BLDE
(DEEMED TO BE UNIVERSITY)

Choice Based Credit System (CBCS)

Curriculum

B.Sc. Programme in
Clinical Genetics

2020-21

Published by
BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956

The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA
Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.
BLDE (DU): Phone: +918352-262770, Fax: +918352-263303 , Website: www.bldedu.ac.in, E-mail:office@bldedu.ac.in
College: Phone: +918352-262770, Fax: +918352-263019, E-mail: bmpmc.principal@bldedu.ac.in

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BLDE(DU)/REG/B.Sc.-Bio-Sci/2020-21/ 1876 May 12, 2020

NOTIFICATION

Sub: Curriculum for B.Sc. Programme in Biomedical Sciences with Semester Scheme

Ref: 1. Minutes of the meeting of the 5th Standing Committee Academic Council of the University held on 06- 05-2020.
2. Approval of Board of Management dtd.08-05-2020
3. Approval of Hon'ble Vice-Chancellor vide order no.1834, dtd.09-05-2020

In accordance with the Rule-09 (ii) of the Memorandum of Association (MoA) of the Deemed to be University, the Board of Management (BoM) has approved the Curriculum of **'B.Sc. Programme in Biomedical Sciences'** in 1) Medical Laboratory Technology (MLT), 2) Anaesthesia Technology, 3) Operation Theater Technology, 4) Respiratory Care Technology, 5) Cardiac Care Technology, 6) Perfusion Technology, 7) Emergency Medicine Technology, 8) Optometry, 9) Forensic Science, 10) Clinical Genetics, 11) Audiology & Speech-Language Pathology, following Choice Based Credit System (CBCS) with Semester Scheme.

The Curriculum shall be effective from the Academic Session 2020-21 onwards, in the Constituent College of the University viz. Shri B. M. Patil Medical College, Hospital and Research Centre, Vijayapura.

REGISTRAR
REGISTRAR
BLDE (Deemed to be University)
Vijayapura-586103. Karnataka

To,
The Dean, Faculty of Allied Health Sciences,
Shri B. M. Patil Medical College,
Hospital and Research Centre,
Vijayapura

Copy to:
- The Secretary, UGC, New Delhi
- The Dean, Faculty of Medicine & Principal
- The Controller of Examinations
- The Dean, Student Affairs
- The Prof. & HoDs of Pre, Para and Clinical Departments
- The Coordinator, IQAC
- PS to the Hon'ble Chancellor
- PS to the Hon'ble Vice-Chancellor

Vision:

- To be a leader in providing quality medical education, healthcare & to become an Institution of eminence involved in multidisciplinary and translational research, the outcome of which can impact the health & the quality of life of people of this region.

Mission:

- To be committed to promoting sustainable development of higher education, including health science education consistent with statutory and regulatory requirements.
- To reflect the needs of changing technology
- Make use of academic autonomy to identify dynamic educational programs
- To adopt the global concepts of education in the health care sector

Course Code	Course Name	Type of paper	Hours/ Week	Duration of Exam (Hours)	IA Marks	Exam Marks	Total Marks	Credits
SEMESTER-I								
BCT 1.1	Fundamentals of Cell Biology	T	4	3	30	70	100	2
BCT 1.1P	Fundamentals of Cell Biology	P	3	3	15	35	50	1
SEMESTER-II								
BCT 2.1	Principles of Genetics	T	4	3	30	70	100	2
BCT 2.1P	Principles of Genetics	P	3	3	15	35	50	1
SEMESTER-III								
BCT 3.1	Cytogenetics	T	4	3	30	70	100	2
BCT 3.1P	Cytogenetics	P	3	3	15	35	50	1
SEMESTER-IV								
BCT 4.1	Molecular Genetics	T	4	3	30	70	100	2
BCT 4.1P	Molecular Genetics	P	3	3	15	35	50	1
SEMESTER-V								
BCT 5.1	Recombinant DNA Technology	T	3	3	30	70	100	2
BCT 5.2	Basic Human Genetics	T	3	3	30	70	100	2
BCT 5.1P	Recombinant DNA Technology	P	3	3	15	35	50	1
BCT 5.2P	Basic Human Genetics	P	3	3	15	35	50	1
SEMESTER-VI								
BCT 6.1	Developmental, Evolutionary and Biometrical Genetics	T	3	3	30	70	100	2
BCT 6.2	Applied and Behavioural Genetics	T	3	3	30	70	100	2
BCT 6.1P	Developmental, Evolutionary and Biometrical Genetics	P	3	3	15	35	50	1
BCT 6.2P	Applied and Behavioural Genetics	P	3	3	15	35	50	1

*** Submission of certified practical record is <u>MANDATORY</u> for attending practical examination.**

Rules and Regulations of Curriculum

B.Sc. Clinical Genetics

Definitions of Key Words:

1. **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year. Choice Based Credit System (CBCS).

2. The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).

3. **Course**: Usually referred to, as "papers" is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/ laboratory work/ outreach activities/ project work/ viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some of these.

4. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.

5. **Credit:** A unit by which the course work is interpreted. It functions the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

6. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the sum total of the credit points obtained by the student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

7. **Grade Point:** It is a numerical marking allotted to each letter grade on a 10-point scale.

8. **Letter Grade:** It is an appreciated point of the student's performance in a selected course. Grades are denoted by letters O, A+, A, B, C and RA x. Programme: An educational programme leading to award of a Degree certificate.

9. **Semester Grade Point Average (SGPA):** It is index of performance of all performance of work in a semester. Its total credit points obtained by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

10. **Semester:** Each semester will consist of minimum of 180 working days. The odd semester may be scheduled from June/ July to December and even semester from December/ January to June.

Duration of Study Programme: The duration of the study for B.Sc. Clinical Genetics will be of three years including 6 Months of Internship.

Program pattern:

- First Semester: July
- Second Semester: January
- Third Semester: July
- Fourth Semester: January
- Fifth Semester-July
- Sixth Semester-January

Eligibility Criteria:

- He/she has passed the Higher Secondary (10+2) with Science (PCB) or equivalent examination recognized by any Indian University or a duly constituted Board with pass marks in Physics, Chemistry, and Biology.
- Minimum percentage of marks: 45% aggregate.

Medium of Instruction:

English shall be the Medium of Instruction for all the Subjects of study and for examinations.

CBCS – Definition and benefits: Choice Based Credit System is a flexible system of learning.

The distinguishing features of CBCS are the following:

- It permits students to learn at their own pace.
- The electives are selected from a wide range of elective courses offered by the other University Departments.
- Undergo additional courses and acquire more than the required number of credits.
- Adopt an inter-disciplinary and intra-disciplinary approach in learning.
- Make best use of the available expertise of the faculty across the departments or disciplines
- Has an inbuilt evaluation system to assess the analytical and creativity skills of students in addition to the conventional domain knowledge assessment pattern.

Semester System and Choice Based Credit System:

The semester system initiates the teaching-learning process and screws longitudinal and latitudinal mobility of students in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a sun shone‟ type approach in which the students can take choice of courses, learn and adopt an interdisciplinary approach of learning.

Semesters:

An academic year consists of two semesters:

	UG
Odd Semester 1st semester	July – December
Odd Semester 3rd, 5thsemesters	June – October/ November
Even Semester 2nd, 4th, 6thsemesters	December –April

Credits:

Credit defines the coefficient of contents/syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus, normally in each of the courses, credits will be assigned on the basis of the number of lectures/ tutorial laboratory work and other forms of learning required, to complete the course contents in a 15-20 week schedule:

a. ***1 credit*** **=** 1 hour of lecture per week

b. ***3 credits*** = 3 hours of instruction per week

✓ Credits will be assigned on the basis of the lectures (L) / tutorials (T) / Clinical Training (CR) / laboratory work (P) / Research Project (RP) and other forms of learning in a 15- 20 week schedule L - One credit for one hour lecture per week

c. **P/T -** One credit for every two hours of laboratory or practical

d. **CR -** One credit for every three hours of Clinical training/Clinical rotation/posting

e. **RP** - One credit for every two hours of Research Project per week – Max Credit 20- 25

	Lecture - L	**Tutorial - T**	**Practical - P**	**Clinical Training/ Rotation– CT/CR**	**Research Project–RP***
1 Credit	1 Hour	2 Hours	2 Hours	3 Hours	2 Hours
RP*	Maximum Credit 20 – 25 / Semester				

Types of Courses: Courses in a programme may be of three kinds:

- **Core Course**
- **Elective Course**
- **Ability Enhancement Compulsory Courses**

Core Course: A course, which should compulsorily be studied by a candidate as a basic requirement is termed as a Core course. There may be a Core Course in every semester. This is the course which is to be compulsorily studied by a student as a basic requirement to complete programme of respective study.

Elective Course: A course which can be chosen from a very specific or advanced the subject of study or which provides an extended scope or which enables an exposure to some other domain or expertise the candidates ability is called an Elective Course.

Discipline Specific Elective (DSE) Course: Elective courses offered by the main subject of study are referred to as Discipline Specific Elective. The University / Institute may also offer discipline related Elective courses of interdisciplinary nature. An elective may be "Discipline Specific Electives (DSE)" gazing on those courses which add intellectual efficiency to the students.

Dissertation / Project: An Elective/Core course designed to acquire special / advanced knowledge, such as supplement study / support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher / faculty member is called dissertation / project.

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline / subject may be treated as an elective by other discipline / subject and vice versa and such electives may also be referred to as Generic Elective.

Ability Enhancement Compulsory Courses: The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).

"AECC" courses are the courses based upon the content that leads to Knowledge enhancement (i) Environmental Science and (ii) English/MIL Communication. These are mandatory for all disciplines.

Assigning Credit Hours per Course: While there is flexibility for the departments in allocation of credits to various courses offered, the general formula would be:

- All core course should be restricted to a maximum of 4 credits.
- All electives should be restricted to a maximum of 3 credits.
- All ability enhancement course should be restricted to a maximum of 2 credits.
- Projects should be restricted to a maximum of 20-25 credits.

Rules and Regulation for Examination of Clinical Genetics Program under CBCS Pattern

1. **Title of the Programme offered**: **Clinical Genetics**
2. **Duration of the Programme:** Three years including 6 Months of Internship.
3. **Medium of instruction:** The medium of instruction and examination shall be in English
4. **Letter Grades and Grade Points:**

   Adopted the UGC recommended system of awarding grades and CGPA under Choice Based Credit Semester System.

4.1 Would be following the absolute grading system, where the marks are compounded to grades based on pre-determined class intervals.

4.2 The UGC recommended 10-point grading system with the following letter grades will be followed:

Table 1: Grades and Grade Points:

Letter Grade	Grade
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B (Good)	7
C (Above Average)	6
F (Fail)/ RA	0
Ab (Absent)	0
Not Completed (NC)	0
RC (<50% in attendance or in Internal Assessment)	

4.3 A student obtaining Grade F/RA will be considered failed and will require reappearing in the examination.

4.4 Candidates with NC grading are those detained in a course (s); while RC indicate student not fulfilling the minimum criteria for academic progress or less than 50% attendance or less than 50% in internal assessments (IA). Registrations of such students for the respective courses shall be treated as cancelled. If the course is a core course, the candidate has to re-register and repeat the course when it is offered next time.

5. CBCS Grading System - Marks Equivalence Table

5.1 Table 2: Grades and Grade Points

Letter Grade	Gra	% of Marks
O (Outstanding)	10	86-100
A+ (Excellent)	9	70-85
A (Very Good)	8	60 -69
B (Good)	7	55 -59
C (Above Average) – **Passing criteria for Clinical Genetics**	6	50- 54
F (Fail))/ RA	0	Less than 50
Ab (Absent)	0	-
NC- not completed	0	-
RC- Repeat the	0	0

5.2 Table 3: Cumulative Grades and Grade Points

Letter Grade	Grade Point	CGPA
O (Outstanding)	10	9.01 - 10.00
A+ (Excellent)	9	8.01 – 9.00
A (Very Good)	8	7.01 – 8.00
B (Good)	7	6.00 - 7.00
C (Above Average)	6	5.01 - 6.00

6. Assessment of a Course: Evaluation for a course shall be done on a continuous basis. Uniform procedure will be adopted under the CBCS to conduct internal assessments (IA), followed by one end-semester university examination (ES) for each course.

6.1 For all category of courses offered (Theory, Practical, Discipline Specific Elective [DE] ; Generic Elective [GE] and Ability Enhancement Courses [AE]; Skills Enhancement Courses [SE] Theory or P (Practical) & RP(Research Project), assessment will comprise of Internal Assessment (IA) in the form of continuous comprehensive evaluation and mid-semester exam, end–semester (ES) examination or college exam as applicable.

6.2 Courses in programs wherein Theory and Practical/Clinical are assessed jointly. The minimum passing head has to be 50% Grade each for theory and practical's separately. RA grade in any one of the components will amount to reappearing in both components. i.e. theory and practical.

6.3 Evaluation for a course with clinical rotation or clinical training or internship will be done on a continuous basis.

7. Eligibility to appear for the end-semester examinations for a course includes:

7.1 Candidates having ≥ 75% attendance and obtaining the minimum 40% in internal assessment in each course to qualify for appearing in the end-semester university examinations.

7.2 The students desirous of appearing for university examination shall submit the application form duly filled along with the prescribed examination fee.

7.3 Incomplete application forms or application forms submitted without prescribed fee or application form submitted after due date will be rejected and student shall not be allowed to appear for examination.

8. Passing Heads

8.1 Courses where theory and practical are involved, the minimum passing head shall be 50% in total including the internal assessment.

8.2 Elective subjects – the minimum prescribed marks for a pass in elective subject should be 50%. The marks obtained in elective subjects should be communicated to the university before the commencement of the university examination.

9 Detention: A student not meeting any of the above criteria maybe detained (NC) in that particular course for the semester. In the subsequent semester, such a candidate requires improvement in all, including attendance and/or IA minimum to become eligible for the next end-semester examination.

10 The maximum duration for completing the program will be 6 years (minimum duration of program x 2) i.e. (3x2) = 6 years, failing which his/her registration will be cancelled. Full fees of entire program of 3 years may be liable to be paid by the students.

11 Carry over benefit:

11.1 A student will be allowed to keep term for Semester II irrespective of number of heads of failure in Semester I.

11.2 A student will be allowed to keep term for Semester III if she/he passes each Semester I and II OR fails in not more than 2 courses each in semester I and II.

11.3 Student will be allowed to keep term for Semester IV irrespective of number of heads of failure in Semester III. However, student must mandatorily have passed each course of Semester I and II in order to appear for Semester IV exam.

11.4 Student will be allowed to keep term for Semester V, if she/he passes Semester I,II, III and IV OR has passed in all courses of Semester I and II and fails in not more than two courses each of Semester III and IV.

11.5 Student will be allowed to keep term for Semester VI, irrespective of number of heads of failure in Semester V. However, student must mandatorily have passed each course of Semester I, II, III and IV in order to appear for Semester VI exam.

12 Grace Marks for UG Courses:

12.1 A student shall be eligible for grace marks, provided he/she appeared in all the papers prescribed for the examination.

12.2 Maximum up to 5 grace marks may be allowed for passing, spread over between subjects.

12.3 No grace marks will be awarded in internal evaluation.

13 University End-Semester Examinations

13.1 There will be one final university examination at the end of every semester.

13.2 A student must have minimum 75% attendance (Irrespective of the type of absence) in theory and practical in each subject to be eligible for appearing the University examination.

13.3 The Principal / Director shall send to the university a certificate of completion of required attendance and other requirements of the applicant as prescribed by the university, two weeks before the date of commencement of the written examination.

13.4 A student shall be eligible to sit for the examination only, if she / he secure a minimum of 40% in internal assessment (individually in theory and practical as applicable). Internal examinations will be conducted at college/ department level.

13.5 Notwithstanding any circumstances, a deficiency of attendance at lectures or practical maximum to the extent of 10% - may be condoned by the Principal /Director.

13.6 If a student fails either in theory or in practical, he/ she have to re-appear for both.

13.7 There shall be no provision of re-evaluation of answer sheets. Student may apply to the university following due procedure for recounting of theory marks in the presence of the subject experts.

13.8 Internal assessment shall be submitted by the Head of the Department to the University through Dean at least two weeks before commencement of University theory examination.

14. Supplementary examination: The supplementary examination will be held in the next semester. Eligibility to appear for supplementary examination will be as per rule number 11.1-11.5.

15. Re-Verification: There shall be provision of re-totaling of the answer sheets; candidate shall be permitted to apply for recounting/re-totaling of theory papers within 8 days from the date of declaration of results.

16. Scheme of University Exam Theory UG Program: General structure / patterns for setting up question papers for Theory / Practical courses, for UG program are given in the following tables. Changes may be incorporated as per requirements of specific courses.

Guidelines to Prepare Internship Research Proposal & Project

1. **Selection of Research Problem:**
   Select your interest area of research, based on felt need, issues, social concern. a.
   State the problem in brief, concise, clear.
   b. State the purpose of selected study & topic. c.
   State the objectives of proposal/project.
   d. Prepare conceptual framework based on operational definition. e.
   Write scope of research proposal/project.

2. **Organizing Review of Literature**
   a. Study related and relevant literature which helps to decide conceptual framework and research design to be selected for the study
   b. Add specific books, bulletins, periodicals, reports, published dissertations, encyclopaedia and text books
   c. Organize literature as per operational definition
   d. Prepare summary table for review of literature

3. **Research Methodology: To determine logical structure & methodology for research project.**
   a. Decide and state approach of study i.e. experimental or non-experimental
   b. Define/find out variables to observe effects on decided items & procedure
   c. Prepare simple tool or questionnaire or observational checklist to collect data.
   d. Determined sample and sampling method
   e. Mode of selection ii) Criteria iii) Size of sample iv) Plan when, where and how data will be collected.
   f. Test validity of constructed tool
   g. Check reliability by implementing tool before pilot study(10% of sample size)
   h. Conduct pilot study by using constructed tool for 10% selected sample size

4. **Data collection: To implement prepared tool**
   a. Decide location
   b. Time
   c. Write additional information in separate exercise book to support inferences and interpretation

5. **Data analysis and processing presentation**
   a. Use appropriate method of statistical analysis i.e. frequency and percentage
   b. Use clear frequency tables, appropriate tables, graphs and figures.
   c. Interpretation of data:
   d. In relation to objectives
   e. Hypothesis
   f. Variable of study or project
   g. writing concise report

6. Writing Research Report a.

Aims:

i. To organize materials to write project report

ii. To make comprehensive full factual information iii. To make appropriate language and style of writing

iv. To make authoritative documentation by checking footnotes, references & bibliography

v. To use computers & appropriate software

b. Points to remember

i. Develop thinking to write research report

ii. Divide narration of nursing research report

iii. Use present tense and active voice

iv. Minimize use of technical language

v. Use simple, straightforward, clear & concise language

vi. Use visual aids in form of table, graphs & figures

vii. Treat data confidentially

viii. Review & rewrite if necessary

Evaluation Criteria for Project Report

Sr. No	Criteria	Rating					Remark
		1	2	3	4	5	
I	**Statement of the problem**						
	1. Significance of the problem selected						
	2. Framing of title and objectives						
II	**Literature Review**						
	1. Inclusion of related studies on the topic and its relevance						
	2. Operational definition						
III	**Research Design**						
	1. Use of appropriate research design						
	2. Usefulness of the research design to draw the inferences among study variables/						
IV	**Sampling Design**						
	1. Identification & description of the target population						
	2. Specification of the inclusion & exclusion criteria						
	3. Adequate sample size, justifying the study design to draw conclusions						
V	**Data Collection Procedure**						
	1. Preparation of appropriate tool						

	2. Pilot study including validity & reliability of tool						
	3. Use of appropriate procedure/ method for data collection						
VI	**Analysis of Data & Interpretation**						
	1. Clear & logical organization of the finding						
	2. Clear presentation of tables(title, table & column heading)						
	3. Selection of appropriate statistical tests						
VII	**Ethical Aspects**						
	1. Use of appropriate consent process						
	2. Use of appropriate steps to maintain ethical aspects & principles						
VIII	**Interpretation of the finding**						
	& appropriate discussion of the results						
IX	**Conclusion**						
	Summary & recommendations						
X	**Presentation/ Report Writing**						
	Organization of the project work including language & style of						

Signature of the Evaluator

18. Eligibility for award of degree

18.1 A candidate shall have passed in all the subjects of all semester's I-VI eligible for award of Clinical Genetics degree.

The performance of a candidate in a course will be indicated as a letter grade, whereas grade point will indicate the position of the candidate in that batch of candidates. A student is considered to have completed a course successfully and earned the prescribed credits if he/she secures a letter grade other than F/RA. A letter grade RA in any course implies he/she has to Re-appear for the examination to complete the course.

18.2 The RA grade once awarded in the grade card of the student is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the subsequent semester in which the candidate has appeared for clearance in supplementary exams

18.3 If a student secures RA grade in the Project Work/Dissertation, he/she shall improve it and resubmit it, if it involves only rewriting / incorporating the revisions suggested by the evaluators. If the assessment indicates lack of student performance or data collection then the student maybe permitted to re-register by paying the prescribed re-registration fee and complete the same in the subsequent semesters.

A candidate shall be declared to have passed the examination if he/she obtains the following minimum qualifying grade / marks:-

(a) For Core courses CT (Core Theory), CL (Core Lab), DE (Discipline centric Electives), student shall obtain Grade B (50 % of marks) in the University End Semester Examination (ES) and in aggregate in each course which includes both Internal Assessment and End Semester Examination.

(b) For Generic Electives (GE), Ability Enhancement (AE) and Skill Enhancement (SE) courses student shall obtain Grade D (40 % of marks) in the College Examination.

19. Guidelines for Clinical Internship or Research internship:

19.1 Internship may be commenced only on completion of all course work. The internship may be observed only at the clinical postings and areas of extension activities of Department of Physiotherapy, BLDEDU. No external postings will be considered during internship. Students are expected to act in a responsible and professional manner at all times during their postings.

19.2 Eligibility for appearing for Internship: On completion of all course work, a candidate is permitted by the Director/Principal to join internship during the beginning of the semester i.e., Odd/ Even.

19.3 Responsibilities during internship: During the internship period candidates should show at least 90% attendance. They must engage in practice/ skill based learning of professional conduct. Their learning outcomes must be maintained and presented in the form of logbooks/ case studies/ research project report. The appropriate formats for the postings/ clinical rotations/ research assignments will be are prescribed as required.

19.4 Evaluation of internees and award of credits: All internees will be assessed based on their satisfactory attendance, performance in the postings/ research labs and the presentation of the logbook. The credits and hours of internship will be as defined in the M.Sc. Medical Anatomy program

Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone & earned by a student, i.e.,

$$SGPA\ (Si) = \sum(Ci \times Gi) / \sum Ci$$

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone & earned by a student over all the semesters of a programme, i.e.

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
Illustration of Computation of SGPA and CGPA

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit x Grade)**
Course 1	3	A	8	3 X 8 = 24
Course 2	4	B+	7	4 X 7 = 28
Course 3	3	B	6	3 X 6 = 18
Course 4	3	O	10	3 X 10 = 30
Course 5	3	C	5	3 X 5 = 15
Course 6	4	B	6	4 X 6 = 24
	20			139
Illustration for SGPA Thus, SGPA = 139/20 = 6.95				

Semester 1	**Semester 2**	**Semester 3**	**Semester 4**
Credit : 20 SGPA : 6.9	Credit : 22 SGPA : 6.8	Credit : 25 SGPA : 6.6	Credit : 26 SGPA : 6.0
Semester 5	**Semester 6**		
Credit : 26 SGPA : 6.3	Credit : 25 SGPA : 8.0		
Illustration for CGPA			

Thus,

$$CGPA = \frac{20 \times 6.9 + 22 \times 6.8 + 25 \times 6.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144} = 6.75/B+$$

ii. Transcript: Based on the above recommendations on Letter grades, grade points and SGPA and CGPA, the transcript for each semester and a consolidated transcript indicating the performance in all semesters may be issued.

Course Registration

17.1. After admission to a Program, a student identity number is generated .This PRN number may be used in the process of registration for a course.

17.2 The registration process is a registration for the courses in a semester. The registration card is generated after a student completes the choice of electives. Every student shall register for the stipulated number of Courses/Credits semester wise even if electives are not prescribed in their regulations for the said semester. Every student must register for Elective/Ability Enhancement Courses semester-wise for the courses he/she intends to undergo in that semester within two weeks of commencement of the semester.

The list of students registered for each elective will be communicated to the HoDs/ Course Chairpersons. Students will be requested to authenticate the chosen electives by appending their signature in acceptance with approval by the HoDs/ Course Chairpersons. A soft copy of the registered students will be submitted to the elective course offering departments for their official use.

Re - Entry after Break of Study:

The University regulations for readmission are applicable for a candidate seeking re-entry to a program.

a) Students admitted the program and absenting for more than 3 months must seek readmission into the appropriate semester as per university norms.
b) The student shall follow the syllabus in vogue (currently approved / is being followed) for the program.
c) All re-admissions of students are subject to the approval of the Vice-Chancellor.

Ranking

The first two ranks of the programme will be decided on the basis of grades of CGPA in the courses (core and DE courses only). In case of a tie, marks % [of core and DE courses only] will be taken into account.

Classification of Successful Candidates

Overall Performance in a Program and Ranking of a candidate is in accordance with the University regulations.

Consolidated Grade Card – Clinical Genetics Program			
Letter Grade	% Marks Range	Grade point	CGPA RANGE
O	80 & Above	10	9.01 – 10
A+	75-80	9	8.01 - 9.00
A	60-74	8	7.01 - 8.00
B+	55-59	7	6.01- 7.00
B	50-54	6	5.01- 6.00
F/RA (Reappear	Less than 50	0	4.51 – 5.00
Ab (Absent)		0	
Not Completed (NC)		0	
Repeat the course (RC = <50% in attendance or Internal Assessment)		0	

A successful candidate will be:

i. Who secures not less than O grade with a CGPA of 9.01 – 10.00 shall be declared to have secured 'OUTSTANDING' provided he/she passes the whole examination in the FIRST ATTEMPT;

ii. Who secures not less than A+ grade with a CGPA of 8.01 – 9.00 shall be declared to have secured 'EXCELLENT' provided he/she passes the whole examination in the FIRST ATTEMPT;

iii. Who secures not less than A grade with a CGPA of 7.01 –8.00 and completes the course within the stipulated course period shall be declared to have passed the examinations with 'Very Good'

iv. All other candidates (with grade B and above) shall be declared to have passed the examinations.

SCHEME OF EXAMINATION UNDER CBCS

Each paper carries a maximum of 100 marks as indicated below:

Theory of 3hrs duration.....70 Marks

Internal Assessment*… ..... 30 Marks

Total – 100 Marks

Internal Assessment –

Theory	Attendance	- 10 marks
	Tests (Two)	- 10 marks
	Seminars / Assignment	- 10 marks
	Total	**- 30 Marks**

Practical of 3hrs duration .....35 Marks

Practical	Attendance	- 05 marks
	Tests (One)	- 10 marks
	Total	**- 15 Marks**

SUBJECT (OPTIONALS) COMBINATION:

Biochemistry/Chemistry is the compulsory optional subject.

The other optional subject may be any one of the following:

1) Biotechnology, 2) Botany, 3) Microbiology, 4) Sericulture, and 5) Zoology.

SEMESTER -I
BCT 1.1 FUNDAMENTALS OF CELL BIOLOGY

52 Hrs.

UNIT I **13 Hrs.**

A. Scope of Genetics

B. Microscopy

Magnification, Resolving power, Principles and Applications of Simple, Compound, Stereozoom, Phase contrast, Fluorescent and Electron microscopes (TEM & SEM).

C. Model Organisms

Life cycle and Genetic significance of: *Bacteriophage* (Lytic and Lysogeny), Bacteria- *E. coli*. (Binary fission and Conjugation), *Saccharomyces* (Budding and Sexual reproduction), *Coenorhabdites elegans, Drosophila, Arabidopsis thaliana and Rattus albicans.*

UNIT II **12 Hrs.**

Ultrastructure and functions of Cell:

Cell Theory, Organization of prokaryotic and eukaryotic cells, Cell wall (Plant): Ultrastructure, Chemical composition and Functions. Plasma membrane**:** Chemical composition**,** Ultrastructure- Fluid Mosaic model, Functions – Osmosis, Phagocytosis, Pinocytosis, Active Transport, Cell Junctions - Tight, Gap, Desmosomes and Plasmadesmata.

UNIT III **14 Hrs.**

Ultrastructure and functions of Cell organelles:

Ultrastructure, Chemical composition and Functions of Cytoplasmic organelles: Endoplasmic reticulum, Ribosomes, Lysosomes, Golgi bodies and Cytoskeleton. Mitochondria: Ultrastructure, Chemical composition and Functions- Kreb's cycle, Electron transport system & Oxidative phosphorylation. Plastids: Types, Ultrastructure of Chloroplast and role in Photosynthesis. Nucleus: Morphology, nuclear envelope, nucleoplasm, nucleolus and chromatin.

UNIT IV **13 Hrs.**

Cell cycle and Cell division:

Cell Cycle: G1, S, G2 and M phases, Check points. Mitosis: Stages, Mitotic apparatus, cytokinesis, Mitogens and Inhibitors, Significance. Meiosis: Stages, Synaptonemal complex, crossing over and chaisma formation, Significance. Cell senescence and Cell death (Apoptosis): Programmed cell death, Mechanism of cell death and significance.

BCT 1.1P FUNDAMENTALS OF CELL BIOLOGY

15 practicals

1. **Microscopy:** **02 Prs.**
   Handling of Dissection, Stereo and Compound microscopes**.**

2. **Genetic study of model organisms and their significance:** **05 Prs.**
   a) Bacteriophage – Lambda phage
   b) Bacteria: E. coli.
   c) Saccharomyces
   d) Coenorhabditis elegans
   e) Drosophila melanogaster
   f) Arabdopsis thaliana
   g) Rattus albicans
3. **Staining Techniques:** **04 Prs.**
   a) RNA and DNA- Methyl green and Pyronin
   b) Mitochondria- Janus green
   c) *Lactobacillus* and *E. coli*- Gram Staining
4. **Observation of Mitotic stages in permanent slides** **01 Prc.**
5. **Temporary squash preparation of Onion root tips for mitosis** **03 Prs.**

BCT 1.1P FUNDAMENTALS OF CELL BIOLOGY

Time: 3 Hrs. **Max. Marks: 35**

1. Prepare a temporary squash of the given material. Identify the stage and comment. (Mitosis) **08**

2. Stain, mount and comment on the given material.
   (Any one of RNA/DNA/Mitochondria/ *E.coli./Lactobacillus.* **07**

3. Identify and comment on any **four** spotters: **15**

i. Microscope- Any one (03)
ii. Mitotic stage- Any one (03)
iii. Model organisms- Any two (2x4.5=09)

4. Class Records **05**

BCT 1.1P FUNDAMENTALS OF CELL BIOLOGY

1. Preparation of Mitotic slide 08
   (Preparation of slide- 04, Identification of stage- 01, Comment on the stage with diagram- 03)
2. Stain, mount and comment on the given material. 07
   (Staining and mounting- 04, comments- 03)
3. Spotters: Identify and comment on any four spotters 15

i. Microscope- Any one
(Identification- 01, Working principle- 01, Applications-01)

ii. Mitotic stage- Any one
(Identification- 01, Diagram-01, Comments-01)

iii. Model organism- any two
(Identification with classification- 01, Comments on life cycle- 2.5, Genetic significance- 01)

4. Class Records 05

References:

1. Biology: The Dynamic Science, 2nd Edition,Peter J. Russell, Paul E. Hertz.. Beverly Mc Millan publications. 2012
2. Cell and Molecular Biology, 4th Edition, P.K. Gupta. 2014
3. Cell Biology, 10th Edition, S.P. Singh and B. S. Tomar. 2014.
4. Cytogenetics, 1st Edition, P.K. Gupta. 2013
5. Instant notes in Microbiology. J. Nicklin *et al.*, 2003.
6. Microbiology, 3rd Edition, P.D. Sharma. 2012.
7. Molecular Biology of Cell, 5th Edition by Alexander Johnson. 2008

BCT 2.1 PRINCIPLES OF GENETICS

52 Hrs.

UNIT I **13 Hrs.**

a. History of Genetics:

Pre- Mendelian genetic concepts: Preformation,Epigenesis, Inheritance of acquired characters and Mutation theory.

Heredity and Environment: Concepts of Phenotype, Genotype, Heredity, variation, Pure lines and Inbred lines.

b. Biography of Mendel and his experiments on pea plants.

c. **Law of Segregation**: Monohybrid cross, Back cross and Test cross, Problems related.

d. **Law of Independent Assortment**: Dihybrid cross in pea plant, Back cross and Test cross, Problems related.

UNIT II **13 Hrs.**

a. **Multiple Alleles:** Definition, ABO blood groups and Rh factor in Human, Genetic Problems related.

b. Gene Interactions

- Deviations from Mendelism: Incomplete inheritance and Co- dominance
- Inter allelic:-

➢ Complementary gene interaction (9:7) Ex: *Lathyrus odoratus*

➢ Supplementary gene interaction (9:3:4) Ex: Grain color in Maize.

➢ Epistasis - Dominant Ex.: Fruit color in *Cucurbita pepo*, Recessive - Ex.: Coat color in *Mice.*

➢ Non- Epistasis - Ex.: Comb pattern in Poultry.

UNIT III **13 Hrs.**

Elements of Biometry

- Measures of Central Tendency - Mean, Median and Mode
- Measures of Dispersion - Variance and Standard deviation
- Test of Hypothesis - Student's 't' Test, Chi square Test.
- Probability - Definition and rules.
- Distribution - Normal, Binomial and Poisson.

UNIT IV **13 Hrs.**

Sex Determination

- Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ-ZW, Genic balance theory of Bridges, Intersexes and Super sexes in *Drosophila*, Y chromosome in sex determination of *Melandrium*.
- Environment and sex determination
- Hormonal control of Sex determination (Free martins).
- Gynandromorphs Dosage compensation in *Drosophila*, *Coenorhabditis elegans* and Man (Lyon's hypothesis).
- Sex differentiation in *Drosophila* and Man.

SEMESTER-II
BCT 2.1 PRINCIPLES OF GENETICS

15 Practicals

1. Temporary squash preparation of: **04 Prs.**

a. Onion Flower buds

b. Grasshopper testes lobes

2. Study of: **01 Prc.**

a. Flower colour in *Antirrhinum/ Mirabilis*

b. Coat colour in Mice

c. Comb pattern in Poultry

3. Blood Typing **01 Prc.**

4. Biometrical Computation of: **03 Prs.**

a. Mean, Median and Mode

b. Variance, Standard Deviation

5. Problems on: Student's 't' test and Chi square test **02 Prs.**

a. Genetic problems on:

b. Multiple alleles **02 Prs.**

c. Gene Interactions (Complemetary/ Supplementary/ Dominant Epistasis gene interactions) **02 Prs.**

BCT 2.1P PRINCIPLES OF GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Prepare a temporary squash of the given material. Identify the stage and comment. (Meiosis) **10**
2. Detect the blood group of the given sample A and B. Report and comment on the results ..... 2.5x2= **05**
3. Identify and comment on any **two** spotters: 3x2= **06**
   i. One spotter from: *Antirrhinum/ Mirabilis*/ Comb pattern in Poultry/ Coat color in mice.
   ii. Meiotic stage.
4. Genetic Problems (03 only): 3x 3= **09**
   i. Biometry- one
   ii. Multiple Alleles - one
   iii. Gene interaction(Complementary/ Supplementary/ Dominant Epistasis gene interactions) – any one
5. Class Records **05**

BCT 2.1P PRINCIPLES OF GENETICS

1. Preparation of temporary squash (Meiosis) **10**
(Preparation- 05, Identification of stage- 01, Comment on the stage with diagram- 04)

2. Detect the blood group of the given sample A and B. Report and comment on the results ..... **2.5 x2= 05**
(Performance-01, Result- 0.5, Comment on result- 01 per sample)

3. Identify and comment on any **two** spotters: **3x2= 06**
(Identification – 01, Comments with diagram- 02)

4. Genetic Problems: (03 only) **3x3=09 (For each)**
problem- 03)

5. Class Records **05**

References:

1. Advanced Genetics. G. S. Miglani. Alpha Science International, Ltd. 2012.
2. Cell and Molecular Biology, 4th Edition, P.K. Gupta. 2014
3. Fundamentals of Biostatistics. 2nd Edition. Khan & Khanum. 2004. Ukaaz publications.
4. Genes- IX, 9th Ed., Benjamin Lewin. Jones and Bartlett Publishers, 2008.
5. Genetics – Classical to modern, 1st Edition. P.K. Gupta. 2013.
6. Principles of Genetics, 7th Edition, Robert H. Tamarin. 2002. Tata- Mc Graw Hill publications.
7. Theory and Problems of Genetics. W. D. Stansfield. 2002. Mc Graw Hill publications.

SEMESTER-III
BCT 3.1 CYTOGENETICS

52 Hrs.

UNIT I **14 Hrs.**

a. Physical Basis of Inheritance:

- Definition, Description of chromatin structure, Chromosome theory of inheritance.
- Eukaryotic Chromosome: Macro-molecular organization. Primary and Secondary constriction, Sat-bodies, Telomeres, Histones, DNA, Nucleosome
- Heterochromatin and Euchromatin and its significance.
- Ultra structure of Chromosome - Nucleosome model, Karyotype and Idiogram.

b. Special types of Chromosomes:

- Structure and Significance of Special type of Chromosomes: Polytene
- Chromosome - Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte.
- Supernumerary B Chromosome.

UNIT II **13 Hrs.**

a. Sex Linkage:

- Definition of sex linkage
- Meiotic behavior of chromosome and non - disjunction. Bridges theory of non-disjunction.
- Sex linkage in *Drosophila*.
- Sex linked genes in poultry, moths and man
- Sex linked inheritance in man (Colour-blindness, Haemophilia)
- Attached X-chromosome.

b. Extra Chromosomal Inheritance / Cytoplasmic Inheritance:

- Characteristic features of Cytoplasmic Inheritance.
- Inheritance of : Mitochondrial DNA, Chloroplast DNA, Kappa articles in *Paramecium*, Sigma factor in *Drosophila*, Shell coiling in snail.
- Cytoplasmic Male Sterility (CMS) in maize.

UNIT III **14 Hrs.**

a. Linkage:

- Definition of Linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage- distance between genes, age, temperature, radiation, sex, chemicals and nutrition, Significance of linkage.

b. Crossing over:

- Crossing over- definition and types of crossing over: Germinal and Somatic crossing over.
- Cytological basis of crossing over: Stern's experiments in *Drosophila*, Creighton and Mc Clintock experiment in maize.
- Mechanism of crossing over: Chiasma type theory, Breakage first theory, Contact first theory, Strain or torsion theory.
- Molecular mechanism of crossing over - Holiday model, Crossing over in *Drosophila*.

- Interference and coincidence, Steps in Construction of genetic map *(Drosophila).*

UNIT IV **11 Hrs.**

Chromosomal aberrations:

Numerical: Euploidy (Monoploidy, Haploidy and Polyploidy) Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomy, Nullisomy and Trisomy.

Structural - Deletions (Terminal, Interstitial), Duplication (Tandem, Reverse tandem and Displaced), Translocation (Simple, Isochrome, Reciprocal, Displaced) and Inversions (Pericentric and Paracentric).

Significance of chromosomal aberrations.

BCT 2.1P CYTOGENETICS

15 Practicals

1. A .Culturing and Handling of *Drosophila*: **02 Prs.**

a) Media Preparation
b) Cleaning and Sterilization of bottles
c) Handling of *Drosophila*

B. Morphology and Sexual dimorphism

2. Study of at least five types of *Drosophila*: **02 Prs.**

a) Body color mutant- Ebony body and Yellow body.
b) Wing mutant- Curly wing and Vestigial wing.
c) Eye color mutant- Bar eye, White eye, Sepia eye.

3. Mounting of Sex Comb of *Drosophila melanogaster*. **01 Prc.**

4. Salivary gland Chromosome- **04 Prs.**

a) Dissection of Salivary glands.
b) Preparation of Polytene chromosome.

5. Study of Chromosomal Aberrations: **03 Prs.**

a) Observation of permanent slides of chromosomal aberrations.
b) Inversion- Salivary gland chromosomes of *Drosophila nasuta*.
c) Translocation- Flower buds of *Rhoeo discolor*.
d) Induction of polyploidy in Onion root tips.

6. Genetic Problems on Linkage and Crossing over: **03 Prs.**

a) *Drosophila*. b) Maize. c) Human (Sex Linkage).

BCT 3.1P CYTOGENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Prepare the Salivary gland Chromosomes from the given material and comment on its salient features. **10**

2. Prepare a temporary anther squash of *Rhoeo* for catenation ring and comment with neat diagram

OR

Mount the Sex comb of *Drosophila melanogaster* and comment with a diagram. **09**

3. Identify and comment with neat labeled diagrams for the following spotters 3 X 2= **06**

a) Any **Two** mutants of *Drosophila melanogaster.*

b) Any **One** Chromosomal Aberration (Inversion/ polyploidy).

4. Solve the given genetic problem on Linkage map / Sex Linkage. **05**

Note: *For construction of linkage map data of two point / three point crosses should be provided.*

5. Class Records. **05**

BCT 3.1P CYTOGENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Preparation of Salivary gland Chromosomes and comment.
   (Preparation - 06, Comments with diagram – 04) **10**
2. Preparation of a temporary anther squash of *Rheo* and comment withdiagram.

OR

Mounting of the Sex comb of *Drosophila melanogaster* and comment with diagram.
(Preparation / Mounting – 05, Comment with diagram– 04) **09**

3. Spotters. **3X2= 06**
(Each spotter: Identification – 01, Comment with diagram – 01)

4. Genetic Problem **05**

5. Class Records **05**

References:

1. Chromosomal Abberrations: Basic and Applied aspects by Obe.G. and A.T. Natarajan (1990) Springer Verlag, Berlin.
2. Cytogenetics, Plant Breeding and evolution by U.Sinha and Sunita Sinha , Vikas Publishing House Private, Limited, 1998.
3. Cytology, Genetics and Molecular Biology by P.K.Gupta (2002), Rastogi publications.
4. Elements of Genetics by Phundan Singh, Kalyani Publishers. 2009.
5. Genetic Maps, 6th edition by O'Brien, S (1993) Book 3: Lower Eukaryotes. Book 4: Nonhuman Vertebrates. Book 5: The Human maps. Book 6: Plants. Cold Spring Harbor Lab press New York.
6. Genetics, 2nd Edition, by Weaver, R.F. and Hendrick, P.W. (1992). W.C. Brown.
7. Instant notes in Genetics by P.C.Winter, G.I. Hickey and H.L.Fletcher (2003) Viva Books Pvt.Ltd.
8. Principles of Genetics by E.J.Gardener, M.J.Simmons and D.P.Snustad.J.Wiley and Sons pubs (1998).

SEMESTER-IV
BCT 4.1 MOLECULAR GENETICS

52Hrs.

UNIT I **13 Hrs.**

a. Chemical Basis of Heredity:

DNA as genetic material- Experiments of Griffith; Avery, Mc Leod and Mc Carty; Harshey and Chase.

RNA as genetic material- Experiment of Fraenkel and Singer.

b. Nucleic acids:

Molecular structure of DNA, Chargaff's rule, Forms of DNA- A, B and Z forms.

RNA types and structure – mRNA, tRNA (clover leaf model), rRNA.

Ribozymes

c. DNA Replication:

Meselson and Stahl Experiment.

DNA Replication in prokaryotes – Initiation, Continuous and discontinuous synthesis, Events at the replication fork, Termination, Enzymology.

Rolling circle replication in φX174 virus. DNA Replication in eukaryotes.

UNIT II **13 Hrs.**

a. Genome organization

Fine structure of the Gene- Cistron, muton and recon. Organization of Chloroplast and mitochondrial genome.

b. Gene expression:

Transcription: initiation, elongation and termination (rho- dependent and rho-independent).

Post transcriptional modifications: methylation, polyadenylation, RNA splicing.

Translation: Genetic code and its properties; process of translation- Initiation, elongation and termination. Post-traslational modifications of proteins.

UNIT III **13 Hrs.**

a. Gene regulation:

Concept of operon, Inducible operon - Lac operon – structure and mechanism, Catabolite repression. Repressible operon - Tryptophan operon - structure and mechanism.

b. Bacterial Genetics:

Transformation, Transduction-Generalized and specialized; Conjugation: F factor mediated, *Hfr* and Sexduction.

c. Introduction to Genomics, Proteomics, metabolomics, microbiome.

UNIT IV 13 Hrs.

a. Transposable elements: Bacteria, Yeast, Maize and *Drosophila*.

b. Mutations:

Introduction and Types of Gene mutations - Base substitution (Transition and transversion), Frame shift mutation, insertion, deletion, missense, nonsense, reverse, suppressor and lethal mutations).

Pleiotropy- definition and examples.

Mutagens – Physical (ionizing and non- ionizing radiations) and chemical (Base analogs, Alkylating agents, Acridine dyes, Deaminating agents, Hydroxylating agents, Tobacco

carcinogens); Oncogenic Viruses.
DNA repair mechanisms (Mismatch repair, photoreactivation, excision and SOS repair).
Mutation as raw material for evolution. Beneficial effects of mutation.
Analogs

BCT 4.1P MOLECULAR GENETICS

15 Practicals

01 INSTRUMENTATION: **02 Prs.**
Centrifuge, Ultra centrifuge, pH meter, Electrophoretic unit, Micropipette, Glass homogenizer, Autoclave, Shaker incubator.

02 EXTRACTION OF DNA : **04 Prs.**
From Cauliflower, Coconut endosperm, Bacteria, Animal Tissue.

03 PAPER CHROMATOGRAPHY FOR SEPERATION : **03 Prs.**
Leaf pigments, *Drosophila* eye pigments, Amino acids

04 ELECTROPHORESIS (DEMONSTRATION) **02 Prs.**
Agarose gel electrophoresis, PAGE (Polyacrylamide gelelectrophoresis)

05 MUTATIONS : **04 Prs.**

a. Study of examples of mutations :
- Sickle cell Anaemia: Mis – sense mutation.
- Thalassemia – frame shift mutation.
- Identification of point mutation types based on the given representation

b. Induction of Mutation in *Drosophila* and detection of sex-linked lethal by *Muller 5 stock.*

BCT 4.1P MOLECULAR GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Extract DNA from the given material. Write the protocol. **10**

2. Perform Paper Chromatography for the given mixture, calculate the Rf value and comment on the principle. **8**

3. Identify and comment on any four: the given spotters **4 x 3 = 12**
i) Instrument (Any two),
ii) DNA / Protein Profile,
iii) Spotter from Mutation Study

4. Class Records **5**

BCT 4.1P MOLECULAR GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Extraction of DNA **10**
(Extraction – 07 marks, Protocol-03)
2. Paper Chromatography **8**
(Performance – 02, Calculation of Rf value - 04, Principle of chromatography – 02)
3. Spotters **4 x 3 = 12**

(Identification – 01, Comments – 02 (for instrument, Comments should be written on the working principle)

4. Class Records **5**

References:

1. Advanced Genetics by G.S.Miglani. 2002.
2. Advanced Molecular Biology by Twyman R.M (1998) Viva Books Ltd.
3. Cell Biology and Molecular Biology by EDP Robertis and EMF Robertis, Saunder College. 1980.
4. Genes- IX, 9th Ed., Benjamin Lewin. Jones and Bartlett Publishers, 2008.
5. Genetics – Analysis of Genes and genomes – VII edition - Daniel L. Hartl and Elizabeth W. Jones. 2011.
6. Genetics – from genes to genomics – Leland Hartwell, Leroy Hood, Charles (Chip) Aquadro, Michael L. Goldberg, Maria Papaconstantinou, Fischer, Janice, Jim Karagiannis. McGraw-Hill Education, 2017.
7. Genomes by T.A. Brown (2002) Viva Books.
8. Instant Notes in Biochemistry 2 edition B.D.Hames and N.M.Hooper (2002) Viva Books.
9. Instant Notes in Molecular Biology by P.C.Turner etal (2002) Viva Books.
10. Molecular cell Biology, 2nd edition by Darnell.J, H.Lodish and D.Baltimore (1990), Scientific American Books, New York.
11. Molecular Genetics by D.N.Bharadwaj. Kalyani, 2008

SEMESTER- V
BCT 5.1 RECOMBINANT DNA TECHNOLOGY

40 Hrs.

UNIT I **14 Hrs.**

a. Introduction to RDT:

Overview of major steps involved

b. Tools for RDT:

Enzymes:

Restriction endonucleases: Types, Nomenclature, Recognition sequences, cleavage pattern; Modification of cut ends DNA ligases **Other enzymes:** A brief account of alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA polymerase and S1 endonuclease.

Vectors:

Properties of an ideal vector, Cloning and expression vectors in prokaryote and eukaryotes.

Cloning vectors:

i) Prokaryotic vectors:

Plasmids- pBR 322; pUC 18; Bacteriophages-
Lambda phage, Cosmids.

ii) **Eukaryotic vectors:** YAC vectors; Shuttle vectors- Yeast and *E. coli.*

iii) For higher plants**:**

Integrative DNA transfer- *Agrobacterium* vectors-Ti plasmid

Non integrative- DNA transfer-Plant viral vectors (CaMV)

For animals: Animal viral vectors- SV 40, SV- GT5, Retroviruse and Adenoviruse.

UNIT II **13 Hrs.**

a. Isolation and construction of a desired gene:

mRNA isolation
cDNA library
Genomic library

b. Gene transfer methods:

Agrobacterium mediated gene transfer- Binary and Cointegration method.

Direct gene transfer methods:

Chemical method-Calcium phosphate method and DEAE -
(Diethylaminoethyl) Dextran mediated DNA transfer
Lipofection
Electroporation
Microinjection
Gene gun method

c. Synthesis of gene: Sangers di deoxy method Organo chemical synthesis

d. Selection and screening of recombinants:

Identification and selection of transformed cells:
Direct methods-Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutrition
Indirect methods- Colony hybridization, Immunochemical detection Use of selectable and scorable genes:

a) Selectable genes: Plants- npt; Animals-*TK*

b) Scorable genes: Plants-Gus; Animals-*lux*

UNIT III **13 Hrs.**

a. Technique for RDT:

Gel electrophoresis: AGE and SDS-PAGE PCR - Principle and applications Hybridization: Southern; Northern; Western; Autoradiography – Principle and applications
DNA foot prints
DNA microarray and DNA chips.

b. Applications:

Transgenic animals: Methodology to create transgenic animals (mouse).
Applications of Transgenic Knock-out Mouse, Sheep, Fish, Cow. Transgenic Plants: Resistance to diseases (Pathogen resistance to viral, fungal and bacterial); insects (*Bt* gene transfer).
Fertilizer management – organization of *nif* gene in *Rhizobium.*

BCT 5.1P RECOMBINANT DNA TECHNOLOGY

15 Practicals.

1. **Instrumentation:** 03 Prs.
   a) Gel doc
   b) Microneedle
   c) Magnetic Stirrer
   d) UV Transilluminator
   e) Thermocycler
2. **Vectors:** 02 Prs.
   a) pBR 322 and Cosmid
   b) YAC
   c) Ti plasmid - Binary vector
   d) SV 40 (any one type- same example from theory)
3. **Transgenic organisms:** 01 Prc.
   Plants: Bt cotton and Animals: Knock out Mouse
4. **Experiments:** 05 Prs.
   a) Quantification of DNA by DPA method
   b) Quantification of RNA by Orcinol method
5. **Demonstrations:** 04Prs.
   a) Restriction Enzyme digestion
   b) Ligation of DNA fragment

BCT 5.1P RECOMBINANT DNA TECHNOLOGY

Time: 3 Hrs. **Max. Marks :35**

1. Quantify DNA / RNA from the given sample and comment on the principle involved.
   (Standard graph to be prepared by students only) **12**
2. Identify and Comment on the working principle of instruments (any two from Instrumentation) **2x3= 6**
3. Identify and comment on any two of the following spotters: **2x3= 6**

a) Transgenic plant / animal
b) Vector (Any one type)

4. Comment on the methodology of any two of the following profiles: **2x3= 6**

DNA Profile: **i)** Plasmid profile **ii)** Restriction profile **iii)** Ligation profile (Chart / Photograph of any two to be provided)

5. Class Records. **5**

BCT 5.1P RECOMBINANT DNA TECHNOLOGY

1. DNA / RNA Quantification. **12**
(Principle - 2, Performance and Observation table – 5, Standard graph- 3, Result- 2).

2. Instrumentation. **2x3=6**
(Identification – 0.5 Mark, Working Principle with application – 2.5 Marks for each).

3. Spotters: **2x3=6**
(Identification – 1, Comments– 2 for each).

4. Profile **(Methodology – 3 Marks for each). 2x3=6**

5. Class Records. **5**

References:

1. Agricultural Biotechnology- S.S. Purohit Agro Botanical Publishers, 1999.
2. An introduction to Genetic engineering (2nd ED). Desmond S.T. Nicholl I South Asian Edition, 2002, Cambridge University Press.
3. Biotechnology Fundamentals and applications - S.S. Purohit, student Edition, Jodhpur, 2003.
4. Biotechnology; B.D. Singh, Kalyani publishers. 2016.
5. Biotechnology; U. Satyanarayana; 2008. Books and Allied (P) Ltd., Kolkata,.
6. Gene cloning- T. A. Brown. Stanley Thornes (Publishers), 1998.
7. Genes-Volumes, Benjamin Lewin, Oxford University Press, Oxford.
8. Genetic engineering: Principles and practice; Sandhya Mitra, 2008. MacMillan India Ltd..
9. Genetics: From Genes to Genomes by Hartwell I.H. *et. al.* 2000. Mc Graw Hill.
10. Molecular Biology of the gene- Watson. 2008.
11. Molecular Biotechnology. Primrose. Wiley, 1992
12. Molecular Biotechnology; Principles and practices, Channarayappa, 2006. University press (India) Private Limited
13. Transgenic animals by Madhur Mohan Ranga. Agrobios (India), 2006

BCT 5.2 BASIC HUMAN GENETICS

40 Hrs.

UNIT I **13 Hrs.**

a. Human Chromosomes:

Normal Human Karyotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes) FACS-
Fluorescence Activated Cell Sorter

b. Genetic Diseases and Inheritance Pattern:

Autosomal inheritance- Dominant
(Ex. Adult polycystic kidney, Achondroplasia and Neurofibromatosis)

Autosomal inheritance- Recessive
(Ex. Albinism, Sickle cell anaemia, Phenylketonuria)

X-linked – Recessive: (Ex. Duchenne muscular dystrophy-DMD)

X-linked- Dominant : (Ex. Xg blood group)

Y-linked inheritance : Holandric gene (Ex. Testes determining factor - TDF)

Multifactorial inheritance :
(Ex.Congenital malformations: Cleft lip and palate, Rheumatoid arthritis and Diabetes)

Mitochondrial diseases: (Ex. Leber's hereditary optic neuropathy)

c. Pedigree studies and Genetic Counselling:

Symbols used in pedigree studies, Pedigree analysis and construction, Pedigree analysis for the inheritance pattern of genetic diseases, Genetic Counselling.

- Stage 1: History and pedigree construction
- Stage 2: Examination
- Stage 3: Diagnosis
- Stage 4: Counselling
- Stage 5: Follow up

UNIT II **14 Hrs.**

a. Immunology and Immunogenetics:

Introduction to immunology- antigens, antibodies, B and T Cells Immunity- Innate and acquired.
Immune response - Humoral and Cell mediated
Genetics of immune system – Antibody gene rearrangement and class switching.
Inherited immunodeficiency- Ex. X- linked agammaglobulinaemia. Major Histocompatibility Complex- Types,
HLA disease associations.
Transplantation, graft-rejection and immunosupressors Concept of immunization

b. Oncogenetics:

A brief account of cancer-definition, types-Benign and Malignant; Sarcoma, Carcinoma, Lymphoma and Leukaemia
Properties of malignant cells,
Types of genes - Proto oncogenes, Oncogenes, Difference between V- onc and C – onc oncogenes,
Tumor Suppressor genes-p53, pRb.
Chromosomal abnormalities associated with the specific malignancies- Acute

Promyelocytic Leukaemia(APL),Chronic Myeloid Leukaemia(CML) and Acute lymphoblastic leukaemia *(*ALL)

UNIT III **13 Hrs.**

a. Dermatoglyphics:

Introduction and Patterns.

Dermatoglyphics in clinical disorders- Down's syndrome, Turner's syndrome, Klinefelter's syndrome and Cri du chat syndrome.

Clinical applications, Advantages and Limitations.

b. Prenatal Diagnosis:

Introduction and types

Invasive Prenatal diagnosis - Amniocentesis, Chorionic villus sampling.

Non – Invasive Prenatal diagnosis – Ultrasonography.

c. Genetics and Society:

Eugenics: Positive and negative, Euthenics, Euphenics Human genome project – introduction and significance Gene therapy with reference to SCID

Stem cells- Properties, types and sources.

A brief account on Cord blood banking and Stem cell therapy.

BCT 5.2P BASIC HUMAN GENETICS

15 Practicals

1. **Study of Karyotypes I**: Normal Karyotyping in Human **1Prc.**
   - Male (46,XY)
   - Female (46, XX).
2. **Study of Karyotypes II:** Abnormal Karyotypes **1 Prc.**
   - Down's syndrome (autosomal).
   - Turner's syndrome (sex chromosomal)
   - Klinefelter's syndrome (sex chromosomal)
3. **Sex chromatin:** **3 Prs.**
   - Study of Barr body in the Buccal epithelial cells.
   - Study of drum sticks in Neutrophils of Blood smear.
4. **Blood Cell counting using Haemocytometer (RBC and WBC) 3 Prs.**
5. **Pedigree analysis and construction:** **2 Prs.**

   Symbols used and problems associated with autosomal recessive disorder, autosomal dominant disorder, Sex linked inheritance (X and Y)
6. **Dermatoglyphics:** **2 Prs.**
   - Recording of print of fingertips and palm.
   - Classifying ridges on the Finger tips: arch, loop, and whorl.
   - Palm print - area demark as hypothenar, thenar and inter - digital areas, Recording presence or absence of Simian crease.
   - Ridge Counting and angle calculation.
7. **Immunology:** Demonstration of **3 Prs.**
   - Ouchterlony Double Diffusion (ODD)
   - Radial ImmunoDiffusion (RID)
   - Dot ELISA

BCT 5.2P BASIC HUMAN GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1) Prepare a Buccal smear / Blood smear for sex chromatin and comment. **07**

2) Count the RBC / WBC in the blood sample. Calculate and report the results. **07**

3) Construct pedigree for the given data / analyse the given Pedigree **06**

4) Identify and comment on the given Karyotype **04**

5) Identify and comment on the given Spotters (**Two**). **2 x 3=06**

i) Dermatoglyphic pattern

ii) ODD / RID / DOT ELISA

6) Class Records **05**

BCT 5.2P BASIC HUMAN GENETICS

Time: 3Hrs **Max. Marks: 35**

1) Buccal smear / Blood smear
(Slide Preparation - 05, Comments - 02) **07**

2) Count the RBC / WBC
(Preparation - 03, Calculation - 03, Report - 01) **07**

3) Pedigree Construction / Analysis with **explanation** **06**

4) Karyotype **(Identification – 01, Comments – 03)** **04**

5) Spotters **(Identification – 01, Comments – 02)** **02 x 03=06**

6) Class Records **05**

References:

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2. Emery's Elements of Medical Genetics- Peter Turnpenny, SlanEllard 15th Edition. 2017.
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5. Genetics in Medicine by M.W. Thompson *et al*, 5 Edition, W.B. Sounders Company, London 1996.
6. Human Cytogenetics. Denise Rooney Oxford University Press, 2001.
7. Human Genetics – Bruce.R.Korf. 2000
8. Human Genetics : Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
9. Human Genetics by S.D. Gangane (2nd edition-Reprint 2001), B.L Churchill Livingstone Pvt. Ltd., New Delhi.
10. Medical Genetics. Lynn Jorde John CareyMichael Bamshad. 2015.
11. Mendelian inheritance in Man by-Mc. Kusick V.A, (1998), 12 Edition, John Hopsins University Press.
12. Molecular Basis of Inherited Diseases, (6th Edition-1989) by Scriver, C.R. A.L. Beudit, W.S. Sty abnd D. Valle (EdsOMcGrawHill, New York.

SEMESTER-VI
BCT 6.1 DEVELOPMENTAL, EVOLUTIONARY AND BIOMETRICAL GENETICS

40 Hrs.

UNIT I **14 Hrs.**

a. **Developmental Genetics**: Early embryonic development in Frog- cleavage, blastula and gastrula. Nuclear transplantation experiments in Amphibians and *Acetabularia*

b. **Genetics of development in plants** – *Arabidopsis*: Flower development (Floral morphogenesis and Homeotic gene expression).

c. **Genetics of development in Animals** - *Drosophila*: Early development; Origin of anterior-posterior and dorso-ventral polarity: Role of Maternal genes, Zygotic genes- Segmentation genes (gap, pair rule and segment polarity genes) and Homeotic selector genes.

d. **Switching genes on and off during development**- Ex. Differential expression of haemoglobin

UNIT II **13 Hrs.**

a. **Evolutionary and Population Genetics:**

Darwinism, Neo Darwinism and Synthetic Theory. Evolution at molecular level: - Nucleotide sequence.

Gene pool, Gene and genotype frequencies: Hardy-Weinberg principle, Evolutionary agents: Selection – differential selection, gametic selection, zygotic selection, fitness; Migration; Mutation and Random drift.

Speciation: Methods of speciation-Allopatric and Sympatric, Isolation- Pre-mating and Post mating isolating mechanisms, role of isolation in Speciation.

b. **Quantitative characters and inheritance**:

Quantitative Characters:-Types- Continuous, meristic and threshold characters with examples.

Quantitative inheritance:-Features of polygenic traits in relation to oligogenic traits. Inheritance of Kernel color in wheat, and Skin colour in human.

Transgressive inheritance in Poultry. Environmental effects-IQ in Humans Significance of polygenic inheritance-Twin study

UNIT III **13 Hrs.**

Biometrical Genetics:

An introduction to Correlation, Regression and ANOVA (Analysis of Variance)

Genetic analysis of quantitative trait: - Ear length in Corn

Variances in polygenic traits: - Phenotypic, genotypic, environmental, additive, dominance and Epistatic variance; Genotype and environmental interaction.

Heritability: - Broad sense and Narrow sense heritability, Quantitative trait loci (QTL).

Problems related to Variance and Heritability

BCT 6.1P DEVELOPMENTAL, EVOLUTIONARY AND BIOMETRICAL GENETICS

15 Practicals.

1. Early embryonic development in Frog- Egg, cleavage, blastula and gastrula **02 Prs.**
2. Genetics of development in *Arabidopsis* – ABC model Homeotic gene expression (Slide/Chart) **01 Prc.**
3. Genetics of development in *Drosophila* - Anterior-posterior/dorso-ventral polarity (Slide/Chart) **03 Prs.**
4. Study of Quantitative inheritance in Kernel colour in Wheat/Skin colour in man (Chart) **01 Prc.**
5. Biometrical problems (Minimum 3 problems in each topic) **08 Prs.**
   - Genetic problems on polygenic variance, Heritability and ANOVA.
   - Problems in Population Genetics.

BCT 6.1P Developmental, Evolutionary and Biometrical Genetics

Time: 3 Hrs. **Max. Marks: 35**

1. Identify and comment on A and B (Frog embryology) 2x3= **6**
2. Identify and comment on the given spotters **(Any Three)** 3x3= **9**

i) Genetics of development of *Arabidopsis*
ii) Genetics of development of *Drosophila*
iii) Quantitative inheritance of Kernel color in wheat/ Skin color in man

3. Genetic Problems: 3x5=**15**

a) Polygenic variability/Heritability – **Any one**
b) ANOVA – **Any one**
c) Gene and genotype frequencies – **Any one**

4. Class Records **05**

BCT 6.1P DEVELOPMENTAL, EVOLUTIONARY AND BIOMETRICAL GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Identify and comment on A and B
   (Identification – 1 mark, Comments – 2 marks) 2x3= **6**
2. Identify and comment on the given spotters (Three) 3X3=**9**
   i) Genetics of development of *Arabidopsis*
   ii) Genetics of development of *Drosophila*
   iii) Quantitative inheritance of Kernel color in wheat/skin color in man
   (Identification – 1mark, Comments -2 marks foreach)
3. Genetic Problems: 3x5=**15**
   a) ANOVA
   b) Polygenic variability and Heritability
   c) Gene and genotype frequencies
4. Class Records **5**

References:

1. Developmental biology by Scott.F.Gilbert. Sinauer Associates, Sunderland. 2000.
2. Evolution - Stickberger, M. W (1990) Jones and Bartlett, Boston.
3. Evolutionary Genetics by Maynard Smith J (1989), Oxford University press.
4. Genetics and Analysis of Quantitative traits by Lynch. M and B. Walsh (1997). Senauer Associates, Sunderland.
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6. Introduction to Quantitative Genetics by Falconer, D (1995) 4th edition Longman, London.
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8. Principles of Development by Lewis Wolpert *et al.* 5th Edition. oxford University press 2015.

BCT 6.2 APPLIED AND BEHAVIORAL GENETICS

40 Hrs.

Unit I

a. Genetics in Medicine and Industry **13 Hrs.**

Production of recombinant insulin, interferon and human growth hormone (HGH)
Vaccines: Hepatitis B vaccine Preparation of molecular probes, Monoclonal antibodies and diagnostic kits Microarray

b. DNA Fingerprinting

Methodology of DNA fingerprinting
Molecular markers –RAPD, RFLP, Microsatellite, SNPs, STR
Applications in Forensic science, Medicolegal aspects.

c. Bioinformatics

Introduction to bioinformatics
Tools of Bioinformatics - FASTA, BLAST, RASMOL Applications of Bioinformatics

Unit II

a. **Genetic resources and Biodiversity** **15 Hrs.**

Germplasm, Classification, Germplasm activities and organization associated with germplasm (NBPGR, IBPGR) Genetic erosion, biodiversity, Red data book, endangered species, *ex- situ* and *in-situ* conservation, Vavilovian center for biodiversity.
Gene bank and cryopreservation – Types and methods.

b. Behavioral Genetics

Mating behavior in *Drosophila*
Hygienic behavior in Honeybee
Nesting behavior in Ants
Territoriality and conflict behavior in Primates.

c. Molecular markers as diagnostic tools

Her2 testing for breast cancer – (FISH), Frigile X syndrome – Microsatellite marker analysis

UNIT III **12 Hrs.**

Heterosis in animal and plants

Introduction to heterosis and characteristics.

a. In Animals:

Animal breeding –Introduction, inbreeding , grading, cross breeding, artificial insemination in cattle Fish breeding (Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding).
Breeding strategies for improvement of livestock for milk, meat, wool production.
Breeding strategies for improvement of Poultry –Giriraja.

b. In plants:

Genetic concepts – Dominance and Over dominance.
Hybridization techniques – Intergeneric and interspecific hybridization, Identification of hybrid plants.
Inbreeding depression.
Hybrid vigor exploitation in Rice and Tomato.

BCT 6.2P APPLIED AND BEHAVIORAL GENETICS

15 practicals.

1. Study of Diagnostic kits -WIDAL and VDRL. **2 prs.**
2. Study of Pollen fertility **1 prc.**
3. Study of hybrid plants - Rice, cotton, chilly and tomato **1 prc.**
4. Study of hybrid animals – Poultry, dairy and fishery. **1 prc.**
5. Study of Mating behavior in *Drosophila* **2 prs.**
6. Study of Hygienic behavior in Honeybee **1 prc.**
7. Study of Nesting behavior in ants **1 prc.**
8. One day field visit to Plant/animal breeding institutes **1 prc.**
9. Project work on - **5 prs.**
   - Bioinformatics
   - Biodiversity
   - Behavioral Genetics - *Drosophila*
   - Animal/Plant breeding.

BCT 6.2P APPLIED AND BEHAVIORAL GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Study of diagnostic kits – WIDAL/VDRL (any one) **6**
2. Study the Pollen fertility of the given material. **5**
3. Identify and comment on the given spotters : **3X3=9**
   - **a.** Hybrid plant (Rice/Tomato)- **Any one**
   - b. Hybrid Animal (Fish/Poultry/Cattle) - **Any one**
   - c. Behavioural Genetics (Ant/ Honeybee) - **Any one**
4. Project Report and viva **10**
5. Class Records **5**

BCT 6.2P APPLIED AND BEHAVIORAL GENETICS

Time: 3 Hrs. **Max. Marks: 35**

1. Study of diagnostic kits – WIDAL / VDRL **6**
   (Performance – 3, Principle – 2, Result and discussion – 1)
2. Pollen fertility of the given material **5**
   (Performance – 3, Calculation of % of fertility – 1 mark, Result – 1 mark)
3. Identify and comment on the given spotters: 3x3=**9**
   (Identification – 01, Comment -02)
4. Project Report and viva **(7+3=10)**
5. Class Records **5**

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2. Cancer Biology, Raymond W.R (2007) Oxford University Press, Newyork
3. Essentials of plant Breeding, Phundan Singh, Kalyanai publishers, 2015
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5. Human Molecular Genetics, Peter Sudbery (2002) 2nd Edition, Prentice Hall
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