ORDINANCES GOVERNING INTEGRATED M. Phil.-Ph.D. DEGREE in Life Sciences
(Effective from Academic Session 2016-17)

Under the powers conferred by Section 4 A of the Banaras Hindu University Act, 1915, as amended and under the provisions of Clause 3 of Section 18 of this Act, the Banaras Hindu University institutes the Integrated M. Phil.-Ph.D. Degree in Life Sciences, Institute of Science with effect from the academic session 2016-17. The following are the Ordinances relating to the said courses to come in force from the academic session 2016-17.

I. GENERAL PROVISIONS

1. The Courses of study leading to Integrated M. Phil.-Ph.D. Degree of the Banaras Hindu University shall be conducted at the DBT-BHU Interdisciplinary School of Life Sciences (ISLS) on full-time basis under the Institute of Science.

2. The Integrated M. Phil.-Ph.D. Degree Courses shall comprise of M. Phil. and Ph.D. components. The duration of the M. Phil. shall be one year (two semesters), whereas the duration of the Ph.D. shall be governed as per the provisions contained in the Ordinances governing the award of Doctor of Philosophy degree of the Banaras Hindu University. A student after successfully completing the M. Phil as per provisions contained in these Ordinances will have the option for exit with M. Phil. degree only or continue to the Ph.D. subject to fulfilling criteria described in clause IX.2 and IX.3 of this Ordinance.

3. The last date for receipt of applications for admission to this course shall be fixed each year by the University/Director, Institute of Science.

4. There shall be an Admission Committee for Integrated-M. Phil.-Ph.D. Courses, constituted under the provisions of Ordinances and consisting of the Director or his nominee and two senior members of the teaching staff. Admission shall be made in accordance with these ordinances and the rules made there under.

5. Provisional admissions to Integrated M. Phil-Ph.D. courses shall be based on combined merit comprising of Test score, Academic Record (calculated as per formula given in the Ph.D. Ordinances) and Interview. For admission into M. Phil-Ph.D. courses, the candidate shall have to appear at the RET as per Ph.D. ordinance of B.H.U. For NET/GATE qualified candidates, only interview will be held. 50% of seats will be filled with NET/GATE and 50% with RET qualified candidates. In case of vacancy, seats may be filled from either category.

6. All provisional admissions shall be finalized within the date notified by the University. Candidates are required to fulfill the minimum eligibility conditions on or before the date of counseling for admissions.

7. Provisional admissions cannot be claimed by any applicant as a matter of right. The provisional admission or readmission of an applicant shall be entirely at the discretion of the Admission Committee, which may refuse to admit any candidate without assigning any reason thereof.

8. Provisional admission shall be made strictly on the availability of seats on the date of admission and the mere fact that call letter has been issued shall not entitle a candidate to claim admission.

9. The candidate granted provisional admission shall deposit fee within the period prescribed by the Director, Institute of Science, failing which the admission shall stand cancelled.

10. Provisional admission of a candidate is liable to be cancelled by the Admission Committee at any time:
    (a) If it is detected that there is something against the candidate which would have prevented him/her from being admitted to the course.
    (b) If the candidate is found at a later stage to have provided any false information, and /or
    (c) If he/she has been punished for an act of gross misconduct, indiscipline or an act involving moral turpitude.

11. The candidates admitted to the respective Courses are required to submit the following certificates at the time of admission or by the time allowed by the Director, Institute of Science.

A Migration Certificate from the University last attended in case the candidate has obtained qualifying degree from an Indian University other than Banaras Hindu University, certifying that he/she has passed the qualifying examination.

<div align="center">OR</div>

A Transfer Certificate showing that the candidate has passed the qualifying examination from the institution last attended, if he/she has obtained qualifying degree from Banaras Hindu University.

A. ELIGIBILITY FOR ADMISSION

A candidate seeking admission to the Integrated M. Phil.-Ph.D. course is required to fulfill following minimum eligibility conditions:

1. He/She must possess either of the following qualifying degrees:
    (a) Master's degree in Life Sciences and its allied areas.
    (b) Master's Degree in any one of the subjects in Zoology, Botany, Biochemistry, Biotechnology, Bioinformatics, Genetics, Microbiology, Molecular & Human Genetics, Environmental Sciences, Applied Microbiology, Neuroscience, Biophysics, Plant Biotechnology, Bioinformatics, Biosciences, Animal Sciences, Forensic Science and other Life Science disciplines.

<div align="center">AND</div>

2. He/She must have at least 50% in the aggregate or equivalent grade point average in the examination of the qualifying degree.

Notes:

(a) The above qualifying degree must be obtained from any Indian University/ Institution recognized by UGC.
(b) In order to be eligible for admission, the candidate must have secured a minimum of 50% marks in aggregate at the qualifying examination as given above under 1(a) or (b) as the case may be. For SC/ST candidates, the condition will be waived off. PC and OBC category candidates must have secured at least 45% marks.
(c) A candidate appearing at the qualifying examination is required to furnish a certificate from the Head of the Institution where he/she is pursuing the course of study, to the effect that he/she has appeared or will be appearing in the qualifying examination to be concluded on or before June 30 of the year of admission.
(d) If such a candidate is offered provisional admission, he/she must submit the proof of acquiring minimum eligibility criteria i.e., Marks sheet of the qualifying examination by the date of counseling.

B. INTAKE AND RESERVATIONS

The total intake in the Integrated M. Phil.-Ph.D. Course shall be 10, out of which 50% will be from NET/GATE and 50% from RET qualified candidates. In case of vacancy, seats may be filled from either category. There shall be reservation for the following categories as per Rules:

1. 15% Seats shall be reserved for Scheduled Caste, 7.5% for Scheduled Tribe and 27% for Other Backward Class candidates.

2. Admission against SC/ST seats shall be made provided the candidate has passed the qualifying examination and appeared in the Test.

3. Admission against OBC seats shall be made, provided the candidate has passed the qualifying examination with prescribed percentage of marks (for OBC candidates a relaxation of 5% marks in aggregate is provided in comparison to the requirement of minimum eligibility prescribed for general candidates) and appeared in the Test.

4. The vacant seats reserved for SC/ST/OBC candidates, if any, shall be filled as per GOI Rules.

5. 3% seats, on horizontal reservation basis, shall be reserved for PC (Physically Challenged) candidates (visually impaired 1% + hearing impaired 1% + orthopedically handicapped 1%), provided they fulfill the minimum eligibility requirements (for PC candidates a relaxation of 5% marks in aggregate in qualifying examination is provided in comparison to the requirement of minimum eligibility prescribed for general candidates) and qualify in the Test Examination. They shall have to submit a PC certificate issued by the district CMO at the time of submitting the application. Candidates who claim for PC category shall be considered under this category on an approval from the University Medical Board only at the time of admission.

6. Admission of foreign Nationals in Integrated M.Phil-Ph.D. course:
   Seats -15 % of the total seats.
   All the application forms may be submitted in the office of the International Students Advisor, International Students Centre, B.H.U. for processing for their admission. The International Students' Advisor, with the help of the Admission Committee constituted to look after the admission work of the foreign nationals shall examine the eligibility of each applicant to the course and also the equivalence of the qualifying examination passed by the candidate. The International Students Advisor shall issue the eligibility letter to the concerned foreign nationals, if they are found eligible. If there is any problem regarding equivalence of the qualifying examination passed by the candidates, the same may be referred to the Equivalence Committee constituted for foreign nationals. The last date of admission in this category will be announced by the International Students Advisor. Foreign Nationals are exempted from appearing in test they will be appear at the interview.

   All the Foreign Nationals have to fulfill the following conditions:

a) **At the time of submission of application:**
   (i) All the Foreign Nationals should submit their application, along with the processing charges, on prescribed format, which can be freely downloaded from the website: www.bhu.ac.in
   (ii) The applications of scholarship holding Foreign Nationals (under various schemes) are required to be routed through the Indian Council for Cultural Relations /Ministry of Human Resource Development (Department of Education), Govt. of India, New Delhi.
   (iii) They hold a valid foreign passport.
   (iv) They have adequate knowledge of English as per the requirements of the Course.

b) **At the time of admission:**
   (i) They have valid Residential permit in India granted for studies/student visa for the prescribed duration of the concerned Course.
   (ii) They fulfill the minimum eligibility requirements.

c) **General:**
   (i) The Degree/certificates of the candidates have been recognized and approved by the Association of Indian Universities (AIU)/Commonwealth Universities/International Association of Universities (IAU) as equivalent to the corresponding Indian degrees/certificates.
   (ii) All the eligible Foreign Nationals are required to fill up the Registration Form prescribed by the University at the time of admission.

The Inter-se merit among the applicants of various Foreign Nationals shall be decided by the "Core Committee for Admissions of Foreign Nationals", which shall be deemed as final.

d) Fee for the Foreign Nationals

The quantum of processing charges and additional charges may be modified by BHU from time to time. Fee structure for all the candidates of Foreign Nationals is as under (Fee details available on website)

  i. Processing charges (US $ 50/100) : At the time of submitting the application
 ii. Usual Course Fee (In INR)   : At the time of Joining the Degree
iii. Additional Charges   : At the time of joining the Degree

Further details regarding admission of Foreign Nationals are available on the website www.bhu.ac.in which is updated periodically.

II. ADMISSION PROCEDURE

1. Admissions to the Integrated M. Phil.-Ph.D. course will be through Research Entrance Test (RET) as mentioned in ordinance I.5.
   As mentioned in the Ph.D. ordinance, candidates will be examined for the scholastic capabilities and aptitude for research, at three levels of tests as follow:
   a) Test A: Test to assess Logical and Analytical Capability
   b) Test B: Test to assess Subject Knowledge
   c) Test C: Research proposal and Personal Interview to test aptitude for research.

2. Tests A and B will be held on a single day at multiple centres across the country while the Test C will be held at BHU in the concerned department/school/centre.

3. Certain categories of candidates, as defined in the relevant Ph.D. Ordinances of the Banaras Hindu University are exempted from appearing at Tests A and B (RET-exempted category), but would be required to qualify at Test C to be eligible for consideration for admission in the Integrated M. Phil.-Ph.D. courses. The RET-exempted categories of applicants are also required to submit application in the prescribed form as and when the applications are invited by the University.

4. Test will be conducted once a year before the July/September term.

a) Test A: Assessment of Logical and Analytical Capability

(i)   This written test is aimed to assess the logical and analytical thinking, quantitative ability, general knowledge, knowledge of computer usages, and language skills.

(ii)   Test A would be common across Faculties and would be organized by the Office of the Controller of Examinations and will be treated as preliminary screening test so that only those candidates who qualify Test A, would be eligible for further consideration.

(iii) This test will have a total of 60 MCQs (one statement with four unambiguous alternative answers from which the candidate would select the best option) distributed as follows:
   - 10 questions for testing logical thinking
   - 10 questions for testing quantitative ability
   - 10 questions for testing general knowledge
   - 10 questions for testing awareness of computer usages
   - 20 questions for testing language skills (this Test will include three subsets of 10 questions each relating to knowledge of Hindi, English and Sanskrit, respectively, of which the candidate may answer any two subsets (10+10 questions in any two languages)

(iv)   This test will be of 60 min duration and 180 total marks.

(v)   Each question will carry 03 (three) marks for correct answer and 01 (one) negative mark for a wrong answer.

(vi) A candidate must secure a minimum of 30% marks (54 marks in aggregate) in this paper to be eligible for further consideration. The said benchmark of 30% marks should not be relaxed.

(vii) No scrutiny/revaluation of the answer books of the RET shall be allowed.

(viii) The MCQs shall be designed to test the logical and analytical capabilities of the candidate, rather than memory power.

(ix) Questions in this test will generally be at a level equivalent to class X (CBSE).

b) TEST B: Assessment of Subject Knowledge

(i) This Test would focus on assessing the knowledge of the candidate in the area of Life Sciences.

(ii) Duration of this test will be 120 min (2 hr.) and it will carry 200 total marks. This test will be conducted in conjunction with the Test–A.

(iii) There will be 40 MCQ type questions (total 120 marks), with 03 (three) marks each for correct answer and 01 (one) negative mark for a wrong answer. In addition, there will be 10 (ten) short answer questions (SAQ), of which any 05 (five) questions may be answered. Each question will carry 16 (sixteen) marks (total 80 marks). Each of the SAQ should be adequately answerable within 150-200 words in the space provided in the answer sheets.

(iv) MCQs and SAQs will be based on the PG syllabus followed at BHU covering all areas in life sciences.

(v) The MCQs and SAQs will be designed to examine understanding and analytical ability. The short answers will, in addition, also examine the expression power, language skill and writing ability.

(vi) Test B would be checked and marked only if the candidate qualifies in Test A.

(vii) A candidate must secure at least 30% marks in the Test B to be eligible for further consideration. This benchmark of 30% marks shall not be relaxed.

(viii) No scrutiny/revaluation of the answer books of the RET shall be allowed.

(ix) Among those qualifying the Test B, a maximum of three times the number of vacancies announced in a given discipline will be eligible to appear at Test C. These will be identified strictly on the basis of merit order at Test B.

c) Test C: Research proposal and Interview

(i) This Test will be conducted in the concerned department/school/centre by an Interview Board to be appointed for the purpose and will carry a total of 100 marks for its two components, viz., writing a two page research proposal (30 marks) followed by personal interview (70 marks).

(ii) The concerned Head/Coordinator of department/ school/centre shall inform all RET qualified and RET-exempt candidates, as per the list received from the Controller of Examinations, the place and date/s for Test C.

(iii) All the candidates called for Test C, will be required to write, on the spot, a two page (A4 size) research proposal of their choice in 30 min and submit the same to the HOD/COS/COC. The Research proposal need not be related to the work that the candidate may actually carry out if admitted. This would essentially be a hypothetical research proposal wherein the candidate will provide a title and write the objective/s, methodology and the likely addition to knowledge by the proposed research. This would not be longer than 800 words.

(iv) The Interview Board will examine the research proposal submitted by the candidate and ask questions relating to it and other questions, including those

relating to the area in which the candidate expects to undertake research, if selected, to test his/her scholastic competence for research in the discipline.

d) Final merit order after Test C

(i) Final merit order shall be based on the composite index comprising of Academic Record plus marks obtained by a candidate in Test C. The Academic Record will be calculated as per following formula:

$M = 45 (X1 + 0.6 X2 + 0.25 X3 + 0.15 X4)/100$, where postgraduate degree is considered as the qualifying examination, and
$M = 90 (X2 + 0.4 X3 + 0.3 X4)/100$, where undergraduate degree is considered as the qualifying examination,

where,

M = Marks for the academic record, which shall be an integer. Any fraction in 'M' shall be rounded off to the nearest integer.

$X1$ = Percentage of marks obtained at the post-graduate examination,
$X2$ = Percentage of marks obtained at the under-graduate examination,
$X3$ = Percentage of marks obtained at the intermediate/higher secondary examination, and
$X4$ = Percentage of marks obtained at the high school examination.

(ii) Candidate must secure a composite index of at least 50 to be eligible for admission. Meeting the said minimum composite index requirement will not guarantee admission in the courses.

(iii) The final merit order will not take into account the marks obtained by a candidate in the Test A or Test B.

5. Names of as many candidates as the number of vacancies given in the Information Bulletin will be announced on the basis of Final Merit Order after Test C for admission. An equal number of wait-listed candidates (in order of merit) will also be prepared for consideration in case seats remain vacant.

6. Non-appearance of the candidate in RET, Test C and Interview on the scheduled date and time shall disqualify him/her for admission.

7. Mere appearance in the RET and Interview shall not entitle a candidate to be considered for admission to the courses unless he/she fulfils the eligibility conditions. Applicants must fully satisfy themselves about their eligibility before filling the application forms of RET.

8. Provisional admission shall be offered to the candidates including for reserved category seats as per their position in the Merit List and the availability of seat in course on the date of admission.

9. In case there are more than one candidate securing equal ranks as obtained by the last candidate in order of merit in the list of candidates to be called for admission, the following inter-*se* ranking rules of the University shall be applicable.
"In case the candidates have equal ranks then:
- the candidate having secured higher marks in the qualifying examination is eligible;
- In case the marks in the qualifying examination are also equal then the candidate senior in age shall be given preference".

10. The mark-sheet of the qualifying examination of a candidate is required to be submitted by the date of counseling for admission and no extension shall be given in this regard on any ground.

11. A candidate provisionally selected for admission shall be required to fill the prescribed form, submit the required documents, collect his/her admit card for admission to the course from the office of the Department and pay fees by a date fixed for the purpose, otherwise the offer made to him/her will automatically stand cancelled.

12. In case any provisionally selected candidate fails to deposit the fee by the last date

prescribed, his/her provisional admission shall be cancelled and the seat thus falling vacant shall be offered to the next candidate in order of merit under the specified category.

13. Wait-listed candidate shall be offered admissions strictly on the basis of ranking provided there is a vacancy in the Courses. Such waitlisted candidates shall have to deposit their fee latest by the date fixed by the Admission Committee.

III. CONDUCT OF THE COURSE

The Integrated M.Phil.-Ph.D. course shall have two semesters- Semester I and II for M.Phil. and semester III onwards for Ph.D. course. Students will have option for exit with M.Phil. Degree only or continuation for Ph.D. course subject to fulfilling criteria described in clause **IX.2 and IX.3** of this ordinance.

(a) The study course leading to Master of Philosophy (M.Phil.) and Ph.D. degrees of the University shall be conducted by ISLS in conjunction with Life Sciences Department(s) of the Institute of Science.

(b) M.Phil. Courses shall be of the duration of 2 semesters.

(c) To qualify for the M.Phil. Degree, the candidate must:

i) Attend regular courses of lectures, seminars, sessionals and practicals as may be prescribed for the M.Phil. Examinations in the prospectus of studies;

ii) Pass in the required number of courses taught during the 2 semesters to accumulate the stipulated minimum number of credit prescribed for the degree. An Examination shall be held at the end of each semester in various courses taught during that semester. The overall performance in sessionals, practicals and written examinations in the prescribed number of courses shall determine the result of the candidate for the M.Phil. Degree in accordance with the rules and regulations prescribed for the purpose.

iii) Sessional shall include class tests, work done in laboratory and seminar relevant to the course, as prescribed by the Board of Studies.

IV. ATTENDANCE RULES

A. For M. Phil

1. A student is required to have full, i.e., 100%, attendance and condonation up to 30% can be considered for specific cogent reasons. Out of this 30%, only 10% condonation shall be permitted without taking any application from the student. Rest 20% condonation may be given by the Director/Dean. Further, a student shall be deemed to have minimum percentage of attendance only if, apart from the above, he/she has attended at least 50% of the classes in each subject also. The cogent reasons for condonation are given below.

   (i) Participation in NCC/NSC/NSS Camps duly supported by certificate.

   (ii) Participation in University or College Team Games or Interstate or Inter-University tournaments, duly supported by certificate from the Secretary of the University Sports Board or President of the College Athletic Association concerned.

   (iii) Participation in Educational Excursions, which form a part of teaching in any subject conducted on working days duly certified by the Director/Dean.

(iv) University Deputation for Youth Festival duly certified by the Director/Dean.

(v) Prolonged illness duly certified by the Medical Officer or the Superintendent, S.S. Hospital, Banaras Hindu University or any other Registered Medical Practitioner, provided such certificate is submitted to the Director/Dean in time.

(vi) No relaxation beyond 30% shall be considered in any case.

2. The attendance of a newly admitted candidate shall be counted from the date of his/her admission, or date of beginning of classes whichever is later, while in the case of promoted candidates, attendance shall be counted from the date on which respective class begins. However in case of promotion after declaration of results of supplementary examination (if any), the attendance will be counted from the date of admission in the respective case.

   There shall be an Attendance Monitoring Committee in the Institute under the Chairmanship of the Director, Institute of Science.

B. For Ph.D.

Attendance rules will be followed as per Ph. D. ordinance of university.

V. SCALE OF TUITION AND OTHER FEES

1. The M.Phil component of the integrated M.Phil-Ph.D programme shall be a special course of study with special course fee Rs. 30,000/- per semester.

2. Candidates migrating to Ph.D. component after successfully completing M.Phil component with prescribed CGPA benchmark shall be required to pay such fees as prescribed by BHU for Ph. D. students from time to time.

VI. COURSE STRUCTURE

A. Credit requirement of the course:

The credit requirement of M.Phil component is given as Part B of the ordinance.

B. Definition of credit:

One credit shall be assigned for a one-hour lecture per week in a course whereas two laboratory hours per week in a course shall be assigned one credit.

VII. SYSTEM OF EXAMINATION

a) The examinations of M. Phil.-Ph. D. course in the Institute of Science shall be conducted in each semester, ordinarily in December/May or on such dates as may be fixed by the Institute for the various Courses/programme taught during that academic year.

b) The academic performance of a candidate shall be evaluated in respect of the courses of study prescribed for each the examinations held in that Semester evaluated in semester.

c) **The Credit System-**Each course shall have a specified number of credits. These credits describe the weightages of the concerned courses. The number of credit that a student has satisfactorily completed measures the performance of the student. Satisfactory progress of a student is subject to his/ her maintaining a minimum Cumulative Grade Point Average (CGPA). A certain minimum number of credits as specified in the syllabus must be earned by the student to qualify for the degree.

d) Each theory/ practical/ seminar course shall be of 100 marks. For evaluation, the overall structure of the distribution of marks in a course shall be such that 30 marks are allotted to various assessments during the semester, while 70 marks shall be allotted for the end semester examinations.

1. The scheme of continuous assessment during the semester (for 30 % marks):

a) The assessment (sessional) in theory courses shall comprise a class test of 1 hour duration for 20 marks and 10 marks for regularity/assignment/viva/quiz/ presentation or any other similar test.

b) The 30 % marks of sessional for courses of Laboratory exercises shall be based on completion of the laboratory exercises in due course of time/keeping up of practical record book/punctuality in the class/viva to the practicals/any other relevant judgment.

c) At the discretion of the concerned Head, a student who could not appear in the internal test(s) already conducted on account of some cogent reasons, such as late admission, illness etc., may be allowed to appear in the internal assignment/test held for such a student.

d) The class tests shall be conducted by the teacher (or group of teachers) teaching the course and the marks shall be displayed on the Notice Board.

e) Head of the Department shall ensure that all internal assessment marks of sessional are sent to the Controller of Examination prior to the commencement of End Semester Examination.

f) There shall not be any sessional marks for courses, which involve Seminar.

g) Sessional marks of a course shall be carried over for failed students in the course.

2. End Semester Examination and evaluation (for 70 % marks):

a) The question papers shall be set and the answer-scripts shall be evaluated by the teachers of the concerned courses. If there is more than one teacher teaching the course, the question paper shall ordinarily be set and evaluated by a teacher of the group, appointed by the Board of Examiners.

b) The End Semester examination answer-scripts shall be shown to the students after evaluation by the concerned teachers within 7 days of the last examination for the semester. Thereafter, within a week, all the answer books along with the statement of marks shall be sent by the examiner to the Office of the Controller of Examinations for declaration of the results.

c) In case of any objection by a student in the evaluation, the same shall be looked after by a panel of two senior faculty members, to be nominated by the Coordinator-ISLS, whose decision shall be final.

d) In cases of practical examination and project/ dissertation evaluation, external examiner may be appointed if and where considered necessary.

e) There shall be no provision for re-evaluation.

3. Admit Card (for End Semester Examinations):

a) A candidate may not be admitted into examination room unless he/she produces his/her admit card to the officer conducting the examination or satisfies such officer that it will be subsequently produced.

b) The Controller of Examinations may, if satisfied that an examinee's admit card has been lost or destroyed, grant duplicate admit card on payment of a further fee of Rs. 10/-

VIII. PERFORMANCE MEASUREMENT

The Performance of a candidate in a semester or up to a semester shall be measured by SGPA and CGPA, details of which are given below:

SGPA: Semester Grade Point Average. CGPA: Cumulative Grade Point Average.

Calculation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

$$\text{(i). } SGPA = \frac{\sum_{i=1}^{n} C_i . P_i}{\sum_{i=1}^{n} C_i}$$

where,

C_i = Number of credit assigned for the ith course of a semester for which SGPA is to be calculated; P_i = Grade point earned in the ith course.

i = 1, ------- n, represent the number of courses in which a student is registered in the concerned semester.

Note: For calculation of SGPA and CGPA, credit of compulsory and optional courses shall not be taken into account.

$$(i). \quad CGPA = \frac{\sum\limits_{j=1}^{m} C_j \cdot P_j}{\sum\limits_{j=1}^{m} C_j}$$

where,

C_j = Number of credit assigned for the jth course, up to the semester for which CGPA is to be calculated.

P_j = Grade point earned in jth course.

$j = 1, \text{-------} m$; represent the number of courses in which a student was registered up to the semester for which CGPA is to be calculated.

A. **Grading System:** The grading system, as detailed hereunder in Table 1 shall be applicable for each course:

Marks Range (Out of 100)	Grade	Grade Point
90 -100	S	10
80 - 89	A	9
70 - 79	B	8
60 - 69	C	7
50 - 59	D	6
40 - 49	E	5
Passed with Grace	P	4
00 - 39	F	0
Non-appearance in examination (Incomplete)	I	0
Incomplete Project / Dissertation / Training	X	0

Explanation:

Latter grades S, A, B, C, D, E and P in a course mean that the candidate has passed that course.

The F grade: The "F" grade denotes poor performance, i.e., failing in the course. A student has to appear at subsequent examination(s), if provided under the ordinances in all courses in which he/she obtains "F" grade, until a passing grade is obtained.

The I Grade: The "I" Grade is awarded, when a student does not appear in the examination of course/courses. This shall be treated as "F" Grade.

The X Grade: An "X" Grade is awarded to a student if he/she does not complete Project/Dissertation/Training. This will be converted to a regular grade on the completion of the Project/Dissertation/Training Work and its evaluation. The "X" Grade shall be treated as "F" Grade.

B. **Grace Rule:** Tabulators shall award grace marks as per the following guidelines:

- A student who fails in not more than 3 theory courses by total marks of not more than ½ the number of total theory courses of the semester (any) fraction is rounded off to the next higher number), shall be awarded grade "P" (in place of grade "F") of Grade Point 4 in the concerned courses.
- Grace Mark will not be awarded for making up shortfall in minimum SGPA/CGPA or improving the grade.

IX. PROMOTION RULES AND SUPPLEMENTARY EXAMINATION

1. M. Phil. (Two Semesters) Course

There shall be a provision of supplementary examinations for I and II Semesters after declaration of results of II Semester. Students failing in courses of I and II Semesters may appear in the supplementary examination.

(A) First Semester Course & Examination

The candidates who have taken admission in the I Semester of Integrated M.Phil.-Ph.D. Courses in a session can be placed in the following two categories on the basis of their attendance in the Semester:

I. (**i**)   Those who have fulfilled the required minimum percentage of attendance for appearing in the First Semester Examination and filled up the examination form in time for appearing at the First Semester Examination.

    (**ii**)   Those who have not fulfilled the required minimum percentage of attendance for appearing in the First Semester Examination or did not fill up examination form in time for appearing at the First Semester Examination.

Candidates under Category I (i) are eligible for appearing at the examination of First Semester, while candidates under Category I (ii) are not allowed to appear at the examination of the Semester. However, category I (ii) candidates are allowed to reappear at the M. Phil admission test of subsequent year(s) for

seeking admission afresh. This implies that no readmission is permissible to those who have not fulfilled the required percentage of attendance for appearing at the examination or did not submit the examination form in time.

II.   After appearing at the Examination of First Semester, the candidates can be placed   in the following categories in the context of declaration of the results of the First Semester Examination:

- **Passed,** i.e., those who have passed in examinations of all courses of the Semester.
- **Promoted,** i.e., those who   have   not passed   in examinations of all the courses of the Semester.
- Minimum passing grade: Grade 'E' for each course. However, candidates with grade 'P' in a course shall also be considered as passed in that course.
- Promotion to Second Semester: All students who have fulfilled minimum percentage of attendance in Semester I and filled up the examination form in time shall be promoted to Semester II.

(B) Second Semester Course & Examination

As in the First Semester, all the candidates who have fulfilled minimum percentage of attendance for appearing at the second semester Examination and have filled in the examination form in time for appearing at the End Semester Examination shall be allowed to appear at the respective examinations. However, students who have not fulfilled the minimum percentage of attendance or did not fill up the Examination form in time in Semester shall be allowed to take re-admission in that Semester (except in the First Semester where re-admission is not permitted).

(C) Declaration of Results after II-Semester (Based on the results of the I and II- Semester Examination)

    After declaration of results of I and II-Semesters, a candidate can be placed   in   the   following   two categories:

(**i**) **Passed:** A candidate who has passed in all the courses of I and II Semesters and obtained at least CGPA of 5.0.

(**ii**) **Failed:**   All those students who have not "Passed" shall be categorized as "Failed".

    Such failed students may clear their failed courses in subsequent available supplementary examinations or main examinations as ex-students. For clearing a course, a student shall have only 03 attempts (1 main examination and 02 attempts in next available supplementary/ main examination). In case he/she fails to clear a course in three attempts, he/she will be treated as failed and would have to leave the courses.

(D) Declaration of Division

    A candidate who has passed in all the papers/ courses of Ist, IInd Semesters of 1-year M. Phil courses taken together shall be declared as 'Passed'. Such passed candidates may be awarded with the

division according to the following criteria:

   (i)   First Division with distinction   : CGPA 8.5 and above
   (ii)   First Division   : CGPA 6.5 and above, but below 8.5
   (iii)   Second Division   : CGPA 5.0 and above, but below 6.5

Note: The SGPA and CGPA shall be computed upto 2 places of decimals (truncated at the second place).

The conversion formula for converting CGPA to the corresponding Percentage of Marks will be as follows:

$$X = 10 Y - 4.5$$

where, X = Percentage of Marks
                Y = CGPA

(E) Ranking to the Candidates

Ranking shall be given to only those candidates who pass all the courses of the courses in one attempt.

Notwithstanding any provision in the ordinances to the contrary, the following category of examinee is also eligible for ranking:

The marks obtained by him/her at the examination shall be considered as the basis for the University Ranking, Scholarships and other distinctions.

In order to get the benefit of this provision, the student should claim that he/she is eligible for this benefit and get a decision in writing after proving his/her eligibility therefore.

(F) Maximum duration for passing the M. Phil. of the Integrated M. Phil.-Ph.D. Courses:

The maximum duration for completion of the M. Phil. of the Integrated M.Phil.-Ph.D. Courses shall be two years. In case he/she fails to clear the courses of the courses within two years of his/her admission in the courses, his/her name will be struck off from the roles of the University and he/she will have to leave the courses.

2. Option for Exit with M. Phil. Degree only or Continuation for Ph.D. course

A student admitted to the Integrated M. Phil.-Ph.D. Courses will become eligible for the award of M. Phil. degree after fulfilling requirements as prescribed above in the present Ordinance. The students will have an option to exit from the courses with M. Phil. Degree only or to continue as Ph.D. scholar subject to fulfilling the minimum requirement prescribed for admission for the Ph.D. courses as stated in the Clause 3 of this Ordinance.

3. Migration of pass-outs of M.Phil. Degree to the Ph.D. course of the Integrated M.Phil.-Ph.D. in Life Sciences

A student admitted in the Integrated M. Phil.-Ph.D. Course of the Institute of Science will be registered for the Ph.D. course provided he/she has passed the M. Phil. Degree course of the Integrated M. Phil.-Ph.D. Course with a minimum CGPA of 6.5 and appears for an interview before a selection committee duly appointed by the Coordinator, ISLS, Institute of Science.

4. Ordinance applicable during Ph.D. Course

Notwithstanding the provisions contained in these Ordinances governing the students of Integrated M. Phil.-Ph.D. Course, existing "Ordinance Governing the Award of the Degree of Doctor of Philosophy/Vidyāvāridhi" of the Banaras Hindu University" shall be applicable to the Research Scholar after their migration/registration for the Ph.D. degree course as per the procedure prescribed at para 3 above. However, Integrated M. Phil.-Ph.D. students will be exempted from the Ph.D. course work as prescribed in the Ph.D. Ordinance of the University.

X. FURTHER CLARIFICATIONS

a) One odd and one even semester shall comprise one academic year, and the academic year in these ordinances shall mean the year from July to June.

b) Academic calendar for the odd and even semesters shall be notified at the beginning of every academic year.

c) A student who is promoted to a higher semester or readmitted to a semester due to shortage of attendance shall be required to study the same syllabus as being taught in that year.

XI. RE-ADMISSION TO THE COURSE/SEMESTER

A student who does not fulfill at least the minimum percentage of attendance required in the, I semester shall not be promoted to the higher semesters. However, such students can take fresh admission in the Integrated M. Phil.-Ph.D. Course after appearing in the Test and being eligible for admission in the course on the basis of result of the Test of the concerned year.

All such students of II semester who have not fulfilled the required minimum percentage of attendance or not filled in the examination form in time shall have the option to be re-admitted in the concerned semester available in the immediately following academic session. No student who has been promoted to the II semester and continues to be a student shall be allowed to reappear in the Test of the same courses for taking fresh admission in the courses.

XII. BREAK IN THE COURSE

Any student taking admission in Integrated M.Phil.-Ph.D. in Life Sciences of the Institute of Science shall not be allowed to pursue any other full time courses/course in the Institute or elsewhere in the entire period of the courses meaning thereby that if a student leaves the courses after passing some of the semesters/courses and takes up a full-time courses/course elsewhere, then he/she shall not be allowed to continue the courses further in the Institute.

XIII. SYLLABUS

The syllabi for the Integrated M. Phil.-Ph.D. Course shall be framed by the ISLS, Institute of Science.

PART - B

DISTRIBUTION OF COURSES AND CREDITS

Semester-I (10/12 Credits)

Compulsory theory courses (10 Credits)

ISMP 101 - Fundamentals of Modern Life Sciences	3 credits
ISMP 102 - Biotechniques	3 credits
ISMP 103- Biostatistics and Bioinformatics	3 credits
ISMP 104- Ethics in Science and Science communication	1 credits

Optional theory courses

(Any 2 to be opted in semester I and /or semester II, 4 Credits)

ISMP 105- Developmental Genetics	2 credits
ISMP 106- Cancer Biology	2 credits
ISMP 107- Basic Human Genetics	2 credits
ISMP 108- Advances in Biochemistry	2 credits
ISMP 109- Mammalian Endocrinology	2 credits
ISMP 110- Microbiology	2 credits
ISMP 111- Plant Biochemistry and Biotechnology	2 credits
ISMP 112- Neurobiology	2 credits
ISMP 113- Population and Evolutionary Genetics	2 credits
ISMP 114- Plant pathology and plant protection	2 credits

Semester-II (10/8 Credits)

ISMP 201- Development of Laboratory skills	3 credits
ISMP 202- Writing and Presentation of Research Project	3 credits

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Course Contents

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ISMP 101: Fundamentals of Modern Life Sciences (3 Credits)

1. Origin of Life

2. Biomolecules:

    2.1   Nucleic Acids: DNA- Watson-Crick double helix model, tools for studying DNA structure, Central dogma and epigenetic modifications, RNA- coding and non-coding, relevance of non-coding RNA in gene expression regulation

    2.2   Carbohydrates: types- simple and complex, relevance in energy metabolism

    2.3   Proteins: sorting, trafficking, post translational modifications

    2.4   Lipids: types- lipoprotein complex and role in lipid transport.

3. Cell Cycle

    3.1. Overview of the cell cycle

    3.2. Cell cycle regulation

4. Cell signalling

    4.1. Concept of ligand, receptor and second messenger

    4.2. Signaling through G-Protein-Coupled Receptors (GPCRs)

    4.3. Signaling through enzyme-coupled cell surface receptors: RTK, PI-3-kinase/AKT, JAK/STAT, TGF-beta/Smad, NF-kB

    4.4. Signaling pathways involved in development: Notch, Wingless, Hedgehog

    4.5. Nuclear receptor superfamily

    4.6. Signaling crosstalk

5. Biochemical Energetics

    5.1   Concept of free energy, determination of ΔG, ΔG and oxidation-reduction reactions

    5.2   Energy rich compounds- ATP, Acyl phosphates, thiol esters, guanidinium phosphates

    5.3   Energy production- substrate level and oxidative phosphorylation, mitochondrial electron transport system, alternative oxidase and its significance, Chemiosmotic theory

    5.4   Photosynthesis-Light harvesting complexes, mechanism of electron transport, photoprotective mechanism, non-photochemical quenching and state transition.

6. Development and Differentiation:

    6.1   Competence, induction, specification and differentiation

    6.2   Early development in Sea Urchin, frog and chick model systems

    6.3   Body Pattern formation in *Drosophila* embryo, Vertebrate limb patterning

    6.4   Morphogenesis in cyanobacteria using model organism, *Fremyella diplosiphon*

    6.5   Cell differentiation, root and shoot development, and floral development in *Arabidopsis*

7. Cell transformation and tumorigenesis

    7.1   Evolution of cancer

    7.2   Oncogenes and Tumour suppressor genes

    7.3   Genomic instability

8. Stress physiology of plants

    8.1   Responses of plant to biotic and abiotic stresses

    8.2   Molecular mechanisms of signal transduction during stress

Recommended books:

1. Boyer: Concepts in Biochemistry (3rd ed. 2006, Brooks/Cole)
2. Lehninger, Nelson & Cox: Principles of Biochemistry (4th ed, 2007, Worth),
3. Stryer: Biochemistry (6th ed. 2006, Freeman)
4. Alberts et al: Molecular Biology of The Cell (6th ed. 2015, Garland Science)
5. Gilbert, Developmental Biology (10th ed. 2015, Sinauers)
6. Wolpert, Principles of Development (4th ed. Oxford)
7. Krebs et al: Lewin's Genes XI (2014, Jones & Bartlett)
8. Strachen & Read: Human Molecular Genetics (4th ed., 2014)

9. <u>Buchanan</u> et al: Biochemistry & Molecular Biology of Plants (2nd ed.,2015, Wiley)
10. <u>Lincoln Taiz</u>, <u>Eduardo Zeiger</u>, I.M. Moller and A. Murpy: Plant Physiology and Development (6th ed, 2015, Sinauers Associate Inc.)

ISMP 102: Biotechniques (3 Credits)

1. Microscopy: Principles and types
2. Cell culture techniques: Sterilization, media preparation, animal and plant tissue culture
3. Histological and Histochemical techniques
4. Centrifugation: Principle, differential and density gradient
5. Spectrophotometry: Laws, types of spectrophotometer
6. Chromatography: TLC, paper, gel filtration, ion exchange, affinity
7. Electrophoresis: Principles, native and denaturing, two-dimension
8. Radiotracer techniques: Principle and applications, half life, liquid and solid scintillation counters, safety rules
9. Detection of proteins, protein-protein and DNA-protein interactions: Western blotting, Immunoprecipitation, Yeast 2-hybrid, Far Western, South-Western, EMSA, DNA-Foot printing, Chromatin immunoprecipitation (ChIP)
10. Mass spectrometry and applications
11. DNA Sequencing: traditional and Next Generation Sequencing (NGS)
12. Recombinant DNA techniques: Restriction endonuclease, gene cloning, transfection
13. Application of recombinant DNA technology: Transgenic organisms, site-directed mutagenesis, knock-out mutation, CRISPR – Cas9
14. Gene expression analysis: Designing primers and PCR, Real Time-PCR, Northern blotting

Recommended Books:
1. Karp: Cell and Molecular Biology (2007, Wiley)
2. Lodish et al: Molecular Cell Biology (2007, Freeman)
3. Sambrook & Russell: Molecular cloning A Laboratory Manual (3rd ed. 2007)
4. Bancroft & Stevens: Theory and Practice of Histological techniques (2002, Churchill-Livingstone)
5. Pearse: Histochemistry: Theoretical and Applied (Vol. I, II & III) (4th ed 1980-1993, Churchill-Livingstone)
6. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd ed.1993, Benjamin/ Cumin)
7. Switzer and Garrity: Experimental Biochemistry (92nd ed. 1999, Freeman)
8. Wilson and Walker: Principles of Biochemical and Molecular Biological Techniques (6th ed 2006, Cambridge University Press)

ISMP 103: Biostatistics and Bioinformatics (3 Credits)

Biostatistics (1.5 Credits)
1. Collection and classification of data, Graphical presentation of qualitative and quantitative data (Bar diagram, Pie diagram, Histogram, Frequency polygon, frequency curve and ogive, and box plot)
2. Measures of central tendency (mean, median and mode), measures of dispersion (variance and standard deviation), concept of coefficient of variation, skewness and kurtosis
3. Correlation (continuous data and ordinal data) and regression (linear and curvilinear), concept of coefficient of determination
4. Concept of probability
5. Concept of standard error and p value, parametric test (Z and t, both paired non-parametric and unpaired) and test (Chi-square)
6. Analysis of variance: one way and multiple comparison, post-hoc tests
7. Principal component analysis

Recommended books:
1. Bruning &.Kintz: Computational Handbook of Statistics, ((1977, Scott)
2. Daniel: Biostatistics: A Foundation for Analysis in Health Sciences.((2000, John Wiley).
3. Milton & Tsokos: Statistical Methods in the Biological and Health Sciences, (1983, McGraw Hill)
4. Quinn & Keough: Experimental Design and Data Analysis for Biologists,(2002, Cambridge Univ)
5. Sharma: Text Book of Biostatistics-I&II, (2008, Discovery Publishing)
6. Snedecor & Cochran: Statistical Methods, (1968, Oxford & IBH)
7. Sokal & Rohlf: Biometry, ((2000, Freeman)
8. Steel & Torrie: Principles and Procedure of Statistics: A Biometrical Approach, (1980 McGraw Hill Book Co).
9. Zar: Biostatistical Analysis (2003, Pearson).

Bioinformatics (1.5 Credits)
1. Introduction to computers, networks and information technology
2. Introduction and scope of Bioinformatics: A concept of digital laboratory
3. Introduction to data archiving systems: FASTA format, Accession, and GI-Number
4. Databases, search and retrieval: NCBI, Swiss-prot, PIR, PDB, KEGG, PubMed
5. Concept of homology: BLAST, Clustal-X and their applications
6. Protein structure bioinformatics: Protein visualization, structure comparison, homology modeling

Recommended Books:
1. Barnes & Gray: Bioinformatics for geneticists (2003, Wiley)
2. Lesk: Bioinformatics (2nd ed 2006, Oxford)
3. Westhead et al: Bioinformatics Instant Notes (Indian ed 2003, Viva Books)
4. Mount, Bioinformatics (2nd ed 2006, CBS)
5. Hunt and Livesey: Functional Genomics (2006, Oxford)
6. Campbel: Discovering Genomics, Proteomics and Bioinformatics (2006, LPE)

ISMP 104: Ethics in science and science communication (1 Credit)
1. Science and ethics : Science as the social, cultural and human pursuit; The source of ethical issues in science: examples from different disciplines - biotechnology, medical sciences, defense research and development, environmental issues, space research, energy, food security, etc.
2. Social and moral responsibilities of scientists and activists
3. Ethical issues in science research and reporting: objectivity and integrity, international norms and standards
4. Scientific temper and virtues; expectations from scientific community
   Desired temper of scientists: truthfulness, simplicity, humility, open mindedness; attitude of service towards social and human well being
5. Socio–Legal issues: Originality, Integrity, Intellectual Property Rights, Patents, Plagiarism
6. Nature and importance of Communication in Science
7. Preparation of manuscripts: review articles, research papers, books, monograms, research projects; review of manuscripts
8. Survey of literature and presentation of data
9. Preparation of power point presentation

Optional theory courses (any 2 to be opted)

ISMP 105: Developmental Genetics (2 Credits)
1. Fertilization in sea urchin and mammals
   1.1. Acrosomal reaction and gamete interaction

      1.2. Prevention of polyspermy
2. Early development
    2.1. Cleavage
    2.2. Gastrulation (amphibians and aves)
    2.3. General concept of potency, commitment, specification, induction and competence

3. Differentiation and pattern formation
    3.1. Stalk and fruiting body formation in *Dictyostelium*
    3.2. Anterior-posterior and dorso-ventral polarity and pattern formation in *Drosophila*, HOX genes and patterning in frog, chick and mammals
4. Late embryonic development
    4.1 Vulva formation in Caenorhabditis
    4.2 Neural tube development and limb patterning in vertebrates
5. Senescence and regeneration
6. Stem cells and application
7. Clinical embryology:
    7.1. Congenital malformation and teretogenesis
    7.2. Reproductive failure and assisted reproduction

Recommended Books:
1. Gilbert, Developmental Biology (10th ed. 2015, Sinauers)
2. Wolpert, Principles of Development (4th ed. Oxford)
3. Alberts et al: Molecular Biology of The Cell (6th ed. 2015, Garland Science)

ISMP 106: Cancer Biology (2 Credits)
1. Cell transformation and tumorigenesis: Sporadic and familial cancers (retinoblastoma, colorectal and breast cancer)
2. DNA repair genes, genetic instability and cancer
3. Genetic heterogeneity and clonal evolution of cancer
4. Telomerase and centrosomal malfunction
5. Epigenetic modifications
6. Tumour progression: angiogenesis and metastasis
7. Cancer stem cells
8. Environment and cancer: Physical, chemical and biological carcinogens

Recommended Books:
1. Cowell: Molecular Genetics of Cancer. (2001, Bios).
2. Ehrlich: DNA Alterations in Cancer. (2000, Eaton).
3. Gersen & Keagle: Principles of Clinical Cytogenetics. (1999, Humana)
4. Meesfeld: Applied Molecular Genetics. (1999, Wiley-Liss)
5. Ptashne: Genetic Switch. (1986, Blackwell)
6. Stillman: Molecular Genetics of Cancer. (1994, CSHL)

ISMP 107: Basic Human Genetics (2 Credits)
1. History of human genetics
2. Pedigrees: Gathering family history, Pedigree symbol, Construction of pedigrees, Presentation of molecular genetic data in pedigrees, Pedigree patterns
3. Monogenic traits: Autosomal inheritance (dominant, recessive), Sex linked inheritance, Sex limited and sex influenced traits, Mitochondrial inheritance
4. MIM number: complications to the basic pedigree patterns- nonpenetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity
5. Genomic imprinting and uniparental disomy, spontaneous mutations, mosaicism and chimerism, male lethality, X-inactivation
6. Complex traits: Approaches to analysis of complex traits
7. Human cytogenetics: Techniques in human chromosomal analysis, Human karyotype- banding,

nomenclature of banding

8. Pathology of human chromosomes, nomenclature of aberrant karyotypes
9. Common syndromes due to numerical chromosome changes
10. Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletion, fragile sites)
11. Common chromosome abnormalities in cancer
12. Genetics of fetal wastage

Recommended Books:
1. Strachen & Read: Human Molecular Genetics (4th Ed., 2014)
2. Mange and Mange: Basic Human Genetics. (2005,Sinauer Assoc).
3. Gersen & Keagle: The Principles of Clinical Cytogenetics. (2005, Humana)
4. Connor & Smith: Essentials of Medical Genetics. (1997, Blackwell)
5. Davies: Human Genetic Disease Analysis. (1993,IRL)
6. Emery and Mueller: Elements of Medical Genetics. (1992, ELBS)
7. Jorde et al : Medical Genetics. (2005, Elesvier).
8. Korf : Human Gentics. (2006, Blackwell).
9. Lewis: Human Genetics. (2006, WCB).

ISMP 108: Advances in Biochemistry (2 Credits)
1. Chromatin structure and gene regulation
    1.1 Chromatin organization
    1.2 DNA replication
    1.3 Transcription
    1.4 Promoter analysis and characterization
    1.5 Post transcriptional gene silencing
    1.6 Epigenetic regulation of gene expression
2. Proteins
    2.1 Structures, determination of primary structure, structure-function relations
    2.2 Translation and regulation
    2.3 Interferons and their applications
3. Enzymology
    3.1 Applications of enzyme kinetics
    3.2 Enzyme: distribution, diversity and evolution
    3.3 Principles and applications of enzyme assay
    3.4 Enzyme technology- markers, sensors, diagnosis
4. Metabolic Regulation
    4.1 Concept of metabolic energy transduction
    4.2 Regulatory mechanisms of major metabolic pathways and their significance
5. Metabolic disorders
    5.1 Glycogen storage disease
    5.2 Mucopolyscharidosis
    5.3 Diabetes mellitus

Recommended Books:
1. Watson et al: Molecular Biology of the Gene, (6th ed., 2008, Cold Spring Harbor)
2. Brown: Genomes (3rd ed., 2006, Garland Science)
3. Krebs et al: Lewin's Gene XI (2015, Jones & Bartlett)
4. Zubay et al: Biochemistry (4th ed., 1998, WCB)
5. Voet & Voet: Biochemistry (4th ed., 2004, John Wiley)
6. Berg et al: Biochemistry (6th ed., Freeman)
7. Kindt et al: Kuby's Immunology (6th ed., 2007, Freeman)
8. Price & Stevens: Fundamentals of Enzymology (2nd ed., 1988, Oxford)
9. Fersht: Enzyme Structure and Mechanisms (2nd, ed., 1985, Freeman)

ISMP 109: Mammalian Endocrinology (2 Credits)

1. Mechanism of hormone action: Peptide hormones, Steroid hormones (genomic and nongenomic pathways)
2. Hypothalamo-hypophysial System: General organization, Neural control of adenohypophysis
3. Adenohypophysial hormones: chemistry and physiological roles of Somatotropin and prolactin, Glycoprotein hormones (FSH, LH and TSH), Pro-opiomelanocortin hormones
4. Neurohypophysial octapeptides (oxytocin and vasopressin)
5. Thyroid hormones: biosynthesis, control of secretion and physiological roles
6. Steroid hormones: biosynthetic pathways
7. Testis: organization and physiological roles of androgens
8. Ovary: organization and physiological roles of estrogen, progesterone, relaxin and inhibin
9. Adrenal: Organization, Physiological role of mineralocorticoid and glucocorticoid hormones, Catecholamine biosynthesis, release and physiological role.
10. Role of parathormone, calcitonin and vitamin D in calcium homeostasis
11. Endocrine pancreas: Physiological functions of insulin and glucagon
12. Pineal gland: Melatonin and photoperiodic measurement, biological clock and calendar

Recommended Books:

1. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
2. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
3. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
4. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
5. Schreibman & Pang: Vertebrate Endocrinology Vol I-IV, Fundamentals & Biomedical Implications (1985 & onwards, Academic Press)
6. Hadley & Levine: Endocrinology, (6th ed. 2009, Pearson Education)
7. Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
8. Turner and Bagnara: General Endocrinology (1984, Saunders)
9. Kronen Breg: Williams Textbook of Endocrinology (11th ed. 2008, Saunders & Elsevier)

ISMP 110: Microbiology (2 Credits)

1. Present status and future challenges in microbiology
2. A brief idea of microbial diversity; evolution of microorganisms – RNA world hypothesis, endosymbiotic theory; A general account of Archaea
3. Isolation, purification and establishment of pure culture of microorganisms; major types of cultures – batch, continuous and synchronous
4. Nutritional types of microorganisms; symbiotic associations - *Rhizobium*-legume symbiosis and mycorrhiza
5. Anoxygenic photosynthesis with special reference to light reaction in purple bacteria; methanogenesis
6. Genetics of bacteria: Genetic recombination- an overview; mechanisms of transformation, conjugation and transduction in bacteria; role of microorganisms in genetic engineering
7. Lytic cycle in T even phages and its regulation; lysogeny and its regulation in lambda phage; a brief account of viroids and prions
8. Role of microbes in wastewater treatment with special reference to activated sludge
9. Basic design of a fermentor; biosensors

Recommended Books:

1. Madigan et al: Brock Biology of Microorganiss. (14th ed., 2014, Benjamin Cummings).
2. Stanier et al: General Microbiology. (5th ed., 1987, MacMillan).
3. Talaro & Chess: Foundations in Microbiology. (8th ed. 2011, McGraw-Hill).
4. Willey et al: Prescott's Microbiology. (9th ed., 2013, McGraw-Hill).

ISMP 111: Plant Biochemistry and Biotechnology (2 Credits)
1. Biological nitrogen fixation
   1.1 Nitrogenase enzyme
   1.2 Substrates for nitrogenase
   1.3 Mechanism of reaction and its regulation
2. Inorganic nitrogen metabolism
   2.1 Nitrate and nitrite reductases, their inhibitors
   2.2 Localization and regulation
   2.3 Pathways of ammonia assimilation
   2.4 Regulation of nitrogen assimilation
3. Sulphur and phosphorus metabolism
   3.1 Sulphate uptake, activation and transfer
   3.2 Assimilatory pathways of sulphate reduction
   3.3 Transport and assimilation of phosphate
4. Principles, methods and applications of genetic transformation in plants
   4.1 Gene transfer methods: particle bombardment, electroporation, PEG and Agrobacterium mediated; floral dip method
   4.2 Marker and reporter genes
   4.3 Marker-free transgenic
   4.4 Transgene silencing
5. Functional Geneomics
   5.1 Concept mapping and sequencing of genomes: *Arabidopsis*, rice and tomato
   5.2 Genome annotation
   5.3 Approaches to analyze differential expression of genes
   5.4 Principles of reverse genetics
   5.5 Gene tagging, Gene trapping and Gene silencing
   5.6 Genome engineering/editing technologies (ZFNs, TALENs, CRISPR/Cas9, Recombineering)

Recommended Books:
1. Agrios: Plant Pathology (1988 Academic Press).
2. Lucas: Plant Pathology and Plant Pathogens (1998,Wiley-Blackwell, CRC Press)
3. Dickinson, C.M.,: Molecular Plant Pathology (2003, Bios Scientific Publisher).
4. Robert et al: Plant Pathology: Concepts and Laboratory Exercises (2003, CRC Press).
5. Bridge et al: Molecular Variability of Fungal Pathogens (1998, CAB International).
6. Singh: Principles of Plant Pathology (2008, Oxford and IBH Publishing Co. Pvt. Ltd).
7. Dhingra et al: Basic Plant Pathology Methods (1995, CRC Press)
8. Hartl & Jones: Genetics – Analysis of Genes and genomes (7th ed., 2007, Jones & Barlett Publishers,)
9. Allard: Principles of Plant Breeding (2nd ed., 1999, John Wiley & Sons)
10. Weigel and Glazebrook : *Arabidopsis* (2002, Cold Spring Harbor Laboratory Press)

ISMP 112: Neurobiology (2 Credits)
1. Organization of nervous system
   1.1 Brain structure: regional organization, neural system, circuit
   1.2 Neurons and glia
   1.3 Blood brain barrier
2. Axonal and synaptic transmission
   2.1 Membrane potential, action potential, transmission of nerve impulse
   2.3 Synapse: types, synaptic transmission- chemical and electrical
   2.4 Excitatory and inhibitory post-synaptic potential
   2.5 Chemical transmission, neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides

3. Learning and memory
   3.1 Types
   3.2 Synaptic plasticity, Hebb's Rule
   3.3 Tools for memory assessment- Morris water maze, Radial arm maze
   3.4 Molecular mechanisms
4. Brain and behaviour
   4.1 Motivation
   4.2 Sleep- types, mechanisms
5. Brain imaging
   5.1 CAT
   5.2 PET
   5.3 MRI
6. Brain aging: structural and functional changes (neurogenesis, neuroplasticity, neurodegeneration, neuroprotection)
7. Neuropathology
   7.1 Strokes
   7.2 Epilepsy
   7.3 Alzheimer disease
   7.4 Huntington disease
   7.5 Parkinson disease

Recommended Books:
1. Longstaff: Neuroscience (2002, Viva Books)
2. Shepherd: Neurobiology(1994, Oxford Univ Press)
3. Squire et al: Fundamental Neuroscience(2003, Academic Press)
4. Eric Kandel: Principles of Neural Science (2000, Mc Graw Hill)
5. Ganong: Review of Medical Physiology (22nd Ed 2005, Lang Medical Publications)

ISMP 113: Population and Evolutionary Genetics (2 Credits)
1. Development and concept of synthetic theory
2. Concepts of punctuated equilibrium, concerted evolution and Co-evolution
3. Population genetics
   3.1 Gene frequency in Mendelian population
   3.2 Hardy-Weinberg equilibrium
   3.3 Conditions for the maintenance of genetic equilibrium
4. Elemental forces of evolution
   4.1 Mutation
   4.2 Natural selection
   4.3 Random genetic drift
   4.4 Migration
5. Genetic polymorphisms at the levels of chromosomes, allozyme and DNA
6. Genetic coadaptation and linkage disequilibrium
7. Isolating mechanisms
8. Concepts of species and modes of speciation: Sympatric and allopatric
9. Evolution at molecular level
   9.1 Molecular phylogenies
   9.2 Neutral theory
   9.3 Molecular clock

Recommended Books:
1. Charlesworth and Charlesworth: Elements of Evolutionary Genetics (2010, Roberts)
2. Dobzhansky: Genetics and the Origin of Species (1964, Columbia)
3. Graur and Li: Fundamentals of Molecular Evolution (2000, Sinauer)

4. Hall and Hallgrimsson: Strickberger's Evolution (2008, Jones and Bartlet)
5. Hartl and Clark: Principles of Population Genetics (1989 and 1997, Sinauer)
6. Hedrick: Genetics of Populations (2005, Jones and Bartlett Publ Inc)
7. Kimura: The Natural Theory of Molecular Evolution (1983, Cambridge)
8. Mayr: Animal Species and Evolution (1966, Belknap Press)
9. Nei and Kumar: Molecular Evolution and Phylogenetics (2000, Oxford)
10. White: Modes of Speciation (1978, Freeman)

ISMP 114- Plant pathology and plant protection (2 Credits)

1. Historical and developmental aspects of plant pathology
2. Mode of infection and role of enzymes and toxins in plant disease
3. Defense mechanisms of plants against infection: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds
4. Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management
5. Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, systemic acquired resistance (SAR) mechanism; application of molecular biology to plant disease control – transgenic approach for crop protection, engineering chemicals that elicit defense response to plants
6. Study of plant diseases caused by fungi, bacteria, viruses, nematodes and mycoplasma like organisms: Wart disease of potato, blight of colocasia, downy mildew of cucurbits, stem gall of coriander, ergot of bajra, smut of sugarcane, Karnal bunt of wheat, linseed rust, Tikka disease of groundnut, red rot of sugarcane, Panama disease of banana, bacterial blight of rice, yellow vein mosaic of bhindi, mosaic of sugarcane, potato spindle tuber mosaic, ear cockles of wheat, grassy shoot of sugarcane, phylloidy of sesamum, Citrus greening

Recommended Books:
1. Agrios, G. N: Plant Pathology (1988, Academic Press).
2. John A Lucas: Plant Pathology and Plant Pathogens (1998, Wiley-Blackwell, CRC Press).
3. Dickinson, C. M: Molecular Plant Pathology (2003, Bios Scientific Publisher)
4. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., Plant Pathology: Concepts and Laboratory Exercises,(2003, CRC Press).
5. Bridge, P.D and Clarkson, J.M., Molecular Variability of Fungal Pathogens, (1998, CAB International)
6. Singh, R. S., Plant Diseases, (2008, Oxford and IBH Publishing Co. Pvt Ltd)
7. Singh, R. S., Principles of Plant Pathology, (2008, Oxford and IBH Publishing Co. Pvt Ltd).
8. Dhingra, O.D. and James, B. Sinclair, Basic Plant Pathology Methods, (1995, CRC Press)

Semester II (10/8 Credits)

ISMP 201: Development of Laboratory Skill (3 Credits)

A Student will devote full time in a lab allotted to him/her, will learn techniques being used in the laboratory and will master three techniques (both theoretically and practically), will maintain a lab book showing these techniques used, experimental results obtained and will present them during the viva voce examination.

ISMP 202: Writing and Presentation of Research Project (3 Credits)

The student will review literature, write a dream/actual project, present it in the form of a seminar and develop skills for research paper writing.