carries a weight of 5.)

19. Describe the synthesis of cholesterol in animals.
20. Give a detailed account on degradation of aminoacids.
21. Discuss the EMP and PPP Glycolytic pathways with the energy yield and regulation.
22. Compare competitive, non-competitive and uncompetitive inhibition with example.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Third Semester M.Sc. Biotechnology Examination - 2019

PG20BS309-BT – Bioprocess Technology (Model question paper)

Time: Three hours Max. Weight: 30

Section- A (Answer any **eight** questions. Each question carries a weight of 1)

1. What is Fed batch culture
2. State the function of Sparger
3. What is Air lift fermenter
4. Mention the significance of Reynold's Number
5. Define Thermal death time
6. What is the mechanism of action of Antifoams
7. What is the significance *Spirulina*
8. Rennet
9. Aflatoxin
10. What is Solid state fermentation

SECTION B (ANSWER ANY SIX QUESTIONS. EACH QUESTION CARRIES A WEIGHT OF 1)

10. Ergot alkaloids
11. Methods of Secondary screening
12. Food poisoning
13. Microbial Transformation
14. Types of fluids
15. Kinetics of batch culture
16. Microbial production of pectinases.
17. Fermented milk products
18. Describe the methods of control of bioreactors

SECTION C (ANSWER ANY TWO QUESTIONS. EACH QUESTION CARRIES A WEIGHT OF 5)

19. Describe the Design of a typical Fermenter.
20. Elaborate on role of microbes in production of antibiotics with an example.
21. Explain Microbiological aspects of manufacture of alcoholic beverages
22. Describe the methods of control of Bioreactors.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Third Semester M.Sc. Biotechnology Examination - 2019

PG20BS310-BT – Recombinant DNA Technology (Model question paper)

Time: Three hours Max. Weight: 30

Section A(Answer any **eight** questions. Each question carries a weight of 1)

1. S1 Nuclease
2. SNP
3. Homopolymer tailing
4. CAT assay
5. Liposomes
6. Chromosome Jumping
7. CTAB
8. Blue revolution
9. Nucleic acid probes
10. GFP

Section B (Answer any **six** questions. Each question carries a weight of 2)

11. M13 vectors
12. In vitro packaging
13. Replica plating
14. HART
15. RNA interference
16. Production of pesticide resistant plant varieties.
17. Reporter gene
18. Alpha complementation

Section C (Answer any **two** questions. Each question carries a weight of 5)

18. Explain the steps of Southern blotting in detail with labelled diagrams.
19. Give an explanation on *E coli* based vectors
20. Outline the production of insulin through rDNA technology
21. Describe the construction of cDNA library
22. Give an account on restriction enzymes.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Third Semester M.Sc. Biotechnology Examination - 2019

PG20BS311-BT – Environmental Biotechnology (Model question paper)

Time: Three hours Max. Weight: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1)

1. Differentiate between BOD and COD
2. What are Catabolic plasmids
3. What is DRANCO
4. What are oxidation lagoons
5. Expand VAM. Mention its significance.
6. Write the important features of UASB
7. What is GMP
8. Ti plasmid
9. List out four demerits of Landfills
10. State the function of leghemoglobin.

Section B (Answer any six questions. Each question carries a weight of 2)

11. Virus as a biopesticide.
12. Biochemistry of Lignin biodegradation.
13. Important features of GATT.
14. Chemical diversity of Biosurfactants.
15. Write notes on Vermicomposting
16. Processes in an Anaerobic digestor.
17. Working of Trickling filter.
18. Explain the hazardous effects of xenobiotics.

Section C (Answer any two questions. Each question carries a weight of 5.)

19. Describe the tertiary treatment strategies for waste water.
20. Explain Symbiotic nitrogen fixation.
21. Describe the Steps of water quality testing.
22. Process of patenting

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Third Semester M.Sc. Biotechnology Examination - 2019

PG20BS312-BT – Plant and Animal Biotechnology (Model question paper)

Time: Three hours Max. Weight: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1)

1. Surface sterilization
2. Lenti virus
3. Ca MV promoter
4. Balanced salt solution
5. Triploids
6. Binory vector
7. Auxins
8. Anchorage dependence
9. Endosperm culture
10. Applications of MAb

Section B(Answer any **six** questions. Each question carries a weight of 2)

11. Suspension culture of plant cells
12. Animal pharming
13. Somaclonal variation.
14. Gene therapy
15. Primary cell lines
16. Organ culture
17. Gene transfer methods in animal cells.
18. Describe haploid production and its significance.

Section C(Answer any **two** questions. Each question carries a weight of 5)

19. Write an essay on Medicinal applications of animal cell culture.
20. Give a detailed description of Agrobacterium based genetic transfer in plants.
21. Describe in detail the Principles and method of preservation of animal cells.
22. Describe the points to be considered during the designing of a tissue culture lab.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS413-BT Advanced molecular techniques (Model question paper)

Time : 3 Hrs Weightage: 30

I. Write Brief Notes on Any Eight (Wt: 1 each)

1. Salting out
2. Phenol chloroform extraction in DNA isolation
3. Ribonuclease
4. Taq polymerase
5. SAGE
6. SNP
7. SMD
8. Electrokinetic Molecule focusing
9. Paired end sequencing
10. Adapter

II. Write Short Essay on Any six (Wt: 2 each)

11. Ligase chain reaction
12. Fluorescent PCR
13. RNA isolation
14. Oligonucleotide Ligation Assay
15. NASBA
16. Riboswitches.
17. Microarray tcchnique
18. Microfluidic DNA sequencer

III. Answer Any Two in Detail (Wt: 5 each)

19. Discuss the various types of PCR
20. Explain the different types of new generation sequencing
21. Specify the importance of various PCR based molecular markers
22. Discuss DNA barcoding and specify its applications

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Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS414-BT Molecular biology of development (Model question paper)

Time : 3 Hrs Weightage: 30

I. Write Brief Notes on Any Eight (Wt: 1 each)

1. Totipotency
2. Mutant
3. Cleavage
4. Gastrula
5. Define metamorphosis
6. Homeo box
7. Floral meristem
8. Bicoid protein.
9. Amniotic fluid.
10. Gene Superman.

II. Write Short Essay on Any Six (Wt: 2 each)

11. Features of necrosis
12. FADD
13. Significance of B chromosomes
14. Caspases
15. Genomic imprinting
16. Germ layers in animals
17. Mechanism of eye lens induction
18. Influence of environment on development.

III Answer Any Two in Detail (Wt: 5 each)

19. Theories on aging
20. Pattern formation in drosophila
21. Mitochondrial pathways of apoptosis
22. Sex determination

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS415-BT Cancer Biology (Model question paper)

Time : 3 Hrs Weightage: 30

I. Write Brief Notes on Any E ight (Wt.: 1 each)

1. BRCA-1
2. Sarcoma
3. Epigenetic theory of carcinogenesis
4. Radiation carcinogenesis
5. HPV
6. Ras
7. TNF
8. Role of proteins in metastasis
9. Protein chip technology
10. PET

II. Write Short essays on Any Six (Wt.: 2 each)

11. Tumour Markers
12. Properties of cancer cells
13. Chemical carcinogens
14. p53
15. Modulation of cell cycle in cancer
16. DNA methylation and its significance in cancer
17. Real time PCR in cancer detection
18. Prediction of aggressiveness of cancer.

III Answer Any Two in Detail (Wt.: 5 each)

19. Explain in detail the various steps in carcinogenesis.
20. Explain the role of oncogenes and its activation in in cancer with 2 examples.
21. Describe the various tools for detection of cancer.
22. Elaborate on advance methods for cancer therapies.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS416-BT Physiology and Biotechnology (Model question paper)

Time : 3 Hrs Weightage: 30

I. Write Brief Notes on Any Eight (Wt: 1 each)

1. Haemopoiesis
2. Rh.factor
3. ECG
4. Cardiac cycle
5. Action potential
6. Rubisco
7. Vernalization
8. Plant hormones
9. Respiratory biosurfactant
10. Ischemia

II. Write Short Essay on Any Six (Wt: 2 each)

11. Blood volume, Blood volume regulation
12. Taste and Tactile response.
13. C3, C4 and CAM pathways
14. Photoperiodism
15. Absorption and transport of water
16. Photorespiration.
17. Neuroendocrine regulation
18. Haemostasis– mechanisms

III Answer Any Two in Detail (Wt: 5 each)

19. Discuss the plant mitochondrial electron transport system and ATP synthesis
20. Explain the physiology in the various responses of plants to biotic and abiotic stresses.
21. Discuss the significance of regulation of water balance, electrolyte balance and acid- base balance in human physiology system.
22. Discuss the growth of microorganisms. Specify the various stages in the growth cycle. Comment on the yield and rate of growth

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS417-BT Microbial Food Technology (Model question paper)

Time : 3 Hrs Weightage: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1)

1. Define water activity.
2. Define nutraceuticals.
3. Write down general steps in cheese production.
4. Discuss the risk associated with RTE food
5. Codex elimentarius commission
6. Golden rice
7. What is ropiness in milk spoilage?
8. Single cell protein
9. Canning
10. Edible vaccine

Section B (Answer any **six** questions. Each question carries a weight of 2)

11. Write note on mechanisms of fish spoilage.
12. Explain fermentative production of beer.
13. Write briefly on radiation preservation
14. Standard labelling of GM Foods and risk associated with GM foods
15. Mycotoxins
16. What are the prerequisites for using a microbial strain to use as probiotics.
17. Give a brief account of the common foodborne illness.
18. Explain briefly on lab diagnosis and detection of salmonellosis in food.

Section C (Answer any **two** questions. Each question carries a weight of 5)

19. 'Adequate assessment, surveillance and regulations are necessary to ensure effective food safety'. Explain the statement with respect to FSSAI food safety measures.
20. Write an essay on the contribution of transgenic plants and animals to food security.
21. Write an essay on HACCP concepts in ensuring international food safety.
22. Explain the principle of different chemical food preservation techniques.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS418-BT IPR and Biotechnology (Model question paper)

Time : 3 Hrs Weightage: 30

Section A(Answer any **eight** questions. Each question carries a weight of 1)

1. Copy right
2. USPTO
3. Biohazard
4. Biosafety cabinet
5. RCGM
6. Cartagena Protocol
7. UPOV
8. PGRFA
9. Seed Bank
10. Patent

Section B(Answer any **six** questions. Each question carries a weight of 2)

11. Impact of GM crops on biodiversity
12. International treaties on biodiversity
13. Climate change and conservation of plant genetic resources
14. Role of institutional biosafety committees
15. Environmental release of GMO
16. Biosafety guidelines in India
17. Discuss the importance of patenting. Explain the advantages of patenting scientific inventions.
18. What are the various types of patents/ Discuss each with examples.

Section C(Answer any **two** questions. Each question carries a weight of 5)

19. Discuss the various requirements of patenting. Comment on each requirement.
20. Discuss the recommended biosafety levels of specific microorganisms in India
21. Discuss the various regulations in the analysis, assessment and management of risk in India
22. Discuss the biodiversity act in India and comment on its merits and demerits.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

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Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS419-BT Environment and Biotechnology (Model question paper)

Time : 3 Hrs Weightage: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1)

1. Food web
2. Red data book
3. Fundamental and realized niche
4. Edge effect
5. Minamata disease
6. Autecology
7. Denitrification
8. Greenhouse gases
9. Gene bank
10. Secondary succession

Section B (Answer any **six** questions. Each question carries a weight of 2)

11. Effects of lead poisoning
12. Carbon cycle
13. Energy flow in an ecosystem
14. Hydrosphere
15. National parks
16. Acid rain
17. Ozone depletion
18. 1Tropical rain forest

Section C(Answer any **two** questions. Each question carries a weight of 5)

19. Microorganisms in Extreme environment.
20. Effects of global warming
21. Strategies for conservation of biodiversity
22. Endangered animals and plants
23. Desert biomes

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS420-BT Food Biotechnology (Model question paper)

Time : 3 Hrs Weightage: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1)

1. Starter culture
2. Pectinase
3. Chymosine
4. Prebiotics
5. Spawning.
6. Blue cheese.
7. Edible vaccines.
8. samroopa.
9. Frost resistant fruits.
10. Biocassava.

Section B(Answer any **six** questions. Each question carries a weight of 2)

11. Star link corn.
12. Steps in mushroom production
13. Marine fermented products
14. Application of proteases and amylases in food industry
15. GMO
16. Terminator genes
17. Disadvantages of SCP
18. Golden rice

Section C(Answer any **two** questions. Each question carries a weight of 5)

19. Write an essay on SCP
20. Explain steps of cheese making
21. Transgenic organisms in food production.
22. Probiotics and their effects on health.

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MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

Fourth Semester M.Sc. Biotechnology Examination – 2020

PG20BS421-BT Genomics: Techniques and applications (Model question paper)

Time : 3 Hrs Weightage: 30

Section A (Answer any **eight** questions. Each question carries a weight of 1)

1. Pseudogenes
2. IS elements.
3. OMIM.
4. Linkage.
5. ENA.
6. Karyotype.
7. exons.
8. Antisense RNA.
9. Promoter sequence.
10. Bermuda principles of HGP.

Section B (Answer any **six** questions. Each question carries a weight of 2)

11. Split genes.
12. Gene interaction mapping.
13. Gene families.
14. RFLP.
15. Human mitochondrial genome.
16. Gene family.
17. Archaeal genome .
18. Microarray.

Section C (Answer any **two** questions. Each question carries a weight of 5)

19. Write a detailed note on Gene therapy
20. Describe RNA sequencing and its significance
21. Comment on HGP and its implications
22. Describe the types of transposons.