

MAHATMA JYOTIBA PHULE ROHILKHAND UNIVERSITY

Bareilly



General Guidelines, Credit Framework & Syllabus

Master of Science (M.Sc.)

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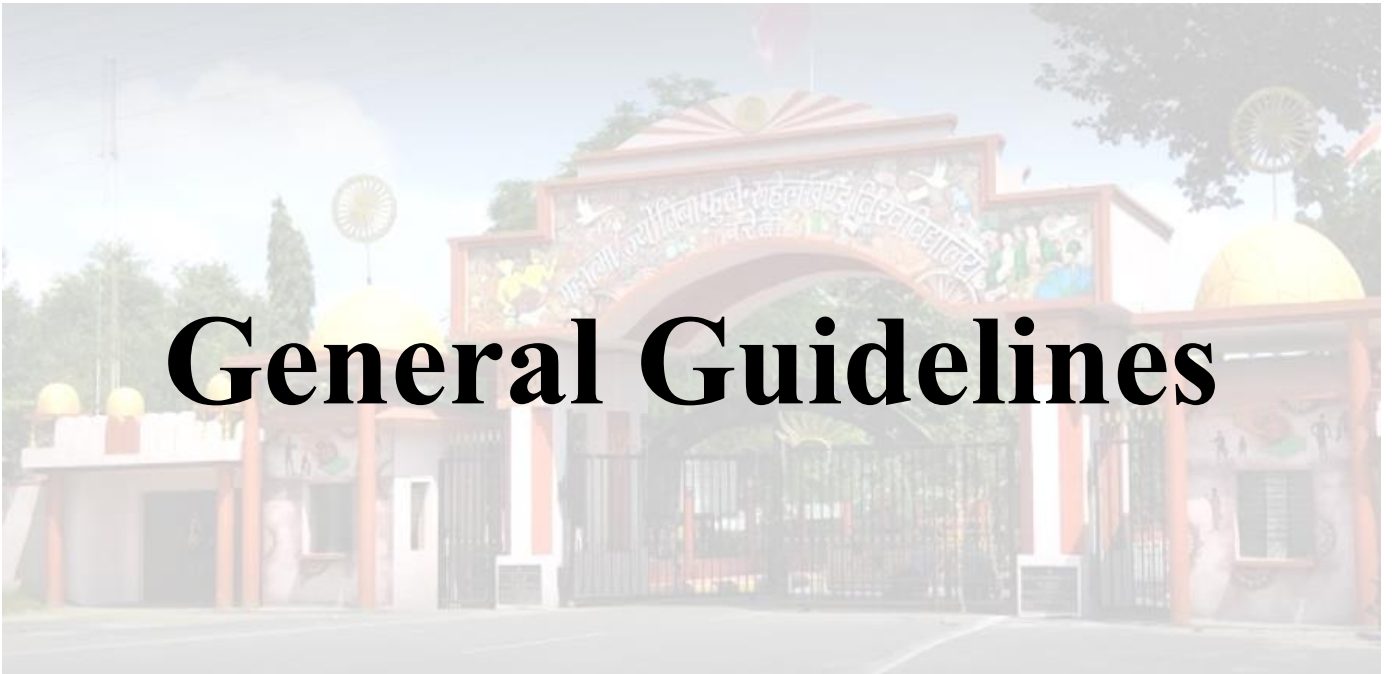
Bioinformatics

**Department of
Bioinformatics and Computational Biology**

FACULTY OF LIFE SCIENCE

2025-26

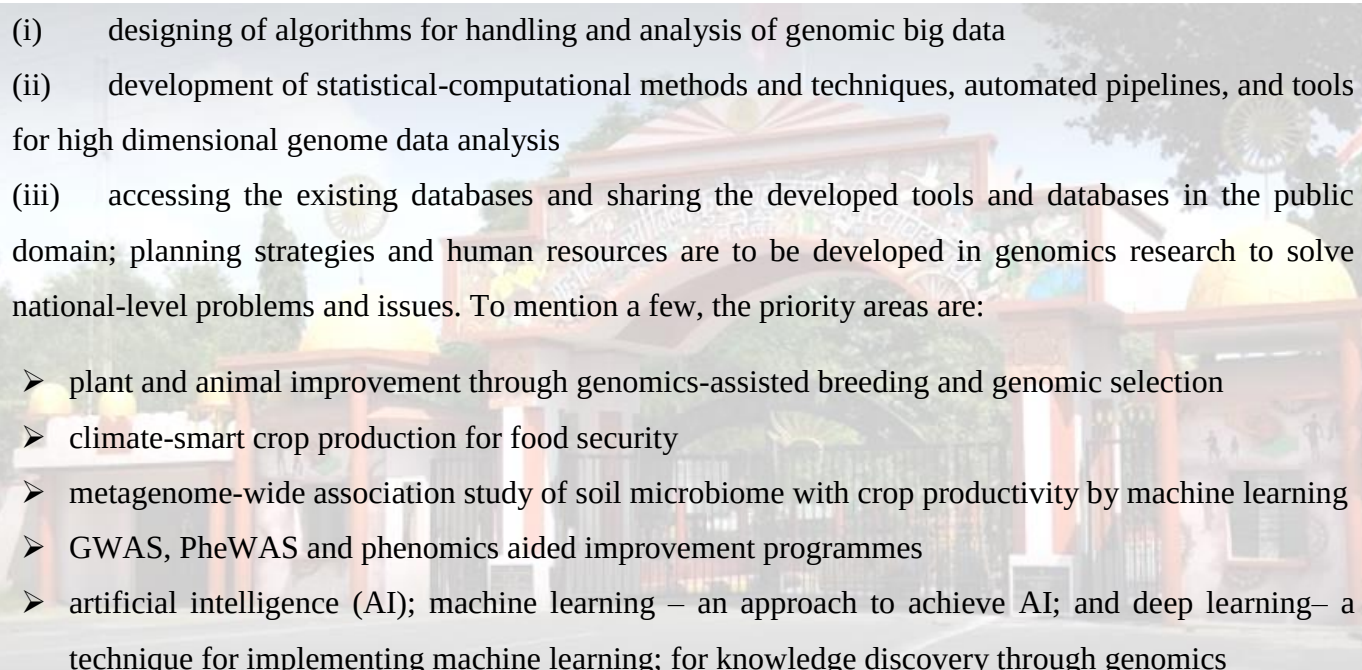
General Guidelines



About the Course

Driven by the recent developments in high throughput Genomics, Bioinformatics is taking an ever-increasing role in genomics. In a similar way, advances in information technology and computational methods are driving the mathematical sciences forward. Artificial Intelligence and Big Data analytics have revolutionized bioinformatics-based genome data analysis. Now with the availability of next generation sequencing technologies, a high volume of both structured and unstructured data is available. Further, data is also available from many genome data repositories like GenBank at the National Centre for Biotechnology Information in the public domain. All these have led to the availability of the huge amount of data from different organisms that need to be analyzed and elicit the hidden information for knowledge discovery to unravel the underlying complex biological phenomena.

In order to achieve the goals of bioinformatics:

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- (i) designing of algorithms for handling and analysis of genomic big data
 - (ii) development of statistical-computational methods and techniques, automated pipelines, and tools for high dimensional genome data analysis
 - (iii) accessing the existing databases and sharing the developed tools and databases in the public domain; planning strategies and human resources are to be developed in genomics research to solve national-level problems and issues. To mention a few, the priority areas are:
 - plant and animal improvement through genomics-assisted breeding and genomic selection
 - climate-smart crop production for food security
 - metagenome-wide association study of soil microbiome with crop productivity by machine learning
 - GWAS, PheWAS and phenomics aided improvement programmes
 - artificial intelligence (AI); machine learning – an approach to achieve AI; and deep learning– a technique for implementing machine learning; for knowledge discovery through genomics
 - blockchain technology and data science for agricultural value chain (vii) role of microbiota in plant and animal health care and expression of economically important traits
 - designing and development of Agri-Encyclopedia of DNA Elements (A-ENCODE)
 - identification of bioremediation bacteria and probiotics from the Indian river system for pollution remediation
 - improved and efficient algorithms for robust genome assembly from data generated under different Next Generation Sequencing platforms.
 - Possessing expertise and skills in computer programming languages like R and Python is essential for bioinformaticians, who are developers of bioinformatics tools and pipelines in the system.

Above all, there exists always a rapidly increasing demand for individuals to be trained in bioinformatics with special skills and knowledge to handle high dimensional genomic data. The

emerging trends in genomic research, the need for human resources for teaching and application of bioinformatics in genomic research for crop improvement, shrinking job opportunities in the public sector etc would warrant students to possess the technical knowledge and skills in bioinformatics coupled with good practical and management skills, to be competitive for both public and private sectors. Hence a thorough updated course curriculum and delivery system is needed.

Bioinformatics has emerged as an interdisciplinary and integrated scientific discipline, which links the computational and statistical sciences with life sciences. A big hurdle in the development of Bioinformatics in India is the limited availability of trained human resource, faculty and Ph.D. scholars in the field. In order to reach the unreached discoveries and innovations through bioinformatics, one should have a reasonably good infrastructure with high-end servers, high-speed internet connectivity, CPU/GPU-based high-performance computing system, high storage, smart classrooms, open-source software, Linux-Apache-MySQL-Perl/PHP (LAMP) technology, etc. The need of the hour is to deploy advanced techniques of artificial intelligence, machine learning and big data analytics to unravel the underlying mechanisms and factors involved in complex biological phenomena and thus, the syllabus has been designed in this light. Recent developments in bioinformatics have become indispensable for use in omics and systems biology approaches.

This syllabus addresses the recent advances and modern concepts of AI, Machine Learning in analyzing big data coming from genomics, transcriptomics, proteomics and other omics research. The demand for trained manpower in bioinformatics is increasing in the private sector, which is a healthy sign for PG students. Care has been taken while devising the syllabus to incorporate more practical on computer programming and high dimensional genome data analysis software.

1. Programme Structure:

M.Sc. Bioinformatics will be a full-time two-year programme to be covered in four semesters. The maximum duration of the programme shall be **twice the minimum** duration of the programme, i.e. four years.

2. Academic Year and Registration

2.1. An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. Each semester will be of 110-day duration. The 1st (autumn) semester is during the months of July – December and 2nd (spring) semester is during months of January – June.

2.2. Dates of registration, commencement of instructions, semester end examination, end of semester and academic year etc. The Academic Calendar shall be developed by the University from time to time and notified accordingly by the Registrar in advance.

2.3. An orientation programme shall be organized by HOD for the benefit of the newly admitted students immediately after commencement of the semester.

2.4. On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/Semester Callender specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/her degree programmes.

3. Eligibility for admissions

A bachelor's degree in the respective / related subjects 6.00/10 or equivalent OGPA/ equivalent percentage of marks for general category candidates and 5.50/ 10 or equivalent OGPA/equivalent percentage of marks for SC/ST/PH category candidates at Bachelor's degree level.

3.1. Mode of Admission and Reservation of seats

The University shall adopt entrance examination or merit at the bachelor's level or a combination of both while making admissions. Particularly for admission out of University/ State students should be based on common entrance test and not by merit only. Reservation on admission will be applicable as per U.P. Govt. rules.

4. Registration

(a) Registration of candidates selected for admission as well as that of continuing students shall be completed on scheduled date (s) notified earlier by the Registrar for each semester.

(b) Normally a student shall not be permitted to offer a course unless he has cleared its pre-requisite course. In case any student has failed in a pre-requisite course after attending the course at least for 15 weeks, the HOD may permit him to register for advance course. In case of genuine difficulties, the Head of the Department may also permit offering of pre-requisite course and the advance course to which it was pre-requisite concurrently.

4.1 Mode of Registration

Registration shall consist of the following steps:

- (i) Enrolment of the students in various courses with individual Instructors at a particular place, date and time.
- (ii) Payment of the University fees and other dues to the Comptroller and the Dean student Welfare.
- (iii) Depositing with the Registrar the prescribed registration cards/forms, duly filled in and signed by the Advisor, Instructors and other officers concerned.

4.2 Registration of Fresh Students

Registration for the first semester of the first year of a degree programme is a part of admission procedure and shall be governed by the admission rules. Admission of new students failing to register in

the prescribed manner on the appointed date is liable to be cancelled and the seats so fallen vacant shall be offered to the next candidates in the waiting list. In the event of a newly admitted student being permitted by the Vice-Chancellor to register late, he shall pay late registration fee as prescribed under Regulation 4 (a) for continuing students, unless exempted by the Vice-chancellor.

4.3 Registration of continuing students

Registration of continuing students in the subsequent semester shall be held in a similar way on the date & time notified by the Registrar.

4.4 Late Registration Fee

(a) A continuing student who does not register on the day of registration, shall be required to pay a late registration fee of Rs. 100.00 for the first day and Rs. 25.00 for each subsequent day, till the registration is completed as prescribed.

(b) Any student may be exempted from the payment of late registration fee by the Vice-Chancellor where he is convinced that the student is late for circumstances beyond his control.

4.5 Last Day of Registration

The registration of continuing students shall not be permitted later than ten working days from the scheduled date of registration in each semester unless allowed by the Vice-Chancellor with late registration fee mentioned in 4.4 (a). No student shall be permitted after expiry of 15 working days from date of registration under any circumstances.

4.6 Summary Cancellation of Registration

The Vice-Chancellor may summarily cancel the registration of any student or group/batch/classes of students who indulge (s) in acts of indiscipline, misconduct, violation of rules and regulation of the University, strikes, absents from classes without permission or without any valid reason or in whose cases the Vice-Chancellor has reasons to believe that their continuance in the University would not be in the best interest of the University.

4.7 Suspension of Registration

The registration of a student may also be suspended by the Vice-Chancellor or the Head of the Department or the Dean of students Welfare either at his discretion or on the recommendations of the Discipline Committee pending enquiry or the receipt of a report from the Warden or a faculty member alleging that the student concerned has committed an act of indiscipline as defined under the regulation. A student whose registration has been suspended as above may also be ordered to vacate the hostel and leave the campus if such a measure is deemed necessary by the authority passing the order of suspension in the interest of academic discipline and peace on the campus.

The period of suspension under this regulation shall not exceed 15 days except in cases in which the Vice-Chancellor or the HOD has reasons to believe that the proceedings in the Discipline Committee cannot be concluded during this period or where it is felt that the enquiry by the Discipline Committee needs to be held in abeyance so as not to prejudice the proceedings in court cases involving the alleged commission of a serious crime or an offence under the laws of the country or the state involving moral turpitude.

4.8 Registration necessary for award of degree

In case a student studies a course without registering in the prescribed manner, he/she will not be awarded any grade in that course.

4.9 Minimum Credit Load

(a) The following shall be minimum credit requirements for registration in each semester.

Postgraduate Students: 12 Credits

Note: If a student is left with less than 12 credits in his approved programme, above limit will not operate.

(b) *Exceptions:* The Head may permit a lower credit load, among others, on the following grounds to be specifically recorded in each case.

- i) Marginal adjustments;
- ii) Unavoidable clashes in time table;
- iii) Non-availability of sufficient number of course to be covered;
- iv) Non-availability of suitable course or failure to clear pre-requisites or for other reasons;
- v) Need for taking up preparatory course;
- vi) In case of post-graduate students' completion of course requirement and being left with only credits for research;

4.10 Maximum Credit Load

(a) The following shall be the maximum credit load to be allowed by an Advisor:

Full time Post-Graduate: 16 credits in a semester.

(b) *Exceptions:* The Head may permit an increase in the maximum credit load (as specified above) upto the limits detailed below on any of the grounds listed in (c) below.

Full-time post-graduate students: 20 credits

(c) The grounds for increase in maximum credit load up to the limits laid down in 4.10 (b) above shall be as follows, but they shall not operate in case of students on Academic Probation.

- i) Where extra departmental or extra-non-credit course are deemed necessary;
- ii) Where a course is not offered in the subsequent semester within the time laid down for the maximum duration of the course;
- iii) Where only thesis requirements are left to be completed; and

iv) Where four or less credits remain to be covered in the subsequent semester.

v) Last semester of the degree programme

(d) Any increase beyond the limits prescribed in (b) above, or on grounds other than those listed in (c) above may be permitted by the Vice-Chancellor on the recommendation of the Head for reasons to be recorded.

5. Record of Class Attendance

Each Instructor shall maintain a record of the students' attendance in each course taught by him in each semester in a register prescribed by the Registrar. All postgraduate students during the course of their registration for thesis research only shall regularly sign on the register maintained in the Advisor/HOD office, as decided by the department. Further, any student leaving for his/her personal work outside the University shall have to take permission from the Advisor, and HOD.

5.1 Minimum Class Attendance

(a) Each student shall be regular in attending classes and shall be required to have a minimum of 75% attendance in each course in each semester, failing which he shall be awarded failure grade in that course unless withdrawal from the course is permitted.

(b) The percentage of attendance of a student in a course in a semester shall be computed on the basis of the total number of lectures, practical and tutorials attended by him and those actually held between the date of commencement of instructions and the date of closing of instruction, irrespective of the date of registration/or the duration of leave granted to him provided that attendance in respect of the students representing the University in games and sports, debates etc. outside the campus shall be calculated after ignoring the period which they spend outside the campus on due authorization by the HOD and Dean Students Welfare subject to the condition that such authorized absence should normally not exceed 7 days in a semester *and further that no condonation even under this clause shall be allowed below 65%.*

(c) (i) The HOD may, on the recommendation of the Instructor/Advisor, condone shortage in attendance up to 5% in a course(s) in exceptional circumstances and allow students with an attendance of 70% or more to appear at the final examinations.

(ii) The Vice-Chancellor may, on the Recommendation of Instructor/Advisor/HOD condone shortage in attendance upto 10% in a course (s) in exception circumstances and allow students with an attendance of 65% or more to appear at the final examination.

(d) All the Instructors shall display on the Department notice board(s) the shortage of attendance of the students (below 75%) in particular course before the start of the final semester examinations with a copy to the HOD. The student will submit the application for condonation of shortage of attendance to the office of the HOD through Instructor, Advisor within a week of the start of semester final examinations. The shortage in attendance of student may be condoned on the grounds and limits as given in (a), (b) and (c). In case the condonation of the attendance is granted by the HOD, the student will apply to the Registrar through Instructor/Advisor/HOD on plain paper for the revision of his grade. No application

for the condonation of shortage in attendance will be entertained under any circumstances after prescribed date mentioned above.

(e) Further in view to have the regularity in the academic programme following shall be observed.

- (1) No teacher shall leave the campus without making arrangement for the class.
- (2) The attendance must be taken whenever class is scheduled whether any student attends or not, notwithstanding.
- (3) The monitoring about holding of the scheduled classes be done by the Head of the Department.
- (4) Reports about defaulters must be promptly submitted and action taken.
- (5) The provision of the regulations regarding attendance shall be strictly adhered to.
- (6) Alternative question papers be prepared and kept sealed from the start of the semester, for use at the final examinations.
- (7) All formalities towards condonation of shortage in attendance must be completed within 7 days of commencement of semester final examination.

5.2 Leave for Illness

In case of unavoidable absence from the class e.g., serious illness, the student shall apply for leave to the HOD through his Hostel Warden, in the prescribed form. The HOD, if satisfied, may permit him such leave and shall inform all the instructors. In such cases efforts should be made to make up the work missed by the students.

6. Addition /Withdrawal of course(s)

(a) A student who desires to add/withdraw course(s) from the original registration has to complete the following steps failing which the addition/withdrawal will not be allowed under my circumstances:

- i) The application is made on the prescribed form, obtainable from the office of the HOD.
- ii) The recommendations of all concerned are obtained in person.
- iii) The approval/recommendation of HOD is obtained.
- iv) The form is submitted in the office of the Registrar in person after payment of necessary fee of Rs. 25/-per course within the prescribed time limit, and
- v) The orders are obtained from the office of the Registrar supplied to the Advisor and Instructor(s) concerned within the prescribed time limit.

(b) The course withdrawn within the prescribed period and manner stated above shall not be shown on the transcript.

(c) (i) A student may be allowed to add a course(s) in original registration upto 6 working days from the scheduled date of registration by the HOD on the recommendation of Advisor and Instructor (s) on payment of fee of Rs. 25/- per course with the condition that the credit load of the student does not exceed the prescribed maximum credit limit, However, in genuine cases, the Vice-Chancellor may permit addition of course(s) upto 15 working days from the scheduled date of registration on payment fee as prescribed above.

(ii) A student may be permitted to withdraw from a course within 4 weeks from scheduled date of registration in the semester by the HOD on the recommendation of Advisor and Instructor(s) concerned on payment of fee of Rs. 25/- per course. In case of prolonged illness, duly certified by the Medical Officer of the University, a student may be permitted to withdraw from a course worth upto 4 credits, upto six weeks by the Vice-Chancellor on the recommendation of Advisor, Instructor(s) and HOD subject to the following conditions:

- The credit load after withdrawal does not fall below 12 credits for Master's students.
- If the credit loads of a student as at (i) falls below 12 credits, the student will not be entitled for graduate Assistantship.

7. Continuance of Students

7.1 Withdrawal from the University

(a) Every enrolled student shall be required to register at the beginning of each semester till the completion of his degree requirements, unless otherwise permitted/ordered by the HOD/Vice-Chancellor, as the case may be, failing which his/her enrolment shall be cancelled. Re-admission in such case shall be by petition, and not as a matter of right.

(b) Permission to withdraw from the University, for a semester shall not be granted unless the application is made through the advisor to the HOD at least 15 days before the commencement of the semester final examinations after obtaining upto date no dues from the Comptroller.

(c) No student will be permitted to drop the Ist semester of his Ist year at Post-graduate level. However, the Vice-Chancellor may permit the dropping of the Ist semester of the Ist year on the recommendations of the HOD in exceptional circumstances i.e.

- Hospitalization for one month or more in the Ist semester.
- Confinement to bed for one month or more in the Ist semester as a result of serious illness/ailment.

(d) A student may be permitted to drop the IInd semester only on the condition that he was not placed on Academic Probation after the first semester final examinations. Under no circumstances a student who was permitted to drop the Ist semester shall be allowed to drop the IInd semester.

(e) Permission to withdraw from the University for a semester shall be accorded on the following grounds:

i) The student is hospitalized in the University Hospital or in a Hospital, advised by the University Medical Officer Incharge or advised complete rest by the University Medical Officer Incharge or the I/C of such Hospital to which his case was referred by the Medical Officer Incharge, University Hospital for a period on account of which his attendance are likely to fall below 65% and/or he is likely to miss or has missed examination as well as make ups thereof . The application, on this ground duly countersigned by the University Medical Officer Incharge and supported by the relevant

certificate(s), is to be made within a week from the last day of hospitalization. No application submitted beyond this period will be considered.

ii) In case of an accident whereby a student has been disabled temporarily to attend his classes, the application for leave duly supported by the Medical certificate(s) countersigned by the University Medical Officer Incharge, is to be made within a week from the day the student is declared fit to attend classes.

iii) In case where a student has left the University Campus on authorized leave on any ground including the unfortunate death of parent/guardian and falls sick there and has to undergo treatment for such a period that his/her attendance falls short of the minimum prescribed limit he/she may also be permitted by the HOD to drop/withdraw from a semester if he/she makes formal application to the HOD through his guardian/parent duly supported by Medical Certificate(s) from a M.B.B.S. registered medical practitioner within a fortnight from the date of expiry of the authorized leave.

iv) Any other unforeseen circumstance which, in the opinion of Vice- Chancellor, are fit reasons for allowing a student to drop a semester.

(f) If a student has not obtained permission from the competent authority as defined above, he/she shall be awarded grades as per the actual performance in various courses by awarding zero in missed examinations. In case his/her attendance falls short of prescribed limit, failure grades shall be awarded.

(g) Normally, permission shall not be granted to a student to withdraw from the University for more than two semester under the Regulation 7.1 (b), (c), (d) and (e).

(h) The Vice-Chancellor may, on the recommendation of the Advisor and HOD, permit temporary discontinuance of studies for maximum period as detailed below on grounds prescribed under 7.1 (i).

Master's programme: 3 semesters

In exceptional circumstance where the Vice-Chancellor is convinced that the duration of withdrawal beyond the limits prescribed above, has become necessary for reasons beyond student's control, he may, on the recommendation of the Advisor and HOD permit a student to withdraw from the University for a longer period, within the provisions of University Regulations.

(i) Permission to discontinue studies may be accorded on the following grounds:-

- The student has to join service and extension in joining date is not possible.
- In case of in-service sponsored student the sponsoring institution wants to withdraw the student for a temporary period.
- Any other circumstances which in the opinion of the Vice-Chancellor, is fit reasons for allowing the student to discontinue his/her studies. Discontinuance of studies on the above grounds shall be permitted only if the application is made in advance, after obtaining upto date no dues from the Comptroller.

(j) (i) No student shall be permitted to withdraw from University for period laid down in clause 7.1 (h) above on any ground whatsoever.

- (ii) In case any student wants to withdraw from the University for more than two semesters, on medical grounds, he shall be advised to seek admission elsewhere or else withdraw from the University permanently and seek readmission when he/she feels completely fit to resume studies.
- (iii) The case of dropping/withdrawal of a semester in respect of such students as may have a OGPA of less than 6.500 in case of Master's upto the end preceding semester, shall be referred to the Petitions committee for disposal.
- (iv) The student permitted to withdraw for one or two semesters on medical grounds shall be required to submit a certificate of fitness from the University Medical Officer Incharge on rejoining.

7.2 Clearance Certificate

Any student who wants to leave the University during or after a semester must officially withdraw by obtaining 'Clearance Certificate' on the prescribed form from all sections and Heads of Deptt. and deposit in the office of the Registrar. A student not following this procedure shall be liable to pay the University fees and other charges until a 'Clearance Certificate' has been filled by him/her or by somebody else on his/her behalf.

7.3 Procedure for Withdrawal

- (a) A student may be entitled to withdraw from the University on completion of his studies in this University.
- (b) No student shall be deemed to have withdrawn from the University unless he has obtained a 'Clearance Certificate' i.e. No Dues certificate from the Comptroller.
- (c) Unless a student has obtained a 'Clearance Certificate' from the University, no refund of the amount due to him/her shall be allowed, nor shall the transcript and any other documents be issued to him/her.
- (d) The 'No Dues certificate', may be obtained by the student himself/herself immediately after completion of his/her degree or at the time of his/her being permitted to withdraw from the University. The 'No Dues Certificate' may also be obtained by making an application to the Comptroller in this behalf.
- (e) It shall be the responsibility of the Sectional Heads concerned, eg. the Warden, the Librarian, the Dean Student Welfare and the Heads of Department etc. to report to the Comptroller immediately, at the end of each semester final examinations, the dues if any outstanding against any student.
- (f) It shall be the duty of the Comptroller to prepare and maintain, an upto date statement of dues outstanding against student and also to furnish a copy of the statement to the Registrar within three weeks from the date of the commencement of the semester break each semester.
- (g) The Registrar shall consult the report furnished by the Comptroller and if no dues are show against a student in the list, shall cause to issue the transcript or any other documents which can be issued to a student after withdrawal from the University. Provided that no application for issue of document shall be held up beyond three weeks for want of a report.

8. Refund of Caution Money

The refund of caution money of a student shall be made only after he/she has obtained a 'Clearance Certificate' from all concerned and deposited it in the office of the Registrar. The refund of caution money shall be permissible upto a period of five years from the date the student leaves the University, where after it shall be credited to the University revenue.

9. Readmission of Students

Students who withdraw from the University or who have been dropped by the University may petition to the Vice-Chancellor for readmission. However, on readmission such students shall be treated as continuing students as far as time of admission is concerned, they shall not be treated as continuing students for the purpose of fees payable.

10. Concession to Students Joining Armed Forces in An Emergency

(a) A student who has withdrawn from the University to join the Armed Forces during a period of emergency or in normal times may petition to the Vice-Chancellor for readmission. Re-admission in such case may be granted by the Vice-Chancellor on the recommendations of the HOD.

(b) If the students have withdrawn from the University during the currency of a semester after completing instruction for not less than 14 weeks the grade in the courses for which he had registered in a semester; shall be deferred. On readmission he/she may be given a proficiency examination.

(c) The maximum duration for the degree in case of student as in (a) above may at the discretion of the Vice-Chancellor, be extended by the period for which he had been in the Armed Forces on temporary commission. This concession shall not be allowed to students having regular commission in the Armed Forces except in case of candidates who might have suffered injury in the battle field rendering him of 'low medical category' or otherwise disabled in any way.

(d) In such cases where concession has been allowed for joining Armed Forces, the graduation requirements may be adjusted in terms of the regulations on courses of studies for degree and diploma.

11. Academic Probation

If at the end of any semester of an academic year the OGPA in case of Master student falls below 6.500 he/she shall be placed on academic probation for the duration of the following semester.

11.1 Removal of Academic Probation

If at the end of the semester during which a student has been on academic probation, the OGPA of the student for that semester is 6.500 or above in case of Master, he/she shall cease to be on academic probation.

12. Dropping from the University

(a) If any student fails to remove the academic probation in accordance to the regulation 11.1, he/she shall be dropped from the University for poor academic performance, with the right to petition for the admission. The student shall, however, be finally dropped with no right to petition if he/she fails to attain a OGPA of 5.000 in case of Master at the end of an academic year. In case a student has been permitted to drop Ist or IInd semester of his Ist academic year or he/she has been admitted in second

Semester, his/her CGPA at the end of first two semesters of his stay in the university will be counted for this purpose.

(b) Any student failing in the same course thrice shall finally be dropped from the University. In exceptional circumstances, however, the Vice-Chancellor may permit a fourth chance on the recommendation of the Advisor and HOD.

13. Repetitions of Courses

(a) If a student secures a 'F' grade, he shall have to repeat the course whenever it is offered by the University.

(b) In case a student obtains 'F' grade in a course and repeat it, the grade secured by the student on repeating the course shall be reflected in the grade report but not on the final transcript.

(c) No student shall register again a course which he/she has already cleared with a passing grade. If he/she registers again a course already passed, subsequent grade shall be ignored.

14. Disposal of Petitions for Readmission

The petitions of dropped students for re-admission shall be examined by a petitions committee appointed by the Vice-Chancellor. The committee shall advise the Vice-Chancellor in respect of each petition whether it may be rejected or accepted, subject to such conditions as the committee may deem fit. In case student has to take make-up examination (s) his performance for the purpose of dropping shall be judged

on the basis of the results already available without waiting for the make-up examination. The decision of the Vice-Chancellor in such cases shall be final. The petitions committee constituted above shall also decide the complicated cases of make-up examinations not strictly covered in the regulations, referred to it by the HOD and make necessary recommendations. On the basis of the recommendations of the petitions committee necessary decision may be taken by the HOD.

15. Breach of Discipline and Punishment(s) there for

15.1 Acts of Indiscipline:

The following shall constitute acts of indiscipline.

(a) Keeping, carrying, using or supplying of any fire arms, lethal weapons, knife with a blade or more than four inches length in the room or outside.

(b) Keeping, using or supplying intoxicants in any form.

(c) Gambling in any form.

(d) Ragging, bullying or harassing of students.

(e) Demonstration in any form including procession and meeting

(f) Strike or hunger strike.

(g) Boycotting of a University function, programme or activity preventing any student from attending to classes, functions, programme or any other activity of the University.

(h) Abusing.

- (i) Recourse of violence, assault, intimidation, rioting.
- (j) Showing or causing to show any disrespect to a teacher or officer or any misbehaviour or intimidation or an employee of the University.
- (k) Incitement to commit any act of indiscipline.
- (l) Any breach of law of the country or the state or the Statute, Regulation, Rules of the University or orders of a competent authority.
- (m) Disturbing other students in their studies.
- (n) Damaging any University property.
- (o) Disorderly behaviour in any form.
- (p) Attending or organizing unauthorized meetings and participation in such meetings.
- (q) Displaying notices, leaflets or posters not signed or countersigned by the Warden or other University officers authorized by the Vice-Chancellor at the hostel and University notice boards or other places or distributing such notices or leaflets or disfiguring or defacing or writing slogans and undesirable things on the building, property etc.
- (r) Any act specifically forbidden by the Warden, Chief Warden, Dean Student Welfare or any officer of the University.
- (s) Any other act intended or calculated to cause inconvenience, annoyance, injury or damage to any other intimate of the hostile, employee of the University or resident of the campus, or guest's visitors to the University.

15.2 Punishment for Indiscipline

- i) Any inmate who violates any regulation or otherwise indulges in any act of indiscipline in clause 15.1 may be fined upto Rs.1000/- by the Warden/Incharge of the hostel/Instructor, if the Warden/Instructor is satisfied that the fine is adequate punishment for the act of indiscipline.
- ii) Cases of indiscipline, which in the opinion of the Warden/Instructor are so serious that a fine of Rs. 1000/-or less would not be sufficient punishment shall be referred by the Warden to the Chief Warden/HOD for taking disciplinary action against the inmates.
- iii) The Chief Warden/HOD on the recommendation of the Discipline Board of his department may award any of the following punishments:-
 - (a) Fine upto Rs. 5000/- This shall be noted on the inmate's permanent record card but shall not go out on the transcript.
 - (b) Placing the inmate on 'Conduct Probation' on the recommendations of department Discipline Board. This will consist of an official warning to the students that one more incident of indiscipline might lead to the dismissal of the student from the University. It shall be noted on the inmate's permanent record card and shall go out on the transcript of the student so long as the student is on such probation.

(c) *Reprimand of Record*: This shall consist of an official warning to the student not to repeat any act of indiscipline. This will be noted on student's permanent record card but not on any outgoing transcript.

(iv) Cases of more serious indiscipline in respect in respect of which the Chief Warden/HOD is satisfied that the forgoing punishment in clause 15.2 above, would not be adequate to meet the ends of justice and call for more severe punishment or cases involving students of more than one department/hostel, shall be referred to the Discipline committee by the Chief Warden or any other officer of the University coming across any acts of indiscipline to the Secretary of the Discipline Committee.

(v) The recommendations of the Discipline Committee shall be forwarded to the Vice-Chancellor as expeditiously as possible.

(vi) The Vice-Chancellor after considering the recommendations of the discipline Committee may award any one or more of the following punishments:

(a) *Monetary Fine*

(b) *Collective or Group Fine*: May be imposed on a group of students, as a whole, when the Vice-Chancellor, on the recommendation of the Discipline Committee, is of the opinion that it is not possible to fix the responsibility on individual member of the group, for any act of indiscipline.

(c) *Reprimand on Record*: This shall consist of an official warning to the student not to repeat any act of indiscipline. This will be noted on student's permanent record card but not on any outgoing transcript.

(d) *Conduct Probation*: This shall consist of an official warning that one more incident of indiscipline might lead to the dismissal of the student from the University. It shall be noted on the permanent record card and shall go out on the transcript so long as the student is on conduct probation.

(e) *Temporary Dismissal*: The student shall be dismissed from the University for a specific semester(s) and required to leave the University immediately. This will be entered on the permanent record card and shall go out in transcript of the student if the same is issued during the period of temporary dismissal. It shall, however, not be mentioned in the outgoing transcript, in case the transcript is issued after re-admission. However, he/she shall be debarred from admission to the University for any further programme.

(f) *Permanent Dismissal /Rustication from University*. The student shall be dismissed permanently from the University and shall be required to leave the University immediately. The punishment shall be entered in the permanent record card and transcript of the student and he shall be debarred from admission to the University for any further programme.

15.3 Suspended Dismissal:

(I) If a student has been awarded the punishment of temporary dismissal for one or more semester and he has only two semesters or less to complete his degree then the punishment of temporary dismissal

may be suspended on compassionate ground and he may be placed on 'Conduct Probation' by the Vice-Chancellor to enable him to complete his degree on his moving an application duly countersigned by his parent/guardian and filling in a bond of good behaviour with such conditions as may be imposed for the remaining period of his stay in the University .

(II) In the case of permanent dismissal, if a student has completed at least two semesters satisfactorily in this University prior to being awarded the punishment of permanent dismissal may be suspended on compassionate grounds and the student may be re-admitted on bond with such conditions as may be imposed of good behaviour under these regulations.

(III) Readmission through suspension of punishment shall invariably be subject to the following conditions:

i) The student concerned may be readmitted not as a matter of right but only on compassionate ground on the submission of an unconditional apology.

ii) The student concerned will remain on conduct probation during the remaining period of his stay in the University.

iii) The student concerned will fill a bond of good behaviour as prescribed duly countersigned by his parent/guardian which would remain operative for the entire period of his stay in the University.

iv) He will not apply for nor will be entitled to admission to any new degree programme in the University.

v) If the student concerned has been permanently dismissed, he may be considered to apply for relief under this regulation only after expiry of three semesters from the date of issue of orders of punishment but in no case will be entitled to re-admission before the expiry of less than four semesters from the effective date of punishment.

vi) No student shall be eligible for seeking relief under this regulation unless he has completed at least 2 semesters satisfactorily in this University prior to his being awarded the punishment of permanent dismissal.

vii) No student shall be eligible to seek or be granted relief under this regulation if he commits any act of indiscipline in the University campus or misbehaves with any officer or teacher of the University within the campus or outside during the period laid down in clause (v) above.

(IV) Before granting the *extraordinary concession of Suspension* of the permanent or temporary dismissal the Vice-Chancellor may follow any procedure that he considers appropriate in order to ascertain as to whether the student applying for the same is likely to abide by the rules and regulations of the University and is not likely to himself indulge or instigate others to indulge in violation of the Rules and Regulations. During the period of suspension of permanent/temporary dismissal, the daily attendance of the student concerned shall be taken by the Warden /Asstt. Warden of the hostel and it shall be obligatory for him to present himself before either of them when called upon to do so.

(V) The Vice-Chancellor may revoke the order of suspension of punishment on his/her own initiative or on the receipt of a report from the Chief-Warden/HOD/Dean Student Welfare /Registrar to the effect that the student concerned has violated conditions of the bond which will in addition to any other specific conditions which may be enforced at Vice-Chancellor's discretion, invariably require him not to:

- i) Absent himself from the hostel for two or more days consecutively without prior permission of the Warden /Chief Warden.
- ii) Boycott or absent himself from any examination without prior permission.
- iii) Fall below 75% in attendance in any of the course offered by him/her.
- iv) Fail to present himself/herself before his/her Advisor, Warden, Chief Warden despite having been asked to do so.
- v) Commit any of indiscipline as defined.
- vi) Fail to maintain a GPA of 6.500 in the case of Master's degree programme.

(VI) However, while the benefit of this regulation may be available to cases of indiscipline where the punishment of temporary or permanent dismissal has been awarded for the first time, it is hereby laid down that (i) the suspension of temporary dismissal may be given to student only once during his stay in the University, (ii) if the orders of suspension of punishment of permanent dismissal have been revoked by the Vice-Chancellor on his own or on receipt of a report from the Chief Warden/HOD/Dean Student Welfare /Registrar to the effect that the student concerned has violated the conditions of the bond or other conditions imposed upon him at the time of readmission , then such a student may apply for the review of revocation order only after the expiry of four semesters from the date of issue of revocation orders of suspended dismissal and may be readmitted on bond with such conditions as may be imposed of good behaviour under the regulations and this re-admission, through review of revocation order of permanent dismissal shall invariably be subject to the same conditions as imposed earlier. In case such a student violates any conditions of the bond or other conditions imposed by the Vice-Chancellor or involve in any act of indiscipline then the student shall be permanent with no right to appeal for readmission.

(VII) The regulations shall also not apply in case a student is awarded the punishment of temporary dismissal for copying or to any student who is awarded the punishment of temporary or permanent dismissal and who after having been debarred from entering the campus is reported to be seen entering the campus without specific permission of the Vice-Chancellor. If a student indulges in any act of indiscipline after completing the graduation requirement and or after obtaining the Provisional Degree Certificate, in such cases a F.I.R. will invariably be lodged with the police and his character certificate will be issued only after the final decision.

- ❖ The advisor of the student concerned, hostel warden concerned may also be invited by the department Discipline Board /Discipline Committee while enquiring into a disciplinary case.

- ❖ A punished student may file a request for review of the decision within one month from the date of issue of the orders after which no review application shall lie and only one review application can be field.

15.4 Procedure for the Removal of Conduct Probation

(A) The HOD may remove a student from the conduct probation on the recommendation of the Advisor, Warden and if necessary, of department discipline board in case he was not involved in acts of indiscipline more than once under the following conditions:-

- 1) If the student was placed on conduct probation by the HOD/Chief Warden on the recommendation of the Department Discipline Board.
- 2) If the student was placed on conduct probation by the Vice-Chancellor and has completed the graduation requirements.

(B) The Vice-Chancellor may remove a student from the conduct probation on the recommendation of the Discipline Committee under the following situations:

- 1) If the student was placed on conduct probation by the Vice-Chancellor on the recommendation of the Discipline Committee;
- 2) If the student was placed on conduct probation either by the HOD/Chief Warden or by the Vice-Chancellor and was involved in acts of indiscipline more than once.

(C) The procedure for removal of Conduct Probation for the students temporarily dismissed or permanently dismissed but readmitted under regulation 15.3 shall be as under:-

- 1) The Conduct Probation of students, temporarily dismissed once and for one semester may be removed by the Vice-Chancellor on the recommendations of the Discipline Committee.
- 2) The conduct probation of students permanently dismissed but readmitted under regulation 15.3 may be removed by the Academic Council on the recommendation of the Committee constituted by the Council.
- 3) The Conduct Probation of students, temporarily dismissed more than once for two semesters or more may be removed by the Academic Council on the recommendation of the Discipline Committee.

NOTE: The constitution of Academic Council's Sub-Committee for removal of Conduct Probation and issuance of documents with good conduct or otherwise in case of permanently dismissed students will be as per the following procedure:

"If a student who was awarded the punishment of permanent dismissal but was subsequently allowed relief under regulation 15.4, wishes that he shall be given a clean record of conduct, he may apply for the same after the completion of his degree. On receipt of such an application a committee would be constituted by the Academic Council on whose recommendation it would be decided as to whether or not the fact of permanent dismissal would be recorded on the outgoing transcript and if a satisfactory character certificate should

be issued to him. This committee would be constituted in a meeting of the Academic Council and shall consist of 7 members of the Academic Council to be selected randomly either with the help of a computer or through table of random members. This committee may follow such procedure as it may deem necessary and may also consider the reports of the Advisor, Warden and Head of the Department or of any other person whose views the committee may deem relevant."

- ❖ Students awarded the punishment of 'dismissal' may at the discretion of the Vice-Chancellor, be readmitted after the expiry of the period of punishment on the recommendation of the HOD and the Discipline Committee on such conditions as may be prescribed in this behalf. No student will, however, be entitled to readmission as a matter of right.

15.5 Temporary Dismissal

The fact of punishment of temporary dismissal or suspended dismissal during the period of temporary dismissal shall be recorded on the permanent record card and shall be mentioned in the outgoing transcript until the punishment has been revoked and the student is re-admitted. It shall, however, not be mentioned in the outgoing transcript after readmission of the student. However, if any prospective employer or institution etc. request for details about the student concerned, the punishment awarded to the student shall normally be intimated to them only after obtaining the orders of the Vice-Chancellor on the desirability or otherwise of giving such information to the party concerned.

15.6 Permanent Dismissal

The fact of punishment of permanent dismissal or suspended dismissal shall be recorded in the permanent record card and shall be mentioned in the outgoing transcript, unless the sub-committee to be constituted as per the procedure laid down under regulations 13 (c), recommended otherwise.

16. Issue of Character Certificate to various categories of students

(A) Character Certificate with good conduct as well as the prescribed two-points Character Certificate shall be issued to all students who are not punished at any time during the period of their studentship as well as to those who are awarded the punishment of

- (1) Reprimand of record/warning,
- (2) Monetary fine and
- (3) Conduct Probation,

provided the Conduct probation has been removed at the time of issuing the certificate.

(B) The two-point Character Certificate shall not be issued to the following categories of students:

- (i) All students awarded the punishment of permanent dismissal, rustication or temporary dismissal for any length of time, even after their re-admission.
- (ii) All students who were found guilty of using unfair means in any examination at any time during their stay in the University.

(iii) Character Certificate with satisfactory conduct may be issued to the students who are awarded the punishment of temporary dismissal only once during period of their stay in the University if the same is recommended by the Discipline Committee and approved by the Academic council.

(C) Character Certificate with satisfactory conduct to the students who have been awarded

(1) punishment of temporary dismissal more than once or

(2) punishment of permanent dismissal /rustication

may be issued if they are allowed readmission under regulation 15.4 only after the recommendation of the Committee constituted by the Academic Council as defined in the note for regulation under 15.4 (C) of the regulations on Admission, Enrolment and continuance of Students.

The Sub-Committee of the Academic Council may collect information from various sources like Advisors, HODs concerned, Wardens, Security Officer and the Discipline Committee before making their recommendations about the issue of Character Certificate to such students.

17. Refusal of Admission to students against whom cases in the Courts were pending

No student who is involved as an accused in a case involving a cognizable offence or who has been convicted of such an offence or of an offence involving moral turpitude shall be admitted to any degree programme in the University.

18. System of Education

Every enrolled student will be required to take a specified load of course work in the chosen subject of specialization (major, minor, supporting, and common courses) and also complete a research project and present this in the form of a dissertation.

19. Credit Requirements

The following Credit hours need to be followed while providing the syllabus for all the disciplines:

Courses	Masters' Programme
i. Course work	40
Major courses	20
Minor courses	08
Supporting courses	06
Common courses	05
Seminar	01
ii. Thesis/Research	30
Total	70

Major courses: From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken may be given (*mark)

Minor courses: From the subjects closely related to a student's major subject

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or

necessary for building his/her overall competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme.

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

Some of these courses are already in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the Dean/HoD/ BoS.

Supporting Courses

The following courses are being offered by various disciplines (The list is only indicative). Based on the requirement, any of the following courses may be opted under the supporting courses. The syllabi of these courses are available in the respective disciplines. If required, the contents may be modified to suit the individual discipline with approval of the BoS.

Course Title	Credits
Mathematics for applied sciences	2+0
Statistical methods for applied sciences	3+1
Experimental designs	2+1
Basic sampling techniques	2+1
Applied regression analysis	2+1
Data analysis using statistical packages	2+1
Computers fundamentals and programming	2+1
Computer organization and architecture	2+0
Introduction to communication Technologies, computer networking and Internet	1+1
Information technology in agriculture	1+1
Basic biochemistry	3+1
Techniques in biochemistry	2+2

5.1 Maximum permissible course work load per semester

Master's Programme: 18 credits

5.2 Mandatory requirement of seminars

To have mandatory seminars one in Master's (One Credit)

The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills.

20. Residential requirements

The minimum and maximum duration of residential requirement for Master's Degree programme shall be as follows:

Degree Programme	Duration of Residential Requirement	
	Minimum	Maximum
Masters' Degree	2 Academic Years	5 Academic Years

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/her admission shall stand cancelled. The requirement shall be treated as satisfactory in the cases in which a student submits his/her thesis any time during the 4th semester of his/her resident ship at the University for Masters' programme.

21. Advisory System

21.1. Advisory Committee: There shall be an Advisory Committee for every student consisting of not fewer than three members in the case of a candidate for Masters' degree with the Advisor as Chairperson. The Advisory Committee should have representatives from the major and minor fields amongst the members of the post-graduate faculty accredited for appropriate P.G. level research. However, in those departments where qualified staff exists but due to unavoidable reasons post-graduate degree programs do not exist, the staff having post-graduate teaching experience of two years or more may be included in the Advisory Committee as member representing the minor.

At any given time, a P.G. teacher shall not be a Chairperson, Advisory Committee (including Master's programme) for more than five students.

The chair person should convene a meeting of the Advisory Committee at least once in a Semester. The summary record should be communicated to the Head of Department, Dean and Registrar for information.

Approval of the advisory committee has to be obtained by submitting it in prescribed form (PG1) by HOD to Dean within three months from start of the first semester for both M.Sc. programme.

A semester wise minimum credit requirement for M.Sc. programme of a student has to be submitted by chairperson of advisory committee through HOD for approval by Dean in prescribed form (PG2).

21.2. Constitution of the advisory committee

Minimum 3 members (2 from major subject including chairman, and one from minor subject) to be constituted within three months of the 1st semester.

21.3. Advisor/Co-guide/Member, Advisory Committee from other collaborating University/ Institute/ Organization:

In order to promote quality post-graduate research and training in cutting edge areas, the University may enter Memorandum of Understanding (MOU) with other Universities/Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/scientist of such partnering university/ Institute/ Organization, he/she may send a proposal to this effect to Director (Education)/Dean PGS along with the proposal for consideration of Student's Advisory Committee (SAC).

The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/Member, SAC, by mutual consent, primarily based on intellectual input and time devoted for carrying out the research work at the particular institution. The faculty member/scientist of partnering institutions in the SAC shall become a temporary faculty member of the University by following the procedure approved by the Academic Council.

21.5. Changes in the Advisory Committee: Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be affected with due approval of the HOD.

Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the post-graduate students of the University. However, HOD may permit them to continue to serve as advisor subject to the following conditions:

- a) The staff member, after leaving the University service is granted the status of honorary faculty's membership by the Vice-Chancellor on the recommendation of the HOD for guiding as Chairperson or Member, Advisory Committee the thesis/theses of the student(s) concerned only.
- b) In case the Chairperson/member of a Student's Advisory Committee retires, he/she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/member stays at the Headquarters of the Faculty, till the thesis is submitted.
- c) If the Chairperson/member proceeds on deputation to another organization, he/she may be permitted to guide the student provided his/her new organization is at the Headquarters of the Faculty and his/her organization is willing for the same.
- d) The change shall be communicated to all concerned by the Head of Department.

Approval of Synopsis:

The synopsis has to be accomplished in the second semester for master's programme.

22. Conduct of Research Work:

22.1. Post graduate students should necessarily complete the post graduate programme in the department where they joined. However, they can conduct the research work elsewhere (other locations recognized by the university for this purpose) with the prior permission of the University.

22.2. As soon as the thesis work is completed and data etc. have been processed, student will deliver a thesis seminar. If teachers or other students suggest any improvement in the presentation and interpretation of results, the same may be incorporated with the approval of the major advisor.

22.3. A student shall submit his/her thesis for Degree after he/she has completed his/her course work requirement, the required number of research credits. The thesis shall be type written and temporarily bound as specified and submitted in quadruplicate along with a “no dues certificate” and a certificate in the prescribed proforma by the advisor.

22.4. Six copies of thesis abstracts of about 150-200 words shall be submitted (two copies for the department, one for the dean’s office and three for university) along with bound copy certificate. PG students should submit two CDs of thesis (one each to library and one to Head of Department) along with bound copies of thesis.

22.5. After approval by the advisory committee, the thesis submitted by the student shall be sent to an external examiner for evaluation who shall be required to send a detailed report on the thesis preferably within three weeks to the HOD. In case, the external examiner recommends acceptance of the thesis, the report will be forwarded to the chairperson of the student’s advisory committee who shall arrange for the conduct of final oral examination. The head of department shall also be a co-opted member of the final thesis oral examination committee, even if he is not a member of the student’s advisory committee for the purpose of conducting the thesis final oral examination. The advisory committee while conducting this examination, shall take into account, the remarks of the external examiner and may suggest changes if any to be made in the thesis. A certificate regarding performance of the candidate in the final viva-voce examination on the thesis in the form prescribed, duly signed by all the members of the committee, shall be forwarded to Dean by the chairperson of the student’s advisory committee through the head of the department. After the certificate is sent, the thesis shall be bound as specified after effecting changes if any by the advisory committee and it shall be submitted by the student in quadruplicate to the chairperson of the student’s advisory committee. Unless final thesis copies are bound by the student concerned and handed over to the chairperson of the student’s advisory committee, his/her final result shall not be declared.

22.5. If a student is not successful in the final oral examination, he/she shall be examined again after a period of three months.

22.6. In case if the external examiner suggests major modification to be made before acceptance, the same shall be communicated to the chairperson of the student’s advisory committee who shall arrange for the revision of the thesis and resubmission, after a period of three months. It shall be considered in

the same manner as in the original submission and the thesis shall be forwarded to the same examiner for re-evaluation. However, if for any reason, the examiner concerned is not available to re-evaluate the thesis either due to relocation or for other reasons, in such a rare instance, the HOD will forward the thesis to an alternate examiner for re-evaluation. In such instances, the modified version of thesis along with the comments made by the first examiner shall be forwarded by the HOD to the alternate examiner for re- evaluating the thesis.

22.7. If the student who has been directed to resubmit the thesis after carrying out the corrections indicated by the external examiner, has to submit within six months from the date of issue of orders by the university. The student should appear for the final thesis viva-voce examination and submit a certificate of having submitted bound copies of thesis within a maximum period of six months from the date of issue of orders by the university.

Note: If the external examiner recommends resubmission of thesis after 3 months, the candidates should resubmit thesis within six months thereafter i.e., Between 3 and 9 months from the date of issue of orders by the university.

22.8. Student may be permitted to carry on their research work at institutions/ Research stations under this university other than those imparting institutions or at other institutions and under persons recognized for the purpose.

23. Evaluation of course work

For M.Sc., multiple levels of evaluation (First Test, Midterm and Final semester) will be done. No comprehensive examination for M.Sc. programme.

Course- evaluation

Theory- Internal

Practical- Internal, to be conducted by the course teacher+one more external examiner to be nominated by the HOD/VC.

The evaluation of the student in a course shall be based on his/ her performance in various kinds of examinations, records, class work and other types of exercises.

Each course may be evaluated @ 50 marks for each credit (theory/ practical) which may finally be converted to 100 for awarding grade. The marks to be allotted between the theory and practical work shall be in the proportion of their respective credit hours. For e.g. a course having 2 theory and 1 practical credit, the weightage for theory and practical examinations may be as follows:

Theory		Practical	
Exam	Marks	Exam	Marks
Assignment/ term papers/ seminar etc. (Internal)	30	Record and class work (Internal)	25
Mid-term examination (Two) (Internal)	20	Final examination (External)	25
Semester final examination of 2 to 3 hrs. duration (External)	50	-	-

Total	100	Total	50
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The distribution of weightage against various components of the internal and external components is as follows:

Course Type	Component	Weightage	External theory
For courses having both theory and practical components	Mid-term	20%	50%
	Practical	30%	
For courses with theory only	Mid-term	30%	50%
	Assignment	20%	
Courses with practical only	Practical (External)	50%	-
	Practical (Internal)	30%	
	Assignment	20%	

The schedule for mid-term examination and semester final examination shall be indicated in the Academic calendar of each semester test/ examinations to be conducted on the dates as prescribed therein. The examination schedules shall confirm to the following programme, namely:

Mid-term examinations after about 50 days from the commencement of the semester.

Semester Final examination at the end of the semester.

23.1. It shall be the responsibility of the Head of the Department to ensure proper conduct of examinations in all the courses offered in the department.

23.2. The Head of Departments shall constantly exercise supervision and control to see that the syllabus listed under each course is adequately covered and assessment of student is done strictly in accordance with the regulations.

23.3. All answer scripts shall be shown to the students by the teachers as soon as evaluation is completed.

23.4. Students registered for a particular course shall take all the examinations conducted during the period of the course, viz. hourly and final semester examination both in theory and practical. If a student is genuinely prevented from taking examination as in the case of serious illness or accident or any other case, a special re-examination may be arranged by the teacher concerned in consultation with Head of the Department. This repeat examination shall be held within two weeks from the date of examination for all the students who have missed that hourly examination.

23.5. In the case of students deputed to represent the university in inter- collegiate or inter – university meets in N.C.C /N.S.S due consideration shall be given in regards to missed tests/ examination so that the students may not suffer while on absence on university directive .In all such cases, make –up examination/test (except semester final examination) given for the missed examination/tests (except semester final examination) within two weeks of the return of the students. The name of the student deputed for such meets may be intimated in advance to the teacher concerned through the Head of the Department.

23.6. Make up Examinations

(a) Pre-final Examinations: Out of Pre-Exams. student will be allowed make-up for any one of the Exams. missed by him by the instructor himself. Under no circumstance a make-up for more than one examination would be permissible irrespective of the reasons. The make-up examination in lieu of the missed pre-final examination shall be administered in the 15th week of the Semester. No make-up of these examinations shall under any circumstances be permissible

(b) Final Practical/Viva-Voce Examinations: Make-up of the final lab practical /Viva-Voce examinations missed by a student shall be completed before the announcement of the Semester final examinations. This make-up will be allowed by the HOD as per regulation for Semester final make-up. No make-up of the final lab/Viva-Voce examinations will be admissible after the commencement of the Semester final Examinations

(c) Final Examinations: Normally no make-up shall be permissible in lieu of the missed final examination(s). However, under special circumstances, make-up examination may be permitted at the discretion of the HOD subject to such directions as may be issued by the Vice-Chancellor from time to time on any one or more grounds such as:

- 1 Hospitalization of the student for a period of 72 hours in Govt. Hospital or as per reference of the Medical officer Incharge of the University. No exemption may be allowed for the diseases for which no clinical examination is possible. In other words, headache, abdomen pain, giddiness etc. shall not be regarded as sufficient justification for make-up examination
- 2 Death of parent(s)
- 3 Attending interview (for final year students, i.e. if his degree is to be completed within next semester only).
- 4 Attendance in court case(s)
- 5 Participation in national level competitions, Debates, Sports & Games etc. organized by various central agencies.

(d) Supplementary Examination: A student failed in a particular course (having back log), can appear this examination in a particular semester, if the concerned course is offered in that semester.

23.6.1. Procedure for obtaining the make-up examination

- 1 If a student failed to appear at any semester final examination for reasons beyond his control, he must file an application on the very day on which the examination is missed.
- 2 The application for make-up examination must be supported with medical certificate and medical examination report and should be routed through the hostel Warden/Advisor /HOD.
- 3 No application for make-up examination shall be considered if received after 72 hours from the expiry of the last date of the semester final examination.
- 4 The application for exemption should be submitted on the date of commencement of sickness itself. The student should be examined by the Advisor/Warden and Chief Warden, besides the Medical Officer.

- 5 Exemption should be granted only if the Chief Warden certifies that he has himself seen the student and found him in a state of sickness to justify the exemption and that the student has been admitted to the hospital.
- 6 The make-up examinations would be held immediately after regular examination as per schedule, notified by the HOD.

23.7. Examination on Demand (EOD): EOD will be conducted for the benefit of students who have backlogs from previous semesters on a pre-announced schedule.

23.8. Minimum & Maximum Time Limit to Complete the Course/Thesis: If a student fails to complete the degree requirements within the maximum time limit prescribed, his /her admission shall stand cancelled. A student may submit thesis after securing 75% attendance in the final semester of study provided that research credits only are registered during that semester and that all the courses prescribed for the award of degree are successfully completed by previous semester.

23.9. Temporary discontinuous and Resumption of studies: If a student to discontinue studies temporarily or take long leave he/she may do so after completion of one semester of study from the date of admission with the approval of the HOD or if this is not possible, the student should seek the approval from the HOD within 30 calendar days from the date of discontinuation (discontinuation before completion of two semesters of study shall result in cancellation of admission).

23.10. If the students fail to seek approval of the HOD within 30 days of discontinued due to genuine reasons like serious illness/domestic problems, such student may be accorded permission by the HOD on payment of late fee of Rs.1000/-per month or part there of up to 5 months. The student who is permitted to temporarily discontinue studies should necessarily complete the entire requirement within the time limit prescribed.

23.11. The student with such approval may be permitted to resume studies within 4 semesters by HOD under intimation to the university. If a student temporarily discontinues in the middle of a semester, he/she is deemed to have discontinued from the beginning of that semester. The discontinuation is allowed only once in a P.G programme. The maximum period of discontinuation allowed is two years (four semesters). The maximum time limit prescribed for the completion of graduation requirements, however, shall remain unchanged.

23.12. Students, who discontinue without the permission of the HOD, shall not be permitted to resume studies. The HOD shall not send proposals for readmission/ resumption of studies, if the student discontinues studies without permission.

23.13. Unfair means in Examination: A student found using unfair means in the examinations shall be penalized as per the norms of the University.

24. Grading System

Master's Programme

- a. Scale:10 point

- b. Minimum passing grade in a course: 6.00
- c. Minimum OGPA to continue and to obtain degree: 6.50

24.1 Grades

The grade in Proficiency Examination shall be

- (i) Satisfactory (S) or
- (ii) Unsatisfactory (US)

No student shall be given a grade as 'Satisfactory' unless he has made at least 6.000 in the examination. Proficiency examination shall be given under the following restrictions and no official record shall be made of failure in the examinations.

- I. They may not be taken only by persons who are in residence.
- II. They may not be taken by students who have received credit for one Semester or more in the subject in advance of the course in which the examination is requested.

Time between Synopsis and Thesis submission

Master's Programme: One semester

24.2 Scrutiny

- 1
 - a) If any student desires scrutiny in any course, he shall be permitted to do so with scrutiny fee of Rs. 100.00 per paper
 - b) He shall have to file an application on the prescribed form which can be obtained from the office of the Registrar
 - c) After having the approval of the Registrar, he will present the form to the Instructor concerned
- 2 Scrutiny means checking of marks, examination of question(s) left unmarked and reassessment of the question(s) already marked.
- 3 Answer-books of the semester final examinations shall be shown by the Instructor concerned to the students on the day following registration in the following semester.
- 4 Application for scrutiny of results shall be entertained upto seven days after showing the semester final examination answer book to students, after which no such application shall be entertained that is normally after eight days of the start of the semester.
- 5 The result of scrutiny shall be intimated to the Registrar as soon as possible, but in no case later than two weeks from the date of registration.

24.3 Change of Grades as a Result of Scrutiny

After the grade has revised as a result of scrutiny the Instructor will send the grade, with reasons under which grade has been revised, to the HOD, who will examine and forward the same to the office of the Registrar. All such grade revised as a result of scrutiny will be forwarded to the Vice- chancellor after the last date of scrutiny. Necessary correction in the students' report card would be made after the approval of the Vice-Chancellor is received.

25. Thesis Submission

Time of Thesis Submission: After thesis seminar

Evaluation: External (one)

Viva Voce: By Advisory committee

Assessment: Satisfactory / Unsatisfactory

* In case of affiliated colleges;

- (i) Students will submit rough bound thesis in HOD office of Department of Bioinformatics and computational biology, M.J.P.R.U. Bareilly for external evaluation.
- (ii) The viva-voce will be conducted at Department of Bioinformatics and computational biology, M.J.P.R.U. Bareilly.
- (iii) Students will submit one copy of final thesis in Department of Bioinformatics and computational biology, M.J.P.R.U. Bareilly.

26. Evaluation of research work

26.1. Prevention of plagiarism: An institutional mechanism should be in place to check the plagiarism. The students must be made aware that manipulation of the data/plagiarism is punishable with serious consequences. **The maximum permissible limit for plagiarism is 20%.**

26.2. Learning through online courses: In line with the suggestion in new education policy and the initiatives taken by ICAR and MHRD in the form of e-courses, MOOCs, SWAYAM etc. and also changes taking place globally in respect of learning through online resources it has been agreed to permit the students to enrol for online courses. It is expected that the provision of integrating available online courses with the traditional system of education would provide the students opportunities to improve their employability by imbibing the additional skills and competitive edge.

The following points are to be followed while integrating the online courses:

- i. Board of Studies (BoS) shall identify available online courses and a student may select from the listed courses. The interested students may provide the details of the on-line courses to the BoS for its consideration.
- ii. A Postgraduate student may take up to a maximum of 20% credits in a semester through online learning resources.
- iii. The host institute offering the course does the evaluation and provide marks/grades. The BoS shall develop the conversion formula for calculation of GPA and it may do appropriate checks on delivery methods and do additional evaluations, if needed.

27. Internship during Masters programme

Internship for Development of Entrepreneurship in Agriculture (IDEA)

To provide the students an opportunity to have a real-time hands-on experience in the industry as per ICAR guidelines (BSMA 2021), an optional internship/ in- plant training to enable the development of highly learned and skilled manpower to start their- own enterprises IDEA shall be implemented.

The main objectives of the programme:

- i. To promote the linkages between academia and industry
 - ii. To establish newer University - Cooperative R&D together with industry for knowledge creation, research and commercialization
 - iii. Collaboration between Universities and industries through pilot projects
 - iv. To develop methods for knowledge transfer, innovation and networking potential
 - v. To enhance skill, career development and employability
- Following criteria for IDEA will be taken into consideration:

At any point of time there will not be more than 50% of students who can opt under IDEA Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry.

Total credits (30) will be divided into 20 for internship/ in-plant training and 10 for writing the report followed by viva-voce similar to dissertation.

Work place will be industry; however, academic/research support would be provided by the University or both. MoU may be developed accordingly.

The IPR, if any, would be as per the University policy.

28. Calculation of marks

% of marks = OGPA x 100/10

The per cent of marks in a subject will be divided by 10 to obtain the grade point.

The grade point average for a semester will be calculated as follows.

$$\text{GPA} = \frac{\sum(\text{Grade Point} \times \text{credit Hours}) \text{ in one semester}}{\text{Total Credit Hours in the Semester}}$$

The Overall grade point earned at any stage of the course will be calculated as overall grade point average (OGPA) as follows.

$$\text{OGPA} = \frac{\sum(\text{Grade Point} \times \text{credit Hours}) \text{ until last semester}}{\text{Total Credit Hours Until Last Semester}}$$

If a student passes in a subject in a second attempt, for calculation of OGPA, the grade point for the subject in the second attempt will only be considered. The final OGPA will be named as overall grade point average (OGPA), which will be mentioned in the final transcript of the students.

29. Award of Degree

A degree under the seal of the university and duly signed by the officers authorized in this behalf shall be presented at convocation, to each candidate who has successfully completed the graduation requirements for the award of the degree. Diplomas of the candidates who have successfully completed graduation requirements for the award of the degree and are admitted in absentia to a degree, at convocation, shall be sent. The diploma shall set forth the name of the candidate, father's name, mother's name, degree, month, and year of the successful completion of the graduation requirements etc.

30. Guide lines to prevent unethical practices in publication of articles etc.

In order prevent changing the order of priority in the authorship of research publications, the following guidelines are framed as in case of other institutes for strict adherence by all the concerned, while preparing the research articles, etc. for publication or their subsequent use.

30.1. For all research papers prepared on the basis of student research, the authorship should be in the order of student, chairperson, co-chairperson and members of advisory committee who have put in considerable efforts in the research work.

30.2. The first author should certify that due weightage was given to all those who contributed for the research work and also clearly indicate the source of material for the research article / publication i.e. student research /scheme work etc. and the period of conduct of such research work. If any part/ whole of the article/ paper/ manual of others is used by the students / staff, acknowledgement should invariably be made with regard to its original author to give a kind of gratification to him/her.

30.3. The research papers (along with one extra copy) should be routed through the head of the department where the work was carried out. The heads of department shall maintain a record of all extra copies so received. The heads of departments shall forward the articles to the dean, after recording the following details in a register of publications which shall be shown to the superior officers during their visit.

- i. Date of dispatch;
- ii. Title of the article/ bulletin;
- iii. Name of authors;
- iv. Source of material for publication.

All the concerned teachers/ students are requested to strictly adhere to the above instructions.

31. Schedule of submissions

31.1. Proposal for formation of advisory committee has to be submitted within 6 weeks from the commencement of the first semester. Subsequent changes to be sent in triplicate whenever required in proper format.

31.2. Proposal for programme of work has to be submitted in proper format at the end of first semester. Proposal for subsequent permanent changes in programme of work has to be sent in triplicate to HOD.

31.3. Synopsis of research work to be carried has to be sent to HOD at the end of first semester. For any subsequent change in title/ programme of work has to be submitted in proper format to HOD in triplicate.

31.4. During III/IV semester, the chairman of the advisory committee shall submit in proper format to the Head of department for action to conduct qualifying examination. After conduct of qualifying examination (written and oral) the result should be sent to the HOD in proper format. One copy to be retained in the department.

31.5. Within a month from the commencement of the semester, GPA reports pertaining to the previous

semester must be obtained and kept in student's file.

31.6. Before end of each semester, proposal for evaluation of Research credits in proper format should be submitted to HOD through chairman.

31.7. Proposal for submission of thesis along with one copy of thesis (one extra copy of thesis shall be preserved in the department), 4 Colour photographs (write name and Reg no. on back side), Course completion certificate, G.P.A. Reports, copy of degree certificate of qualifying examination and Convocation application form stating that degree will be received in person/absentia are to be sent to HOD.

31.8. After conduct of final via –voce examination, the result has to be communicated in proper format to HOD along with three copies of thesis and abstracts of thesis and CD with bound copy certificate. One bound copy to be presented in the department.

32. Compliance with the National Education Policy-2020

While implementing the course structure and contents recommended by the BSMA Committees, the Higher Education Institutions (HEIs) has to be complied with the provisions of National Education Policy-2020.

33. Definitions of academic terms

Chairperson means a teacher of the major discipline proposed by the Head of Department duly approved by the Director of Education/Dean Post Graduate Studies (or as per the procedure laid down in the concerned University regulations) to act as the Chairperson of the Advisory Committee and also to guide the student on academic issues.

Course means a unit of instruction in a discipline carrying a specific number and credits to be covered in a semester as laid down in detail in the syllabus of a degree programme.

Credit means the unit of work load per week for a particular course in theory and/or practical. One credit of theory means one class of one clock hour duration and one credit practical means one class of minimum two clock hours of laboratory work per week.

Credit load of a student refers to the total number of credits of all the courses he/she registers during a particular semester.

Grade point (GP) of a course is a measure of performance. It is obtained by dividing the per cent mark secured by a student in a particular course by 10, expressed and rounded off to second decimal place.

Credit point (CP) refers to the Grade point multiplied by the number of credits of the course, expressed and rounded off to second decimal place.

Grade point average (GPA) means the total credit point earned by a student divided by total number of credits of all the courses registered in a semester, expressed and rounded off to second decimal place.

Overall Grade Point Average (OGPA) means the total credit points earned by a student in the entire degree programme divided by the total number of credits required for the P.G. degree, expressed and

rounded off to second decimal place.

The final grading of student shall be done on a 10-point scale. The Grade point shall be obtained by dividing the total percentage of marks earned in a course by 10. The grade point shall be expressed in this scale up to one decimal place.



GUIDELINES REGARDING THESIS WRITING

Definition of Thesis: A thesis is a statement of research, presenting the author's findings and any conclusions drawn, submitted by the author in support of his/her candidature for a higher degree.

Importance of Thesis: Presentation of entire research related work carried out for the post graduate degree in a systematic manner is now need of time.

The students must adhere to the following guidelines while preparation of thesis:

1. Paper and Typing: Each thesis should be typed on white bond paper measuring 22 cm x 28 cm (A4 size). Margin of at least 3.5 cm on binding side, 2.0 cm on free side, 3.0 cm on the top and 2.5 cm on the bottom should be kept. Font New Times Roman and font size of 12 should be used. Typing should be done in one and half space on both sides of the sheet and justified alignment. The entire thesis should be typed on the same computer (letter quality or laser printer) and photostat copies in required number can be prepared. Errors in typing should be avoided. Spell checker should be used for corrections prior to final printing. Simple error in typing may be corrected using black ink. Cutting is not permitted. In case of more serious errors or errors exceeding 4, the sheet will have to be retyped. Not more than 10 corrections in the whole thesis would be permitted. No word should remain incomplete and be carried over to the next page.

2. Illustrations and Photographs: The illustrations and photographs should be included in the thesis text at the appropriate places.

3. Structure of the Thesis

3.1 Title Page: The title page should have following details.

(a) The title of the thesis near the top and centered.

(b) The following should be typed below the title:

Thesis Submitted to the



DEPARTMENT OF -----

FACULTY OF AGRICULTURE SCIENCES AND TECHNOLOGY

MAHATMA JYOTIBA PHULE ROHILKHAND UNIVERSITY

BAREILLY – 243 006 (U.P.), India

(c) Still below, the following should be given:-

BY

Name of the student

Enrollment No.

(d) Below this, the following should be typed

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
..... (mention approved degree title)

(e) At the bottom, the month and year of submission of the thesis should be given.

All the above should be properly centered and spaced (see specimen - 1)

3.2 Certificates: Each thesis will have two certificates, one from advisor and another one from advisory committee. (see specimens – 2 and 3)

3.3 Acknowledgement: A short acknowledgement, signed with date and place by the student, should be next to the title sheet. Efforts and contribution of all concerned may be acknowledged. However, it should not be too lengthy and should avoid unnecessary thanks giving. Financial assistance received by the student from any financing institute/agency should be duly acknowledged.

3.4 Table of Contents: The table of contents should give the chapter headings and also the sub-titles, if any, with appropriate page references, and should be placed next to the certificate sheets. This should be followed as applicable by:

- (a) List of Tables
- (b) List of Figures
- (c) List of Plates
- (d) List of Nomenclatures/Symbols
- (e) Chapter contents

Format for (a), (b), and (c) is

Table/ Figure/ Plate No.	Title	Page No.
--------------------------	-------	----------

Format for (d)

Abbreviation	Full name
--------------	-----------

Format for (e)

Sl.No	Chapter	Page No.
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3.5 The thesis should generally consist of the following chapters:

1. Introduction
 2. Review of Literature
 3. Materials and Methods
 4. Results
 5. Discussion
 6. Summary and Conclusions
- References/ Literature Cited
- Appendices
- Abstract (English)
- Abstract (Hindi)
- Vitae (a statement giving the bio-data of the student)

Each of the above main chapters can have sub-titles. However, all chapter-headings and sub-headings should be listed, wherever necessary, in the table of contents and appropriate page references be given. This should be followed by the list of illustrations and tables along with page number in pencil. However, permanent page number will be given in finally bound copies.

3.6 Format for the Chapter style:

Chapter title – All Capitals

Heading of the Section – Title case

Heading of the subsection – Sentence case

Example of the above is as follows

Chapter 3. MATERIALS AND METHODS

3.1 Experimental Materials

3.2 Experiment Details

3.2.1 Experiment design

Numbering may be restricted to 4 places (e.g. 3.2.1.1) as far as possible.

4. References/ Literature Cited: Standard style of quoting references should be used in the text and under the heading “References/ Literature Cited”. The references should be arranged strictly alphabetically. The items of information of different types of publications should be given as follows:

A. Journal Article: Name(s) of author(s). Year of publication of the article. Title of the article. Name of the journal, volume (in bold) No. (issue No.): page(s). The name of the journal should be abbreviated according to International Standards Organization rules.

B. Simple Book: Name(s) of author(s). Year of publication. Title of the book. Volume No. (in case of multivolume book), Edition No. (if it is later than I edition). Place of Publication, Publisher’s name. Pagination (when a particular page of the book is cited then; ‘p’ should be mentioned before page number cited; ‘p’ following the page number means total number of pages contained in the document).

C. Contribution to Composite Book/ Edited book: Name(s) of chapter author(s). Year of publication. Title of contribution. Connecting word ‘In’: and the following items of the host document: Names(s) of authors. Title of book. Volume No. (in case of multivolume book), Edition No. (if it is later than I edition). Place of publication, publisher’s name. Pagination (‘pp’ should be used before writing plural pages).

D. Conference / Workshop / Symposium / Seminar Proceedings: Name (s) of author(s). Year of Conference etc., Place, Date of Conference. Year of publication. Title of the publication. Name(s) of editor(s). Place of publication, publisher’s name. Pagination (as indicated in B).

E. Contribution to Conference/ Workshop/ Symposium/ Seminar Proceeding: Name(s) of author(s). Year of publication. Title of contribution. Connecting word ‘In’: and the following items of information of the host document: Name of the Conference, Place, Date of the Conference etc., Title of

the publication. Name(s) of editor(s). Place of publication, publisher's name. Pagination (as indicated in C).

F. Thesis: Name of author. Year of submission. Title of the thesis. The word Thesis, Name of the degree. Name of the University, Place, Pagination (as indicated in B).

G. Institution/Society Publications: Name of the institute/society, Place. Year of publication. Title of the publication. Place of publication, publisher's name, pagination (as indicated in B).

H. Government Publications: Name of Territory. Name of the Ministry, etc. Name of the Department, Section, etc. Year of publication. Title of publication. Place of publication, publisher's name, Pagination. **I. Genbank Accession:** Name(s) of author(s). Year. Title of accession. Accession No.

J. Website reference: Name of the website. Title. Date of visit to the website. (see specimen – 4)

When quoting reference in the text of the thesis, the last names of the authors (up to two authors and if more than two authors are there, then last name of the first author et al. (in italic) should be given followed by the year of publication within parentheses. If reference made to more than one publication by the author(s), in the same year, the publication should be numbered as (a) and (b) of that the earliest publication of that year being designated (a) and so on.

5. Abstract & Summary: Every student, in addition to the thesis, must also submit an mini abstract in English (2 hard copies and one soft copy in PDF format) as well as in Hindi (2 hard copies and one soft copy in PDF format) of about 300 words on white bond paper measuring 22 cm x 28 cm (A4 size) as per directions for typing the thesis. Summary (four hard copies) of about 3000 words must also be submitted separately on white bond paper as per directions for typing the thesis.

6. Final Submission of Thesis: Master's thesis will be bound in dark blue hard cover. Other documents to be submitted with the final thesis are as follows:

Three hard bound copies of the complete thesis. One soft copy on CD (PDF format) mentioning the name and Enrolment number of the student along with degree programme and major discipline with the help of marker pen.

**COMPUTATIONAL ANALYSIS OF MICROARRAY STUDIES
IN FUNGAL SPECIES**

*THESIS
SUBMITTED TO THE*



**DEPARTMENT OF BIOINFORMATICS &
COMPUTATIONAL BIOLOGY**

**FACULTY OF LIFE SCIENCE
MAHATMA JYOTIBA PHULE ROHILKHAND UNIVERSITY
BAREILLY – 243 006 (U.P.), India**

BY

RAJESH KUMAR

Enrollment No. 542112369

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

BIOINFORMATICS

JULY, 2027



Certificate-I

This is to certify that the thesis entitled “-----” submitted in partial fulfillment of the requirements for award of the degree of **Master of Science in Bioinformatics, Faculty of Life Science, Mahatma Jyotiba Phule Rohilkhand University, Bareilly** is a genuine record of bonafide research work carried out by **Mr./Ms. -----**, **Enrollment No. -----** under my guidance and supervision. The results of the investigation in this thesis have not so far been submitted for any other degree or diploma.

It is further certified that the help or information received during the course of investigation and preparation of the thesis have been duly acknowledged.

Date:

Name & Designation
(Chairman)
Advisory Committee



Certificate – II

We, the undersigned members of the Advisory Committee of **Mr./Ms. -----**, **Enrollment No.-----**
-----a candidate for the degree of **Master of Science in Bioinformatics**, have gone through the thesis manuscript and agreed that the thesis entitled “-----” may be submitted in the partial fulfillment of the requirements for award of the degree.



Signature
Name & Designation
Chairman
(Advisory Committee)

Signature & Name
(External Examiner)

Endorsed by:

Signature
Name & Designation
(Co Advisor)

Signature
Name & Designation
(Co Advisor)

Signature
Name & Designation
(Co Advisor)

Signature
Name & Designation
(Co Advisor)

Signature and Seal
(Head of Department)

REGULATIONS ON ISSUING OF DOCUMENTS TO THE STUDENTS

All the students who are admitted to the University shall be required to submit copies of the following documents:

- a. Attested Copies of mark sheets and Certificates for all educational qualifications starting from High school or equivalent to the qualifying examination.
- b. Character Certificate in original from the last institution attended.
- c. Transfer Certificate /Migration Certificate (in original) from the last institution attended.
- d. Certificate for utilizing the intervening period, if any, after leaving the last institution.
- e. Passport size five copies of recent Photograph.
- f. Any other certificate as may be prescribed.

The office of the Registrar will issue the following documents as per the procedure outlined below:

- a. Semester Report Card.
- b. Bonafide Certificate.
- c. Degree/Course Completion Certificate.
- d. Provisional Degree Certificate.
- e. Transcript.
- f. Transfer Certificate or Migration Certificate.
- g. Character Certificate.
- h. Degree.

If any student requires any other type of certificate or signature on some forms, the same may also be issued by the office of Registrar if considered necessary.

No documents shall be issued to students unless the required documents detailed hereunder are submitted by them:

- a. **Semester Report Card:** It may be issued without insisting any earlier document because registration in subsequent semester is involved.
- b. **Bonafide Certificate:** On submission of TC/Migration (in original), mark sheet of qualifying examination and 5 copies of photographs unless not done already.
- c. **Degree Completion Certificate, Course Completion Certificate, Thesis Submission Certificate, Character Certificate and Incomplete Transcript:**
- d. On submission of documents at sl.no. 2 above, mark sheets of earlier examinations, two point character certificate, gap certificate (if any) and upto date no dues from the comptroller.
- e. **Complete P.D.C. and Character Certificate:** On submission of documents at sl.no.2 and 3 above plus all copies of certificates/degrees and final no dues. In case any certificate/degree are lacking he will give an undertaking to submit the same later.
- f. **Transcript/Migration/TC:** As 4 above except if some certificate is from where he passed that examination that it has not been issued to him.

g. **Degree:** On submission of all documents only.

❖ Character Certificate with satisfactory conduct may be issued to the students who are awarded the punishment of temporary dismissal only once during the period of their stay in the university if the same is recommended by the Discipline Committee and approved by the Academic Council.

❖ In case of foreign students, in whose cases the institutions last attended i.e. Universities or Colleges, are located abroad, exemptions shall be given from submitting the two point character certificate, transfer certificate, migration certificate and gap certificate. However, if foreign students have completed last degree certificate from the institution located in India, the above exemption will not apply.

❖ For staff students, gap certificate and may not be insisted if they produce a certificate from the office of the C.P.O. that their antecedents have been verified satisfactorily with the provision that character certificate to staff students will be issued from the office of the C.P.O.

❖ Students who have qualified privately, would be required to submit Transfer Certificate and Two-point Character Certificate, from the institution from where they passed earlier examination as regular student.

❖ The name of the students, both in English and Hindi, in the documents to be issued by this University, shall be spelled as given in the Marksheet and Certificate/Degrees of the qualifying examination only. In case, the name of the student either in Hindi or English are not available in the marksheet certificate of earlier examination, the same shall be spelled as given in the application form submitted by the students at the time of admission.

❖ The surname of graduating girl students may be changed only after submission of marriage certificate or satisfactory evidence to this effect by the student concerned. In place of Ms./Km. word Mrs./Smt. be added as brief after the name changed as above.

❖ The University may issue a duplicate copy of the Degree certificate to a student who might have lost it in the following manner:

a) The candidate who has lost the degree shall swear an affidavit in the court of law to the effect that he has lost the degree and submit the same to the University.

b) He shall also issue a notice in the press that he has lost the degree immediately after the loss of the same and enclose with his application a copy of press notice issued in this regard, while intimating detailed circumstances under which the original degree has been lost.

c) The candidate applying for issue of a duplicate copy of a degree shall also give an undertaking to the effect that in case his original degree is recovered subsequently he will surrender the duplicate copy of the degree to the University.



Credit Framework

COURSE TITLE WITH CREDIT LOAD

Course Code	Course Title	Credit Hours (L+P)
-------------	--------------	--------------------

Major Courses: 20 credits

BI 501	Introduction to Bioinformatics & Computational Biology*	3 (2+1)
BI 502	Statistical Genomics*	3 (2+1)
BI 503	Genome Assembly and Annotation	2 (1+1)
BI 504	Biomolecular Modelling and Simulation*	3 (2+1)
BI 505	Transcriptomics and Metagenomics	3 (2+1)
BI 506	Biological Data Management*	3 (2+1)
BI 507	Biological network modelling and analysis	3 (2+1)
BI 508	Computer programming in bioinformatics	3 (2+1)
BI 509	Machine Learning Techniques in Bioinformatics	3 (2+1)

Minor Courses: 08 credits

BI 511	Principles of Biotechnology	3 (3+0)
BI 512	Fundamentals of Molecular Biology	3 (3+0)
BI 514	Genomics and Proteomics	2 (2+0)

Supporting Courses: 06 credits

COM 501	Basics of Computer and Programming	3 (2+1)
BI 510	Computer Aided Drug Design	3 (2+1)

Common Compulsory Courses: 05 credits

PGS 501	Library and Information Services	1 (0+1)
PGS 502	Technical Writing and Communication Skills	1 (0+1)
PGS 503	Intellectual Property and Its Management in Agriculture	1 (1+0)
PGS 504	Basic Concepts in Laboratory Techniques	1 (0+1)
PGS 505	Agriculture Research, Research Ethics and Rural Development Program	1 (1+0)

BI 599	Master Seminar	1 (0+1)
BI 500	Master Research	30 (0+30)

Total credits: 70

SEMESTER WISE COURSES AND CREDIT LOAD DISTRIBUTION

First Semester (Total Credits = 18)

Course Code	Course Title	Credit Hours	Exam Pattern			
			Mid Term Exam	Practical/ Assignment	Final Term Exam	Paper Format
BI 501	Introduction to Bioinformatics & Computational Biology*	3 (2+1)	20	30	50	Annex. – I
BI 506	Biological Data Management*	3 (2+1)	20	30	50	Annex. – I
BI 512	Fundamentals of Molecular Biology	3 (3+0)	30	20	50	Annex. – I
BI 511	Principles of Biotechnology	3 (3+0)	30	20	50	Annex. - II
COM 501	Basics of Computer and Programming	3 (2+1)	20	30	50	Annex. - II
PGS 501	Library and Information Services	1 (0+1)	-	100	-	-
PGS 502	Technical Writing and Communication Skills	1 (0+1)	-	100	-	-
PGS 503	Intellectual Property and Its Management in Agriculture	1 (1+0)	30	20	50	Annex. - II

Second Semester (Total Credits = 17)

Course Code	Course Title	Credit Hours	Exam Pattern			
			Mid Term Exam	Practical/ Assignment	Final Term Exam	Paper Format
BI 502	Statistical Genomics*	3 (2+1)	20	30	50	Annex. – I
BI 503	Genome Assembly and Annotation	2 (1+1)	20	30	50	Annex. – I
BI 505	Transcriptomics and Metagenomics	3 (2+1)	20	30	50	Annex. – I
BI 509	Machine Learning Techniques in Bioinformatics	3 (2+1)	20	30	50	Annex. – I
BI 510	Computer Aided Drug Design	3 (2+1)	20	30	50	Annex. – I
PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)	-	100	-	-
PGS 505	Agriculture Research, Research Ethics and Rural Development Program	1(1+0)	30	20	50	Annex. - II
GPB 591	Master Seminar	01	-	100	-	-

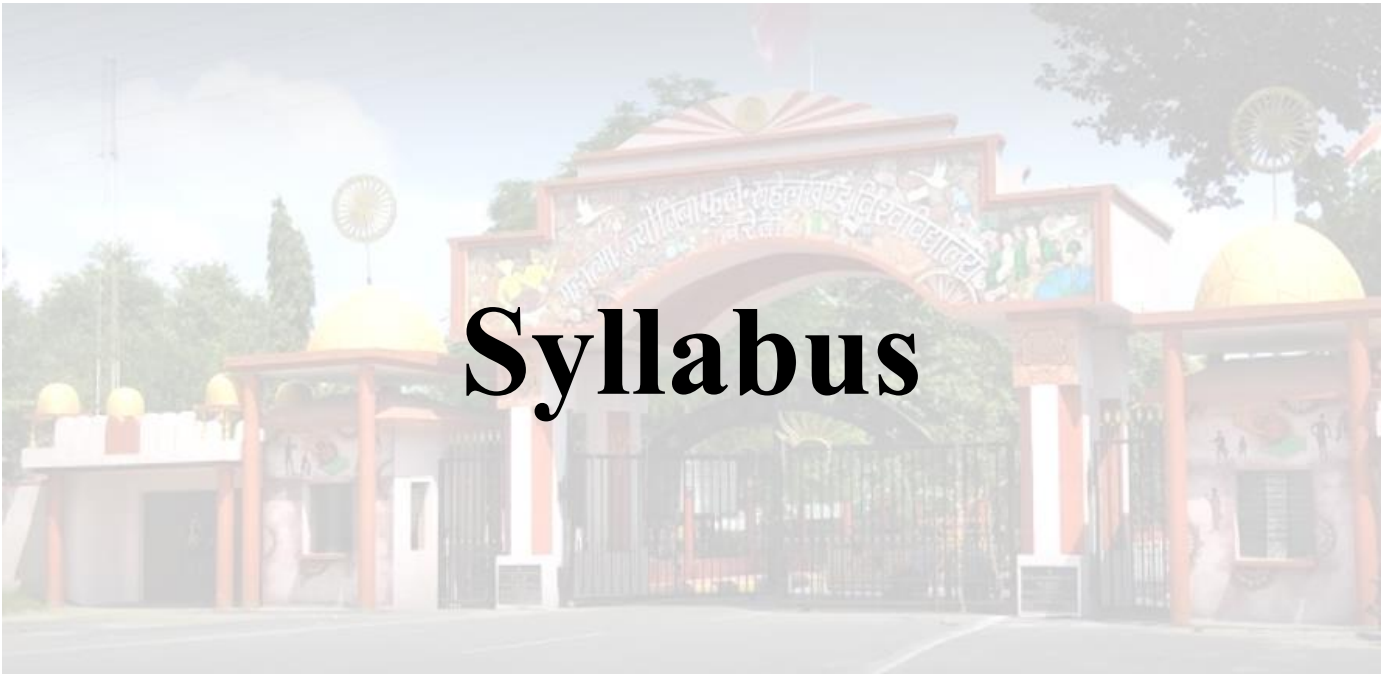
Third Semester (Total Credits = 17)

Course Code	Course Title	Credit Hours	Exam Pattern			
			Mid Term Exam	Practical/ Assignment	Final Term Exam	Paper Format
BI 504	Biomolecular Modelling and Simulation*	3 (2+1)	20	30	50	Annex. - I
BI 514	Genomics and Proteomics	2 (2+0)	30	20	50	Annex. - II
GPB 599	Master Thesis/Research	12	-	-	-	-

Fourth Semester (Total Credits = 18)

Course code	Course Title	Credit Hours	Exam Pattern			
			Mid Term Exam	Practical/ Assignment	Final Term Exam	Paper Format
BI 500	Master Thesis/Research	18	-	-	-	-

Syllabus



COURSES CONTENTS

(Major Subject)

I. Course Title: Introduction to Bioinformatics and Computational Biology*

II. Course Code: BI 501

III. Credit Hours: 2+1

IV. Aim of the course

To provide theoretical and practical knowledge about handling and processing of genomic data, optimization and data mining techniques used in bioinformatics.

V. Theory

Unit I

Overview of available genomic resources on the web; NCBI/ EBI/ EXPASY etc; Nucleic acid sequence databases; GenBank/EMBL/ DDBJ; Database search engines: Entrez, SRS. Overview/concepts in sequence analysis; Pairwise sequence alignment algorithms: Needleman and Wunsch, Smith and Waterman; BLAST, FASTA; Scoring matrices for Nucleic acids and proteins: PAM, BLOSUM, Multiple sequence alignment: PRAS, CLUSTALW. Sequence based gene prediction and its function identification.

Unit II

Pre-processing of gene expression data; Data Normalization techniques, Data quality control: Modelling of errors, Imputation etc; High-throughput screening.

Unit III

Optimization Techniques: concept and applications, Simulated Annealing, Genetic Algorithms: *Ab initio* methods for structure prediction; Information theory, entropy and relative entropy.

Unit IV

Foundations for Machine learning Techniques: Unsupervised and Supervised Learning, Cross Validation Techniques, Markov Model, Bayesian Inference: concepts and applications, Hidden Markov Model and applications, Introduction to WEKA package.

VI. Practicals

Database Similarity Searches, Multiple sequence alignment, Genome databases, Structural databases, Derived databases, Gene annotation, Gene prediction software. Analysis of DNA microarray experiments, Expression profiling by microarray/gene chip, Proteomics, Pattern recognition, Hidden Markov Models, Gibbs Sampling, Analysis of single and multiple DNA or protein sequences.

VII. Suggested Reading

- Baldi, P. and Brunak, S. 2001. *Bioinformatics: The Machine Learning Approach*. MIT Press.
- HTT and Shasha D. 2004. *Data Mining in Bioinformatics*.
- Amaratunga D and Cabrera J. 2004. *Exploration and Analysis of DNA Microarray and Protein Array*. John Wiley.
- Gupta GK. 2006. *Introduction to Data Mining with Case Studies*. Prentice Hall of India,
- Han J and Kamber M. 2006. *Data Mining: Concepts and Techniques*. Morgan Kaufman.
- Hand DH, Mannila P Smyth. 2001. *Principles of Data Mining*. Prentice Hall of India, New Delhi.

I. Course Title: Statistical Genomics***II. Course Code: BI 502****III. Credit Hours: 2+1****IV. Aim of the course**

This course builds the basic understanding of statistical methods used in genetics and genomics.

V. Theory**Unit I**

Fundamentals of Population genetics: Hardy –Weinberg law, Effect of systematic forces on changes in gene frequency; Principles of Quantitative genetics: Values, Means and Variances, Detection and Estimation of Linkage, Inbreeding, Selection, Genetic Parameter Estimation, Variance component estimation, BLUP, G X E interaction, Path Analysis

Unit II

Molecular Marker based classification: similarity measures, clustering methods, bootstrapping; QTL mapping: Detection and Estimation of QTL, Single Marker Analysis, Interval Mapping and MQM;

Unit III

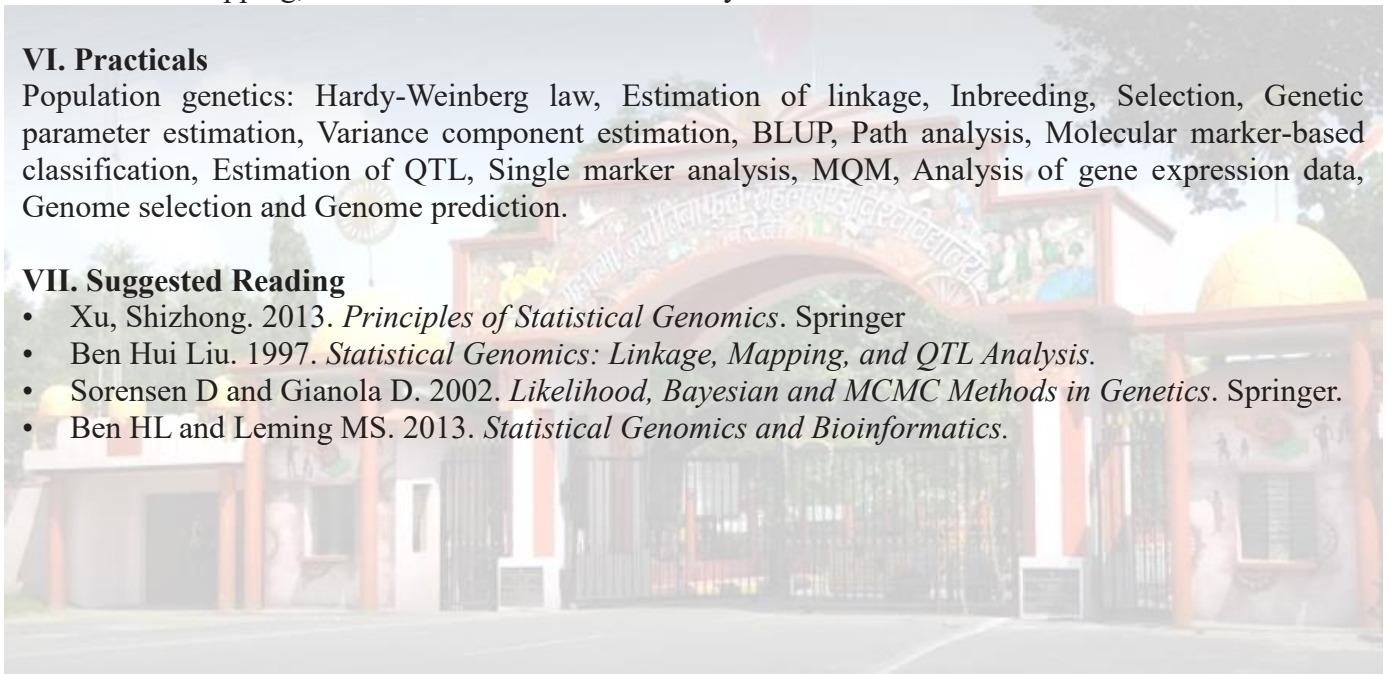
Design and Analysis of Expression Data; Genome Selection; Genome Prediction, Genetic Markers, Association Mapping; Genome Wide Association Analysis

VI. Practicals

Population genetics: Hardy-Weinberg law, Estimation of linkage, Inbreeding, Selection, Genetic parameter estimation, Variance component estimation, BLUP, Path analysis, Molecular marker-based classification, Estimation of QTL, Single marker analysis, MQM, Analysis of gene expression data, Genome selection and Genome prediction.

VII. Suggested Reading

- Xu, Shizhong. 2013. *Principles of Statistical Genomics*. Springer
- Ben Hui Liu. 1997. *Statistical Genomics: Linkage, Mapping, and QTL Analysis*.
- Sorensen D and Gianola D. 2002. *Likelihood, Bayesian and MCMC Methods in Genetics*. Springer.
- Ben HL and Leming MS. 2013. *Statistical Genomics and Bioinformatics*.



I. Course Title: Genome Assembly and Annotation**II. Course Code: BI 503****III. Credit Hours: 1+1****IV. Aim of the course**

The primary objective of this course is to develop practical understanding of techniques and tools used in genome assembly with emphasis on issues and challenges of its structural and functional annotation.

V. Theory**Unit I**

Types and methods of genome sequence data generation; Shot gun sequencing method; Problems of genome assembly, Approaches of genome assembly: Comparative Assembly, DE novo Assembly; Read coverages; Sequencing errors, Sequence Quality Matrix, Assembly Evaluation; Challenges in Genome Assembly.

Unit II

Various tools and related methods of genome assembly: MIRA, Velvet, ABySS, ALLPATHS-LG, Bambus2, Celera Assembler, SGA, SOAPdenovo, etc.

Unit III

Basic concepts of genome annotation; Structural and Functional Annotation; Identification of open reading frame (ORF) and their regularization, Identification of gene structure, coding regions and location of regulatory motifs

VI. Practicals

Genome assembly methods for data from various sequencing platform, Sequencing error determination, Sequence quality matrix; Various tools for genome assembly: MIRA, Velvet, ABySS, ALLPATHS-LG, Bambus2, Celera Assembler, SGA, SOAPdenovo, etc. Structural and functional Genome annotation.

VII. Suggested Reading

- Jung, S., Paul, Gordon, M.K., Sensen, C. W. 2012. *Genome Annotation*. Chapman and Hall/ CRC
- Venter, J. C., 2000. *Annotation of the Celera Human Genome Assembly*. Celera.
- Mark Menor. 2007. *Multi-genome Annotation of Genome Fragments Using Hidden Markov Model Profiles*
- Carson Hinton Holt. 2012. *Tools and Techniques for Genome Annotation and Analysis*
- Alistair G. Rust, Emmanuel Mongin and Ewan Birney Loraine A.E and Helt G.A. 2002. *Genome annotation techniques: new approaches and challenges*. *Drug Discovery Today*. 570- 576 p.
- Weizhong Li and Adam Godzik. 2002. *Discovering new genes with advanced homology detection*. *Trends in Biotechnology*, 20: 8, 315-316 p.

I. Course Title: Bio-molecular Modelling and Simulation***II. Course Code: BI 504****III. Credit Hours: 2+1****IV. Aim of the course**

The course aimed to develop understanding of biomolecular modelling techniques and simulation

V. Theory**Unit I**

Methods for 3D Structure Prediction: Homology modelling of protein 3D structures approaches to loop building, energy considerations and evaluation of the accuracy of the model. *ab initio* approach to 3D structure prediction; Threading approach to 3D structure prediction. A Comparison of protein structure prediction methods: CASP

Unit II

Basic principles of modelling, modelling by energy minimization technique, concept of rotation about bonds, energy minimization by basic technique for small molecules, Ramachandran plot, torsional space minimization, energy minimization in Cartesian space, molecular mechanics-basic principle

Unit III

Basic concepts of Simulation Modelling: Units and derivatives, Force field and energy landscape, Truncation of non-bonded interactions, Introduction to solvation, Periodic boundary condition, Wald summation, implicit solvent model and continuum electrostatics, Monte Carlo simulation on parallel computers. Replica-exchange simulations, Restraint potentials, Free energy calculations, Membrane simulations

Unit IV

Energy Minimization: Concept of energy minimization - hypersurface, local and global energy minima, statement of problem. Derivative minimization methods - first derivative methods: the steepest descents method, line search in one-dimension, arbitrary step approach, conjugate gradients minimization. Second derivative method – the Newton-Raphson method. Applications of energy minimization.

VI. Practicals

Protein structure databases: PDB, MODBASE, Structure visualization – Rasmol and PyMol, Structural analysis- classification, CATH, SCOP, Protein geometry – bond length, bond angle, torsion angle, calculation of surface area, volume and radii: Swiss PDB Viewer. Small molecule generation - peptides and nucleic acids: ISIS draw / ChemSketch, Selection of query sequence, template selection: pdbBLAST, Comparative 3D structure prediction – SWISSMODEL, Model generation - building side chains and loops using Modeller, Threading, *ab initio* modelling, Structure validation - generation and analysis of Ramachandran plot using PROCHECK, WHATCHECK via SAVS server, Force field calculation and energy minimization, Structure refinement - loop building, removing non-bonded contacts, adding missing side chains via WhatIf interface, Scoring structural similarity - 3D structure alignment - RMS superimposition – VMD, Molecular dynamics simulation using Tinker. Simulation dynamics, Monte carlo simulation on parallel computers. Replica exchange simulation, free energy calculation. Docking

VII. Suggested Reading

- Schlick T. 2010. *Molecular Modeling and Simulation: An Interdisciplinary Guide*. Science.
- Gunsteren WF, Weiner PK, Wilkinson AJ. 1997. *Computer Simulation of Biomolecular Systems: Theoretical and experimental application*. Springer.
- Martin JF. 2007. *A Practical Introduction to the Simulation of Molecular Systems*. Cambridge
- Leach AR. 2001. *Molecular Modeling: Principles and Applications*. Prentice Hall. 784p.
- Marx D and Hutter J. 2009. *Ab Initio Molecular Dynamics: Basic Theory and Advanced Methods*. Cambridge University Press. 578.

I. Course Title: Transcriptomics and Metagenomics**II. Course Code: BI 505****III. Credit Hours: 2+1****IV. Aim of the course**

The course aims to teach basic concepts of metagenomics and various techniques used in the analysis of metagenomic data

V. Theory**Unit I**

Microarrays, RNA-seq, Chip-Seq, EST-clustering, differential expression analysis

Unit II

Taxonomic and genetic annotation of high throughput sequence data, microbial diversity analyses, analyses of microbial community composition and change and metabolic reconstruction analyses.

Unit III

Comparison between Metagenomics and AL, EC, Comparison between LCS and Metagenomics, Symbiotic Evaluations: SANE, Comparison between SANE and Metagenomics, Horizontal Gene Transfer: Microbial GA.

Unit IV

Metagenome Sequencing, Single Cell Analysis, Host-Pathogen Interaction; Shotgun metagenomics; High-throughput sequencing; Comparative metagenomics; Community metabolism; Meta transcriptomics.

VI. Practicals

Meta genome annotation, Analyses of microbial community composition and change and metabolic reconstruction analyses; Meta-transcriptomics; Comparative metagenomics. Microarray data analysis; RNA-seq, chip-seq, EST-clustering.

VII. Suggested Reading

- Diana marco. 2010. *Metagenomics: Theory, Methods and Applications*. Ceister academic press
- Streit WR and Daniel R. 2010. *Metagenomics: Methods and Protocols*. Springer protocols.
- Yeh WK, Yang H, McCarthy JR. 2010. *Enzyme Technologies: Metagenomics, Evolution, Biocatalysis and Biosynthesis*.wiley
- Muthukumar V. 2003. *Metagenomics for the Identification of Plant Viruses*. ProQuest.

I. Course Title: Biological Data Management**II. Course Code: BI 506****III. Credit Hours: 2+1****IV. Aim of the course**

The course aims at teaching database management system and familiarizing with the techniques of data sources, data curation and integration of data sources

V. Theory**Unit I**

Database Management System (DBMS): Need for DBMS - File system vs Database system, Advantages of DBMS - DBMS Architecture – DBMS services - Data abstraction - Overview of Data Models: Hierarchical Model - Network Model - Entity-Relationship (E-R) Model: Symbols - Components of E-R Model: Entities, Attributes, Relationships - Relational Model, Object-oriented Model.

Unit II

Overview of Relational Database Objects – Relation – Tuple - Cardinality – Attribute – Degree - Domain - Primary key – Foreign key - Relational data structure – Relational Data Integrity and Constraints: Domain constraints, Entity integrity, Referential Integrity, Operational constraints - Codd's Rules – Normalization: 1NF, 2NF, 3NF, BCNF, 4NF and 5NF.

Unit III

Structured Query Language (SQL): Overview of SQL – SQL Data types and Literals – SQL Commands: Data Definition Language (DDL), Data Manipulation Language (DML), Data Querying Language (DQL), Data Control Language (DCL), Data Administration Statements (DAS), Transaction Control Statements (TCS), SQL Operators: Arithmetic, Comparison, Logical and Set Operators – SQL Query, Nested Query - SQL Aggregate functions.

Unit IV

Curation of genomic, genetic, proteomic data, High-throughput screening, array, qPCR data sets; Quality management of data: tools and techniques. Biological data sources, Data granularity, Schema modelling, architecture, query design, extraction, transformation and loading, Long term data management, storage and security. Bio-chip information system, visualization and reporting, Risk factors for data quality management. Un-structured or noSQL database; AI and BIG data Analytics

VI. Practicals

Understanding the data sources, Data granularity, Data modeling and architecture, development of database, Storage, Security, Visualization and reporting.

VII. Suggested Reading

- Large scale data handling in biology. Ventus Publishing. ISBN978-87- 7681-555-4.
- Harold, E. and Means W.S. 2004. XML in a Nutshell, Third Ed. O'Reilly, Sebastopol, CA
- Witten, I.H. and Frank E. 2005. Data Mining: Practical Machine Learning Tools and Techniques (WEKA), 2nd Ed. San Francisco, Morgan Kaufmann,
- Lodish, H. et al. 2000. Molecular cell biology. New York: Freeman & Co.
- Kaneko K. 2006. Life: An Introduction to Complex Systems Biology. Springer.

I. Course Title: Biological Network Modelling and Analysis**II. Course Code: BI 507****III. Credit Hours: 2+1****IV. Aim of the course**

This course aims to develop basic understanding of system biology through biological network modelling and its analysis.

V. Theory**Unit I**

Introduction to biological networks, Graph theoretic modelling and analysis of biological networks, Discrete Dynamic modelling (Boolean networks, Petri nets), Continuous dynamic modelling (ODEs, stochastic simulation, etc.)

Unit II

Probabilistic modelling (Probabilistic Boolean networks, Bayesian networks, Mutual Information), Network inference from experimental data, Genome-scale modelling and network integration

Unit III

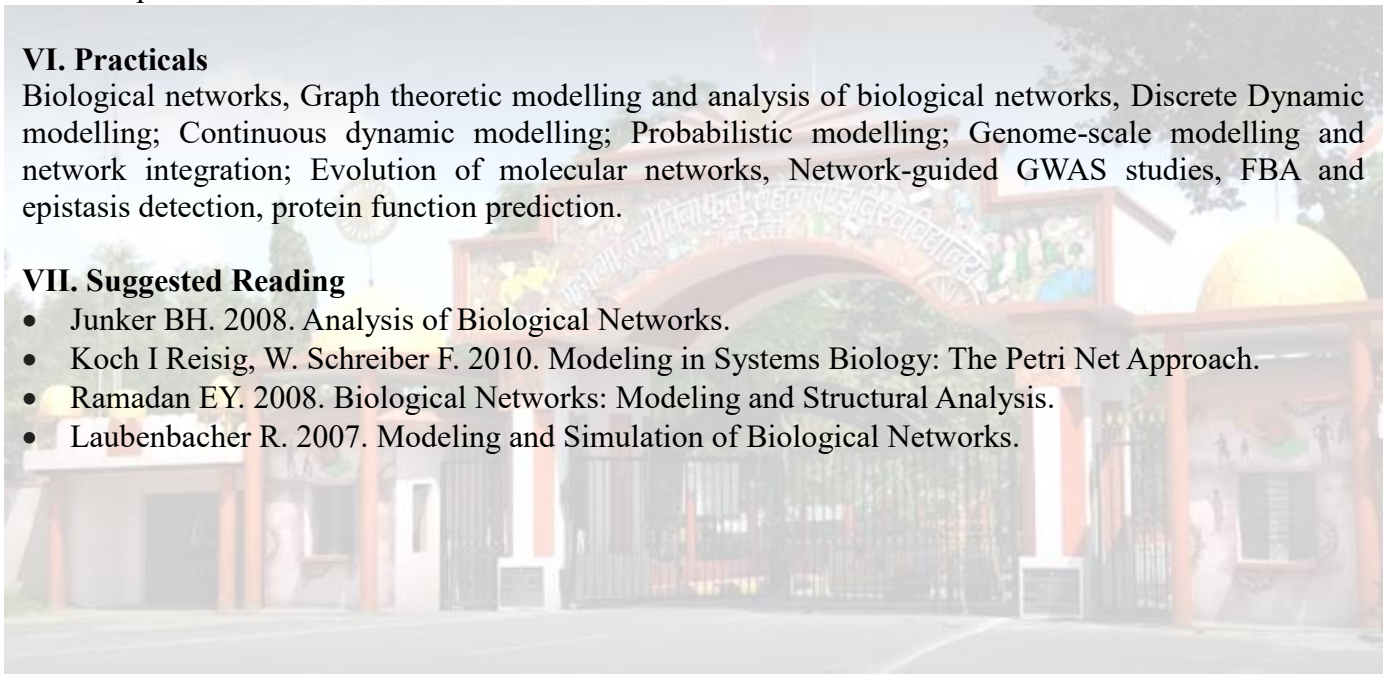
Evolution of molecular networks, Network-guided GWAS studies, FBA and epistasis detection, protein function prediction.

VI. Practicals

Biological networks, Graph theoretic modelling and analysis of biological networks, Discrete Dynamic modelling; Continuous dynamic modelling; Probabilistic modelling; Genome-scale modelling and network integration; Evolution of molecular networks, Network-guided GWAS studies, FBA and epistasis detection, protein function prediction.

VII. Suggested Reading

- Junker BH. 2008. Analysis of Biological Networks.
- Koch I Reisig, W. Schreiber F. 2010. Modeling in Systems Biology: The Petri Net Approach.
- Ramadan EY. 2008. Biological Networks: Modeling and Structural Analysis.
- Laubenbacher R. 2007. Modeling and Simulation of Biological Networks.



I. Course Title: Computer Programming in Bioinformatics**II. Course Code: BI 508****III. Credit Hours: 2+1****IV. Aim of the course**

To learn programming skills for parsing biological data, parallel computing, database connectivity and web-interface.

V. Theory**Unit I**

BioJava- Packages, Data Import, Manipulation; Python- Basic Syntax, Loops, Functions; BioPython.

Unit II

Bioperl: Introduction, Modules: SeqIO, SearchIO, Seq Feature, Finding introns, Alignments, LiveSeq and Tree.

Unit III

OpenMP: Clauses, Worksharing constructs, Synchronization constructs, Environment variables, Global Data, Runtime functions, Message Passing Interface (MPI): Introduction and programming, Point to point communications, Collective communications, Advanced MPI1 concepts, MPI2 introduction, Hybrid (openMP + MPI) programming.

Unit IV

Compute Unified Device Architecture (CUDA): Introduction and Programming, GPU computing.

VI. Practicals

BioPerl programming using bioperl modules such as SeqIO, SearchIO, LiveSeq and Tree; OpenMP programming on Work sharing and Synchronization constructs, Environment variables and global data; MPI programming on Point-to-point communications and Collective communications; Compilation of OpenMP and MPI programs; Execution of OpenMP and MPI programs; Use of high-performance computing, computing resources and job scheduling.

VII. Suggested Reading

- Tisdall J. 2001. Beginning Perl for Bioinformatics. O-Reilly.
- Schwartz RL, Phoenix T, Foy BD. 2008. Learning Perl. O-Reilly.
- Orfali R and Harkey H. 1999. Client/Server Programming with JAVA and CORBA. John Wiley.
- Sriram Srinivasan. 1997. Advanced Perl Programming. O-Reilly.
- Bunce T and Descartes A. 2000. Programming the Perl DBI. O-Reilly.
- Mitchell L Model. 2010. Bioinformatics Programming Using Python, O'Reilly media, Cambridge, Bal HP 2003. Perl Programming for Bioinformatics, Tata McGraw Hill.

I. Course Title: Machine Learning Techniques in Bioinformatics**II. Course Code: BI 509****III. Credit Hours: 2+1****IV. Aim of the course**

The purpose of the course is to explain various machine learning techniques and its applications on biological data.

V. Theory**Unit I**

Introduction to statistical learning theory, Empirical Risk Minimization, Structural Risk Minimization; Classification: Decision tree, Bayesian, Rule based classification, ANN, SVM, KNN; Case based reasoning and Applications in Bioinformatics.

Unit II

Clustering: Partition Methods, Heirarchical methods, Density based methods, Grid based clustering, Model based clustering, clustering of high dimensional data, constraints based clustering, Analysis of MD trajectories, Protein Array data Analysis.

Unit III

Dimensional Reduction Techniques, Methods of Feature Selection, Resampling Techniques, Elements of Text Mining and Web Mining, Soft Computing and Fuzzy logic system and application in bioinformatics.

VI. Practicals

Decision tree, classification techniques: ANN, SVM, KNN, Case based reasoning and its applications on biological data. Clustering techniques; Clustering of high dimensional data; Dimensional reduction techniques; Resampling techniques; Text mining and Web mining. Soft Computing and Fuzzy logic system & application in bioinformatics.

VII. Suggested Reading

- Witten, H.I., Frank, E. and Hall, M.A. 2011. *Data Mining: Practical Machine Learning Tools and Techniques*.
- Hastie, T., Tibshirani, R., Friedman, J.H. 2009. *The Elements of Statistical Learning: Data Mining Interface and Prediction*.
- Clarke, S.B., Fokoue, E. and Zhang, H.H. 2009. *Principles and Theory for Data Mining and Machine Learning*.

(Minor Courses)

I. Course Title: Principles of Biotechnology

II. Course Code: BI 511

III. Credit Hours: 3+0

IV. Aim of the course

To understand the basics of Molecular biology, plant and microbial Biotechnology Importance and applications in agriculture, case studies and success stories. Public education, perception, IPR and related issues

V. Theory

Unit I

History, scope and importance of Biotechnology; Specializations in Agricultural Biotechnology: Genomics, Genetic engineering, Tissue Culture, Bio-fuel, Microbial Biotechnology, Food Biotechnology etc. Basics of Biotechnology, Primary metabolic pathways, Enzymes and its activities.

Unit II

Structure of DNA, RNA and protein, their physical and chemical properties. DNA

function: Expression, exchange of genetic material, mutation. DNA modifying

enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; DNA/RNA libraries; Applications of gene cloning in basic and applied research, Plant transformation: Gene transfer methods and applications of GM crops.

Unit III

Molecular analysis of nucleic acids -PCR and its application in agriculture and industry, Introduction to Molecular markers: RFLP, RAPD, SSR, SNP etc, and their applications; DNA sequencing, different methods; Plant cell and tissue culture techniques and their applications. Introduction to genomics, transcriptomics, ionomics, metabolomics and proteomics. Plant cell and tissue culture techniques and their applications.

Unit IV

Introduction to Emerging topics: Genome editing, gene silencing, Plant microbial interactions, Success stories in Biotechnology, Careers and employment in biotechnology. Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

VI. Suggested Reading

- Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. 2014. *Molecular Biology of the Gene*, 7th edition, Cold Spring Harbor Laboratory Press, New York
- Brown T A. 2010. *Gene Cloning and DNA analysis an Introduction* 6th edition, Wiley Blackwell
- Primrose SB and Twyman R. 2006. *Principles of gene Manipulation* 7th edition, Wiley Blackwell
- Singh BD. 2012. *Biotechnology: Expanding Horizons* 4th edition, Kalyani publisher, New Delhi, India

I. Course Title: Fundamentals of Molecular Biology**II. Course Code: BI 512****III. Credit Hours: 3+0****IV. Aim of the course**

To understand the basics of DNA, RNA, structure, types and chromatin assembly. To get insights into the Central Dogma, basic cellular processes, role of mutation and recombination. To understand different levels of gene regulation and the pathways involved.

V. Theory**Unit I**

Historical developments of molecular biology, Nucleic acids as genetic material, Chemistry and Nomenclature of nucleic acids; Structure of DNA: primary structure; secondary structure, Forms of DNA: A, B, Z and their function; Structure and Types of RNA Genome organization in prokaryotes and eukaryotes; DNA Topology; DNA re-association kinetics, Types of repeat sequences.

Unit II

Central dogma of Molecular Biology; DNA replication- Classical experiments, Models of DNA replication; DNA replication, Origin and Steps in DNA replication - initiation, elongation, and termination; Enzymes and accessory proteins and its mechanisms; Eukaryotic DNA replication in brief. Types of DNA damages and mutations; DNA repair mechanisms, Recombination: Homologous and non-homologous, Genetic consequences.

Unit III

Prokaryotic transcription, initiation, elongation and termination, promoters, Structure, and function of eukaryotic RNAs and ribosomal proteins. Eukaryotic transcription – RNA polymerase I, II and III, Elongation and Termination, Eukaryotic promoters and enhancers, Transcription factors, Post transcriptional processing, Splicing: Catalytic RNAs, RNA stability and transport, RNA editing.

Unit IV

Genetic code and its characteristics, Universal and modified genetic code and its characteristics, Wobble hypothesis; Translational machinery; Ribosomes in prokaryotes and Eukaryotes. Initiation complex formation, Cap dependent and Cap independent initiation in eukaryotes, Elongation: translocation, transpeptidation and termination of translation; Co- and Post-translational modifications of proteins; Translational control; Protein stability -Protein turnover and degradation.

Unit V

Gene regulation in prokaryotes, Constitutive and Inducible expression, small molecule regulators; Operon concept: lac and trp operons, attenuation, anti-termination, stringent control. Gene regulation in eukaryotes– regulatory RNA and RNA interference mechanisms, Silencers, insulators, enhancers, mechanism of silencing and activation; Families of DNA binding transcription factors: turn-helix, helix-loop-helix etc. Epigenetic regulations

VI. Suggested Reading

- Nelson DL and Cox M.M. 2017. *Lehinger's Principles of Biochemistry*, 7th edition, W H Freeman Publication New York.
- Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. 2017. *Lewin's Genes XII* 12th edition, Jones & Bartlett Learning publisher, Inc.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M and Losick R. 2014. *Molecular Biology of the Gene*, 7th edition, Cold Spring Harbor Laboratory Press, New York.
- Alberts, B. 2017. *Molecular Biology of the Cell* 5th edition, WW Norton & Co, Inc.
- Allison, L.A. 2011. *Fundamentals of Molecular Biology*. 2nd Edition, John Wiley and Sons.

I. Course Title: Genomics and Proteomics**II. Course Code: BI 514****III. Credit Hours: 2+0****IV. Aim of the course**

To familiarize the students about the genomic and proteomic concepts and usage of various algorithms and programmes in analysis of genomic and proteomic data.

V. Theory**Unit I**

Genomics: Whole genome analysis and comparative genomics, classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation.

Unit II

Functional genomics: Candidate gene identification, DNA chips, Mutants and RNAi, Metabolomics for elucidating metabolic pathways, etc.

Unit III

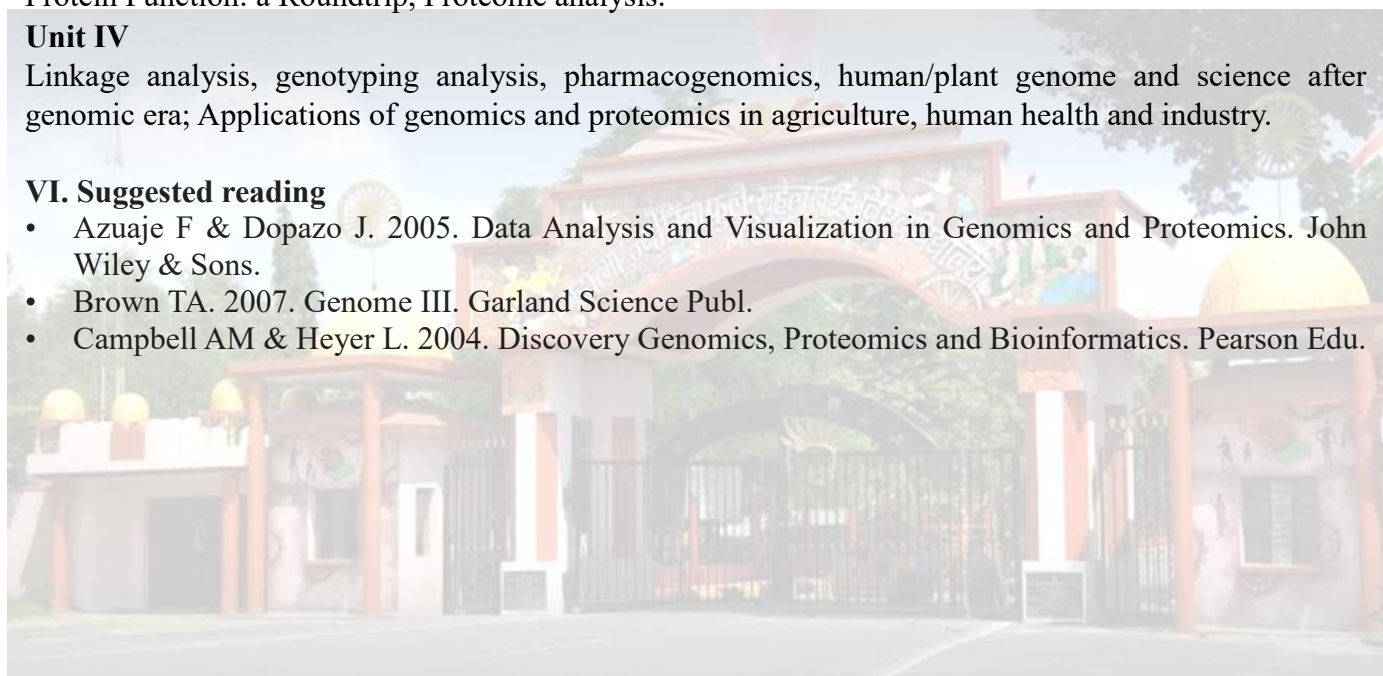
Proteomics - Introduction to basic proteomics technology, Bio-informatics in Proteomics, Gene to Protein Function: a Roundtrip, Proteome analysis.

Unit IV

Linkage analysis, genotyping analysis, pharmacogenomics, human/plant genome and science after genomic era; Applications of genomics and proteomics in agriculture, human health and industry.

VI. Suggested reading

- Azuaje F & Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics. John Wiley & Sons.
- Brown TA. 2007. Genome III. Garland Science Publ.
- Campbell AM & Heyer L. 2004. Discovery Genomics, Proteomics and Bioinformatics. Pearson Edu.



(Supporting Courses)

I. Course Title: Basics of Computer and Programming

II. Course Code: COM 501

III. Credit Hours: 2+1

IV. Aim of the course:

To provide theoretical and practical knowledge about computers, their applications and introduction to various programming languages

V. Theory

Unit I

Basic Computer Organisation, Types of Computers, Number System (Binary and decimal), Concept of programming: Procedural/ Non-procedural, Structured programming, Object oriented programming, Algorithm fundamentals.

Unit II

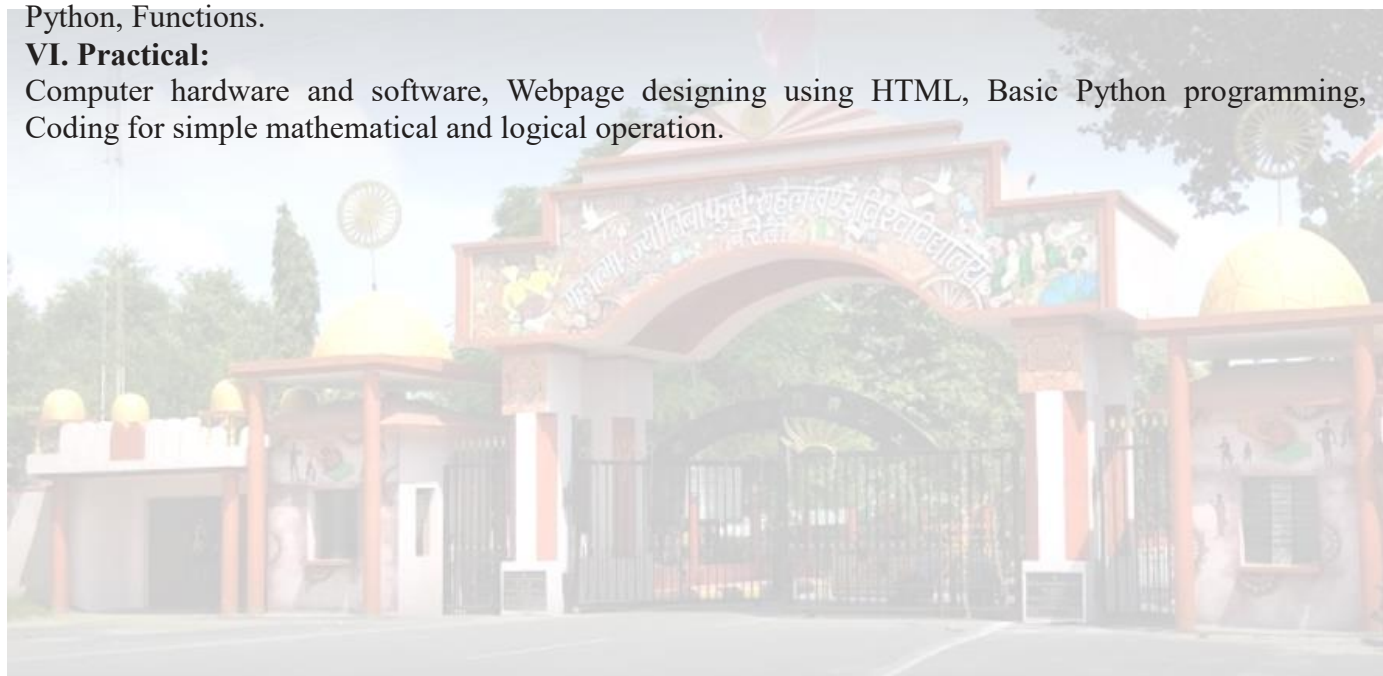
HTML, Introduction to tags, Elements, Attributes.

Unit III

Python programming: basics, data types, Operators, Expression, Statement, type conversion, Input/output, Errors, syntax, conditional statement and looping, Strings, lists, introduction to modules in Python, Functions.

VI. Practical:

Computer hardware and software, Webpage designing using HTML, Basic Python programming, Coding for simple mathematical and logical operation.



I. Course Title: Computer Aided Drug Design**II. Course Code: BI 510****III. Credit Hours: 1+1****IV. Aim of the course**

The purpose of the course is to explain various machine learning techniques and its applications on biological data.

V. Theory**Unit I**

Application of molecular graphics. Energy minimization of small molecules, Use of Force Fields and MM methods, Local and global energy minima. Techniques in MD and Monte Carlo. Simulation for conformational analysis, *Ab initio*, DFT and semiempirical methods.

Unit II:

Design of ligands, Classical SAR/QSAR, CoMPFA, CoMSIA, Molecular Docking methods, protein-protein, protein-ligand interaction studies.

Unit III:

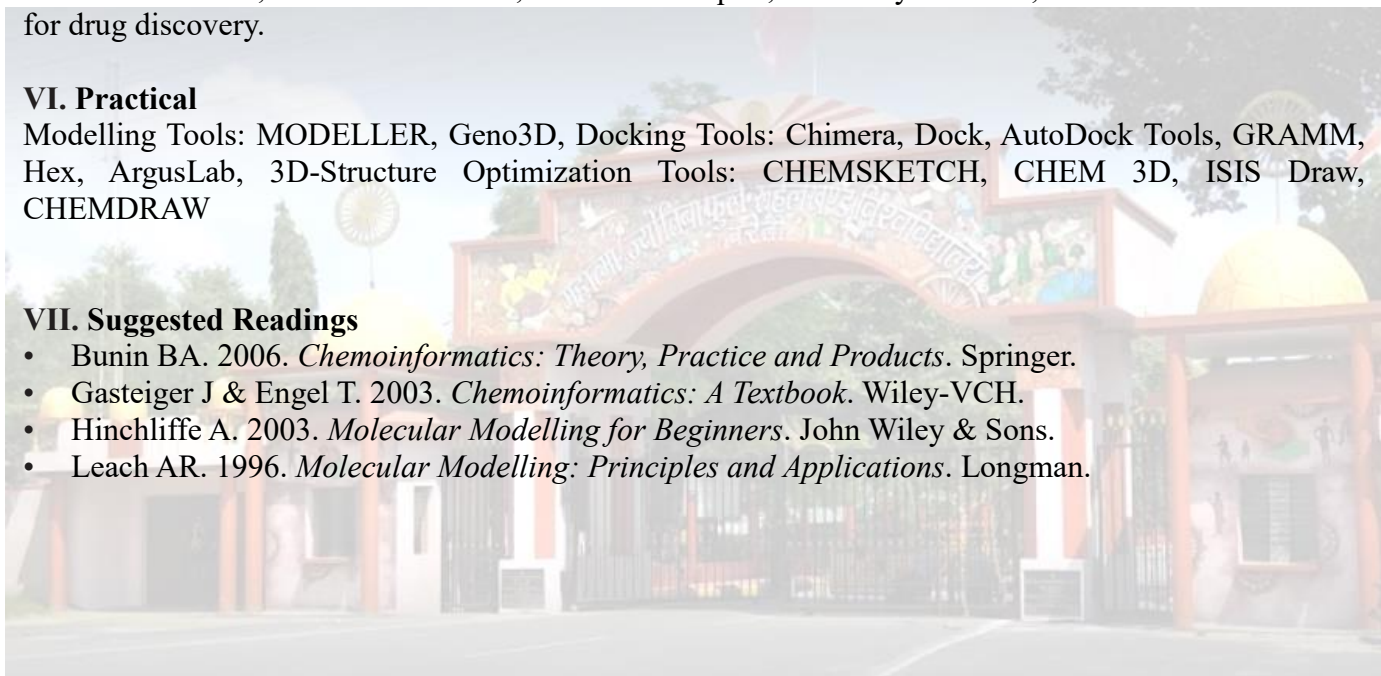
Role of computers in chemical research; Structure representation, SMILES; Chemical Databases, 2D and 3D structures, reaction databases, search techniques, similarity searches; Chemoinformatics tools for drug discovery.

VI. Practical

Modelling Tools: MODELLER, Geno3D, Docking Tools: Chimera, Dock, AutoDock Tools, GRAMM, Hex, ArgusLab, 3D-Structure Optimization Tools: CHEMSKETCH, CHEM 3D, ISIS Draw, CHEMDRAW

VII. Suggested Readings

- Bunin BA. 2006. *Chemoinformatics: Theory, Practice and Products*. Springer.
- Gasteiger J & Engel T. 2003. *Chemoinformatics: A Textbook*. Wiley-VCH.
- Hinchliffe A. 2003. *Molecular Modelling for Beginners*. John Wiley & Sons.
- Leach AR. 1996. *Molecular Modelling: Principles and Applications*. Longman.



(Compulsory Common Courses)

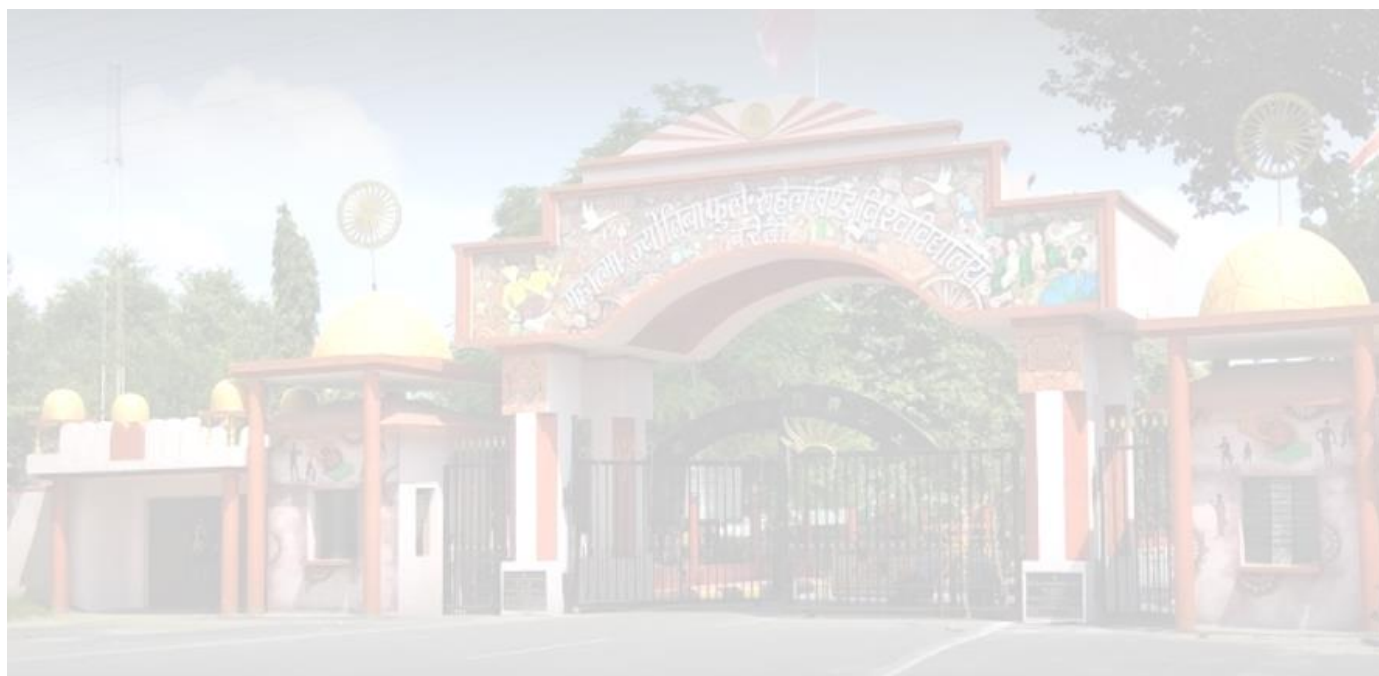
Course Title: Library and Information Services

Course Code: PGS 501

Credit Hours: 1 (0+1)

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.



Course Title: Technical Writing and Communication Skills

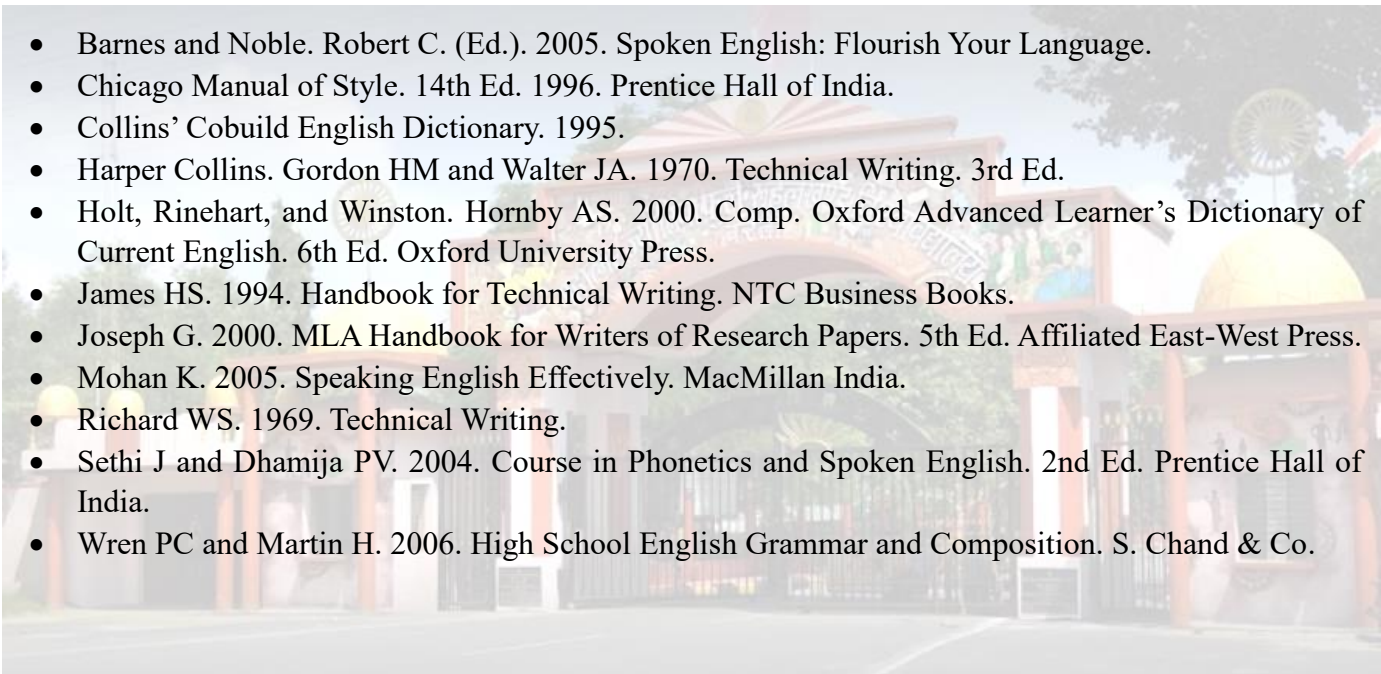
Course Code: PGS 502

Credit Hours: 1 (0+1)

Practical (Technical Writing)

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations, etc.; Commonly used abbreviations in the theses and research communications; Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article; Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech; Participation in group discussion; Facing an interview; Presentation of scientific papers.

Suggested Readings

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- Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
 - Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
 - Collins' Cobuild English Dictionary. 1995.
 - Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
 - Holt, Rinehart, and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
 - James HS. 1994. Handbook for Technical Writing. NTC Business Books.
 - Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
 - Mohan K. 2005. Speaking English Effectively. MacMillan India.
 - Richard WS. 1969. Technical Writing.
 - Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
 - Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

Course Title: Intellectual Property and Its Management in Agriculture**Course Code: PGS 503****Credit Hours: 1 (1+0)****Theory**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPs Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

- Erbis, F. H. and Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli, P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
- Rothschild, M. and Scott, N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha, R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

Course Title: Basic Concepts in Laboratory Techniques

Course Code: PGS 504

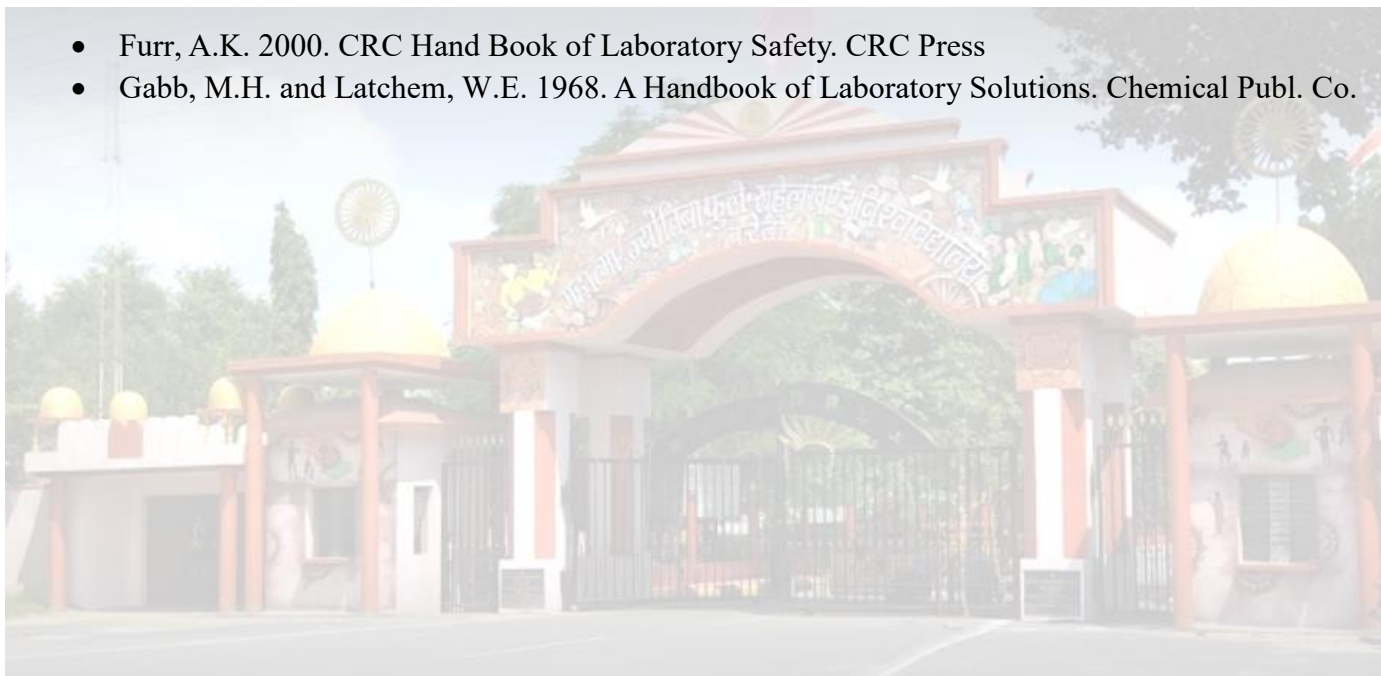
Credit Hours: 1 (0+1)

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/ chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

- Furr, A.K. 2000. CRC Hand Book of Laboratory Safety. CRC Press
- Gabb, M.H. and Latchem, W.E. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.



Course Title: Agriculture Research, Research Ethics and Rural Development Program

Course Code: PGS 505

Credit Hours: 1 (1+0)

Theory

UNIT I History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards, and problems in research ethics.

UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

- Bhalla, G.S. and Singh, G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
- Punia, M.S. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.
- Rao, B.S.V. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations, and Initiatives. Mittal Publ.
- Singh, K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

