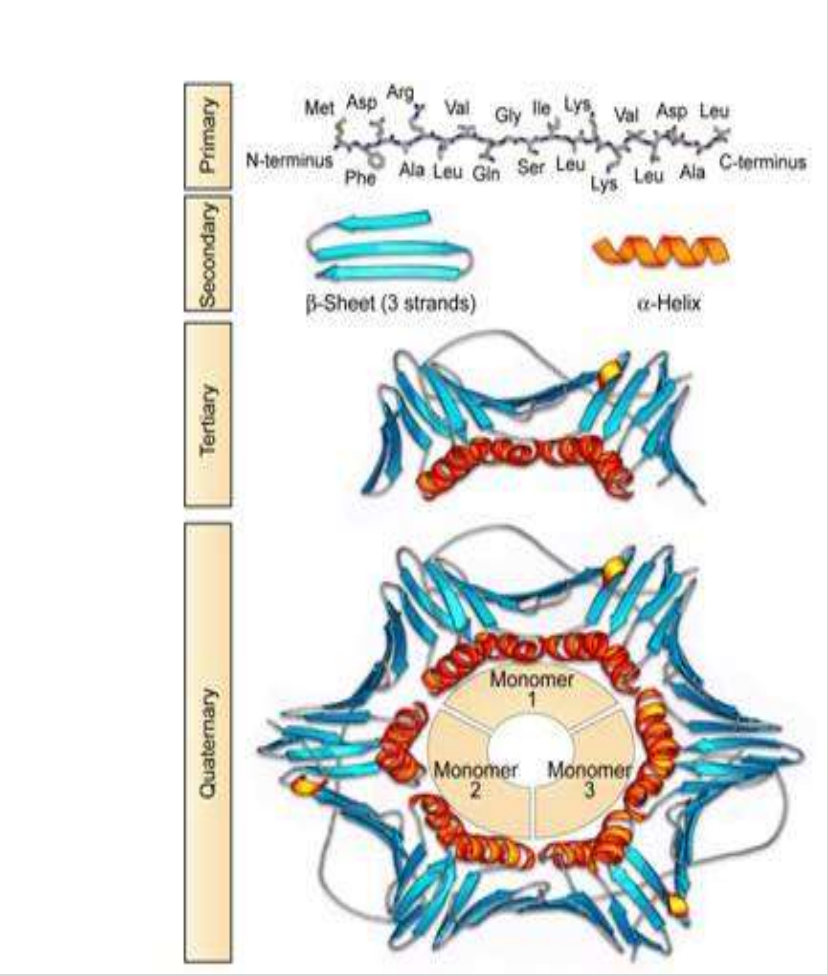
PROGRAMME GUIDE
M.Sc. (BIOCHEMISTRY)
(MSCBCH)



SCHOOL OF SCIENCES
INDIRA GANDHI NATIONAL OPEN UNIVERSITY
NEW DELHI-110068

RECOGNITION

The UGC Notification No. F. 1-1/2020(DEB-I) dated 4th Sept., 2020 regarding recognition of Degrees and Certificates acquired through ODL mode states as under:

— 22. Equivalence of qualification acquired through Conventional or Open and Distance Learning and Online modes.— Degrees at undergraduate and postgraduate level in conformity with UGC notification on Specification of Degrees, 2014 and post graduate diplomas awarded through Open and Distance Learning mode and/or Online mode by Higher Educational Institutions, recognised by the Commission under these regulations, shall be treated as equivalent to the corresponding awards of the Degrees at undergraduate and postgraduate level and post graduate diplomas offered through conventional mode.

January, 2024

Further information on Indira Gandhi National Open University courses may be obtained from the University's office at Maidan Garhi, New Delhi-110 068.

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ABOUT THE UNIVERSITY

The Indira Gandhi National Open University came into being on September 20, 1985, by the Act of Parliament to achieve the following objectives:

- democratising higher education by taking education to your doorsteps;
- providing access to high quality education to all those who seek it irrespective of age, region or formal qualifications;
- offering need-based academic programmes by giving professional and vocational orientation to the courses;
- promoting and developing distance education in India.

The Indira Gandhi National Open University has an international jurisdiction, a nationwide student support service network, socially and academically relevant programmes based on students' need analysis which is also cost effective, with provision for you to study at your own pace.

The University operates through its 21 Schools of Studies. The methodology of instruction in this university is different from that of the conventional universities. The Open University System is more learner-oriented, and the learner is an active participant in the teaching- learning process. Most of the instruction is imparted through distance mode rather than face-to-face communication. The University follows a multi-media approach for instruction. It consists of: self-instructional printed course material, audio and video programmes, the online repository of course related material – eGyankosh, face-to-face counseling at Learner Support Centres by academic counselors, assignments, laboratory work, teleconference/web conference, interactive radio counseling, WEAS (web enabled academic support) portal and the Gyan Dhara channel.

MESSAGE FROM THE PROGRAMME TEAM

Dear Learner,

Congratulations on taking admission in M.Sc. (Biochemistry) programme at IGNOU! We extend you a warm welcome to this newly launched programme in the open and distance learning (ODL) mode. This programme is designed to provide you with the comprehensive and in-depth understanding of the fascinating field of biochemistry.

The M.Sc. (Biochemistry) programme has advanced courses in all the important areas in biochemistry. As you know, bioanalytical techniques, cell & molecular biology, genetic engineering, clinical biochemistry, bioinformatics are few examples of important areas in the study of advanced biochemistry courses. Hence, while preparing the programme curriculum care has been taken to include the basics to advanced topics in biochemistry. This will provide a strong foundation in this subject and will greatly benefit the learners in grasping the concepts and applications covered in the courses of the programme.

The study materials for the courses are uploaded on the eGyankosh site (https://egyankosh.ac.in/) of IGNOU. The student support services such as counseling sessions for the theory courses and the practical sessions for the laboratory courses will be conducted at the designated Study Centres. The information regarding these activities will be made available on the website of your Regional Centre from time to time. IGNOU faculty will also provide you support through Web Enabled Academic support (WEAS) Portal of IGNOU. For your admission cycle (Jan, 2024), the first term-end examination will be held in Decemebr, 2024 for the courses of the first and second semesters, and every six months thereafter.

This **Programme Guide** contains key information about the programme including the details of courses on offer, the syllabi of courses, how to study the courses, evaluation methods, rules and regulations and links to important forms. It will help you to navigate through the different stages of the programme and progress in it.

At all stages of your journey in IGNOU, please use the **IGNOU website** as your primary source of all the latest information on different aspects like cut-off dates for submission of different forms and fees for different services. Please check the IGNOU website regularly for these announcements.

We are excited to have you join our M.Sc. (Biochemistry) programme and embark on this journey of intellectual growth and exploration. We are committed to providing you with a high- quality learning experience. You may reach out to us at our **dedicated email address** mscbch@ignou.ac.in for academic queries on the programme.

Once again, we extend our warmest welcome and wish you all the best in your pursuit of knowledge and excellence in the field of biochemistry.

Sincerely,

Programme Team (M.Sc. Biochemistry)

IGNOU WEBSITE

The IGNOU website is **http://www.ignou.ac.in**. It offers relevant information to the general public and student support facilities to the learners through the Single Window Information and Student Support (SWISS). These include:

- Online registration for fresh admission to various programmes
- Online Re-Registration
- Online submission of Term-End Examination Form
- Results of the Term End Examinations
- Checking status of study material
- Downloads of Assignments/Question papers/Forms
- Catalogue of audio/video programmes
- Schedule of Gyan Darshan/Gyan Vani/ programmes
- Admission announcements
- Addresses of regional and Study Centres
- Updates on the latest happenings at the University
- Checking registration details
- Web Enabled Academic Support (WEAS)
- TEE date-sheet
- Examination Hall Ticket
- Course Completion Status
- Accessing eGyanKosh: using this web site you can download your course material and view videos related to your courses.
- Student Portal (after admission): https://ignou.samarth.edu.in/: **All students are advised to register on the Student Portal after confirmation of their admission and create their own Student Account.**

1. M.Sc. (BIOCHEMISTRY) PROGRAMME

Programme Code: MSCBCH

The M.Sc. (Biochemistry) programme housed in the School of Sciences has been designed by eminent biochemists and teachers from across the country. The courses of this programme strive to cover all the core concepts in different areas of biochemistry. It offers an exciting opportunity to people who are interested in biochemistry and would like to pursue a career in teaching or research and development in biochemistry and allied areas.

Objectives of the Programme

This programme has the following broad objectives:

- To inculcate the concepts of biochemistry;
- To provide the knowledge and skills required by a postgraduate in biochemistry;
- To fill the gap between academia and industry with regard to demand and supply.

Duration

The **minimum** duration of the programme is **two years,** which is divided into **four semesters**. The **maximum** period allowed for completion of the programme is **four years**.

Eligibility Criteria

The committee members were of unanimous view that admission to the M.Sc. programme should be restricted to learners having Bachelor's degree in Science/ Pharmacy/ B.Tech-Biotech/ Medical Graduates/Vocational Students/Nursing Students with Chemistry in their UG Programme. Learners with non-biology background at UG level must have studied 10+2 with Physics, Chemistry and Biology subjects.

Medium of Instruction

The programme is available only in **English**.

Programme Fee

The programme fee, exclusive of examination fee is Rs. 72,400/-* for the full programme to be paid year wise @ Rs.36,200/- per year plus additional charges as applicable. As and when it is necessary, the University can revise the programme fee and the revised fee shall be payable by you as per schedule of payment notified by the University.

Re-Registration

Learners have to submit the Re-Registration (RR) forms for the IInd year (comprising 3rd and 4th semester courses) 'Online' only on https://ignou.samarth.edu.in/ as per schedule being notified by the University from time to time. Timely payment of fees is the responsibility of the students. Students are expected to remit fee as early as possible without waiting for the last date. In case, you fail to remit the fee as per the schedule, you will have to wait for next cycle of fee payment schedule. Non- payment of fee results in discontinuation of the dispatch of study material. Such students will not be permitted to write the examinations. In case any

student willfully appears in the examination without proper registration for a course(s), the result shall not be declared.

Note that you have to re-register in the second year, irrespective of whether you have cleared allthe Courses in your first and second semester. While the programme has a semester structure, the fee is to be paid annually. At the time of your admission you have paid the fee for the first year (1st and 2nd semesters). At the time of re-registration, you need to pay the fee for the second year (3rd and 4th semesters).

2. PROGRAMME STRUCTURE

Studies in this 2 year programme are divided into **4 semesters (2 semesters per year)**.To successfullycomplete this programme, you will have to earn **80 credits** over a period of 2 to 4 years depending onyour convenience. These 80 credits comprise

1.	**Core Courses (Theory and Practical)**	**44 + 12** credits
2.	**Elective Courses**	**16** credits
3.	**Project**	**8** credits
	Total	**80 credits**

The details of these courses are given in Sec.5. After successfully completing the programme youwill be awarded the **degree** of **M.Sc. (Biochemistry).**

Core Courses

The core courses are offered in all four semesters of the programme. They deal with the fundamental concepts in biochemistry and allied fields which will help you to apply these concepts to new areas in biochemistry and excel further. The detailed syllabi of these courses are given in Sec. 5.

Elective Courses

Three elective courses are being offered in allied subjects of biological sciences and research. An attempt is made to update you with the developments in these areas and expose you to the interdisciplinary nature of current research in science.

The **semester-wise details of the courses of M.Sc (Biochemistry) programme** are as follows: (The Laboratory courses are marked with a *)

FIRST SEMESTER

Course Code	Course Title	Type of Course	Credits
MBC-001	Concepts of Biochemistry	Theory (Core)	4 Credits
MBC-002	Cell and Molecular Biology	Theory (Core)	4 Credits
MBC-003	Bioanalytical Techniques	Theory (Core)	4 Credits
BCL-001	Biochemistry Lab I	Practical	4 Credits

MBCE-012	Plant Biochemistry	Elective	4 Credits
MBCE-013	Human Physiology	Elective	4 Credits
MBCE-013	Microbiology	Elective	4 Credits

SECOND SEMESTER

Course Code	Course Title	Type of Course	Credits
MBC-004	Enzymes and it's applications	Theory (Core)	4 Credits
MBC-005	Concepts and connections in metabolism	Theory (Core)	4 Credits
MBC-006	Recombinant DNA Technology and its applications	Theory (Core)	4 Credits
*MBCL-002	Biochemistry Lab II	Practical	4 Credits

***These Laboratory Courses (MBCL-001 and MBCL-002) will be conducted over the period of Semesters 1 and 2 and the Study Centres will prepare the schedule accordingly.**

****Only two courses out of MBCE-012, MBCE-013, and MBCE-014, to be opted**

THIRD SEMESTER**

Course Code	Course Title	Type of Course	Credits
MBC-007	Bioinformatics and Biostatistics	Theory (Core)	4 Credits
MBC-008	Genetics and Evolutionary Biology	Theory (Core)	4 Credits
MBC-009	Clinical Biochemistry	Theory (Core)	4 Credits
*MBCL-003	Biochemistry Lab III	Practical	4 Credits
MBCE-015	Immunology and immunological techniques	Elective	4 Credits
MBCE-016	Toxicology	Elective	4 Credits
MBCE-017	OMICS	Elective	4 Credits

*** For lab courses Centres will prepare the schedule accordingly**

****Only two courses out of MBCE-015, MBCE-016, and MBCE-017, to be opted**

FOURTH SEMESTER

Course Code	Course Title	Type of Course	Credits
MBC-010	Research methodology	Theory (Core)	4 Credits
MBC-011	Animal and Plant tissue culture	Theory (Core)	4 Credits
MBCP-001	Research Project	Project	8 Credits

3. INSTRUCTIONAL SYSTEM

The M.Sc. (Biochemistry) programme instructional system includes Self-Learning Material (SLM, Open Educational Resources (OERs), assignments, counseling sessions and practical sessions at the LearnerSupport Centres (LSCs).

Print Material

For courses other than those offered through OERs, the study material will be provided in digital form (on eGyankosh, the repository for SLMs of the University) and/or in printed form. The study material is properly planned and are self-instructional in nature.

The **printed study material is sent to you by registered post to the address provided by you in the application form at the time of admission**. The material will be dispatched to you **semester wise**. You can check status of dispatch of study materials on the IGNOU website using the web link: www.ignou.ac.in/ignou/aboutignou/division/mpdd/material, provided by MPDD. For non-receipt of study material, students are required to write to the Registrar, Material Production and Distribution Division, IGNOU, Maidan Garhi, New Delhi –110 067 or e-mail to mpdd@ignou.ac.in.

The soft copy of the learning material can be downloaded from eGyankosh (at https://egyankosh.ac.in) and also IGNOU E-Content mobile App (which can be downloaded from Google Play Store).You can also access your course materials, assignments, and other learning resources through Web Enabled Academic Support **(WEAS) Portal of MSBCH.** To access the WEAS Portal click the link - https://sites.google.com/ignou.ac.in/weas.

Open Educational Resources (OERS)

For some courses (or parts of some courses) of this programme, the course material will be in the form of Open Educational Resources which may be in the form of video lectures or ebooks. The links for the same will be provided on **eGyankosh**. You will not receive the printed SLM for these courses.

How To Study A Course

- **SLM based Courses**

  The learners joining open and distance learning institutions like IGNOU are expected to be self-learners. As there is no regular and face-to-face classroom teaching in such institutions, you are provided **self-learning materials (SLM)** for the courses of the programme which are developed in self-instructional style and completely cover the course contents. An effort is made to make SLMs self-contained so that you do not need any additional help to understand.

Since SLMs for the courses are the primary learning resource, you should know how these SLMs are structured and how you can make best out of it.
SLM of the courses in IGNOU are offered in the form of booklets called **Blocks**. Each blockis divided into several units so that the learning material is presented in smaller portions, which are easier to absorb at a time. The units in a block have the unity and are structured in a standard way.

Each **unit** contains expected learning outcomes which tell you what you are expected to know after studying the unit. These goals state what conceptual understanding you should have, what kind of ability to reason and problem-solving skills you should develop.

We give the **summary** at the end of the conceptual discussion followed by a section called **terminal questions**. The last section gives the answers/ solutions to (SAQs and TQs) problems.

Biochemistry, as you know, cannot be learnt passively. Learning Biochemistry is not like listening to a story and memorizing it. You have to not only understand concepts but acquire the abilities of reasoning and problem solving. The idea is not to memorize without understanding, but to understand and apply concepts to a variety of problems.

Biochemistry being language of life has the potential to discuss the proof of concepts towards the life and it maintenance in any form. The first thing you must understand while studying the courses in Biochemistry is that, how the living systems survive and regulate their metabolic activities? It is also important to know that Biochemistry being an interdisciplinary subject addresses and answers the basic concepts of Molecular biology and Genetic engineering. Please find the below given advice regarding how to study SLMs for the courses of the programme:

- Always keep a pen/pencil and paper with you while studying.
- Work through all steps in the derivations given in the text **yourself**. Also, **work each step** in the solved examples given in the text on your own.
- You may use the Blocks of the course as your notebook. **Make notes in the text as well as in the margin.**
- You will have to work out the mathematical steps, SAQs, Terminal Questions on separate papers, as no space has been provided in the text for this purpose.
- You may need to use a **calculator** for calculations in numerical problems. So keep a calculator handy.
- We advise you to make an honest attempt at solving the Self Assessment Questions (SAQs) and the Terminal Questions. Do not immediately turn to the answers given at the end of each unit if you cannot solve a problem in the first instance. You should gothrough the unit once more and then attempt the questions again.
- You must also express the answers to numerical problems in proper units.

- **OER Content**

  For the OER content in courses wherein the course content will be provided to you in the

form of video lectures or e-Text, within any SLM either in digital or printed form. Of course, a detailed write-up as to how these video lectures or e-Texts are to be watched/studied to cover the course content in a systematic manner will be provided. While going through the video lectures, similar to the study with SLM, you should attempt the examples/exercise yourself. You should take notes while watching the lectures. You can pause or rewind and watch the lecture/ part of the lecture, where you find the concept difficultto understand. We will give you the links to the transcripts of the lectures, wherever available. By reading the transcripts, you can understand the subject discussed in the lecture better.

Practical Work

Three out of the twenty courses of this programme are Laboratory courses. The practical sessions for these courses will be conducted at the LSCs, in the Biochemistry Laboratories and Computer Laboratories. The laboratory session for each laboratory course will run for 14 days. Attending practical sessions is **compulsory** for all the learners. Completing minimum 70% of each laboratory session is mandatory. It qualifies you to appear for the term-end practical examination for the course which is held on the last day of the session. Schedule for practical sessions will be made available to you by your LSC/RC.

Teleconference

Teleconference/web conference, using one-way video and two-way audio transmission via satellite, is another medium used by the University to impart instruction to and facilitate learning for a distance learner. The schedule for the teleconferencing sessions would be available on the website of the University or the Regional Centres.

Interactive Radio Counselling

Interactive phone-in radio counselling sessions conducted by the University are available on and GyanVani FM station. The radio counselling sessions are broadcast 'live' and are relayed by stations across the country. Now, there is a synchronized weekly transmission "IGNOU HOUR" on Sundays from

4.00 p.m. to 5.00 p.m. with coverage of almost all over the country.IRC sessions can be accessed

through radio at the frequency 105.6 MHz, through DTH and also through Internet at the link gd.ignouonline.ac.in/gyandhara. The phone numbers for interaction are: 01129533581, 01129536131, 29533103 and 1800112347.

Gyan Darshan

Gyan Darshan, the 24 hours educational TV channel is a joint venture of IGNOU with Doordarshan. It is available through the Cable TV network. The telecast schedule of Gyan Darshan is madeavailable on IGNOU web site: http://www.ignou.ac.in .

Please ask your cable operator to provide this channel.

IGNOU e-Content Mobile App

IGNOU-e-Content Mobile App is an official mobile app of Indira Gandhi National Open University (IGNOU), New Delhi. This app is an ICT initiative of IGNOU to provide Digital Learning Environment to IGNOU learners and extending Technology Enhanced Learner Support Services to them. The aim of this initiative is to disseminate the digitised course material to IGNOU Learners. IGNOU learners can use this app to access their course material through their hand held devices such as Mobile Phones and Tablets.

Scheme of Study

In order to enable you to complete your M.Sc. (Biochemistry) programme within the minimum period of two years, you will have to complete 80 credits worth of courses in four semesters. Registration to the programme is annual, so you register for the first and second semester in Year 1 and for the third and fourth semester in Year 2. In the second year irrespective of whether you pass or not in all the courses of the first year, you must re-register for the third and fourth semester by submitting the Re- registration Form with the requisite programme fee.

It is quite possible that you may not find sufficient time to prepare for the Term End Examinations of all the courses you have registered for. You can focus only on those courses in which you intend to take the examination. You can give the examination of the remaining courses later. You may appear for the term-end examinations for the first time after one year of admission to the programme, at that time, you are eligible to appear for the exams of the first and second semesters. Thereafter you can appear for your exams every six months till the completion of the validity of your admission. Examinations are held in the month of June/December of each year. In this way, you can plan your courses within two to four years. By a proper planning every year, you can complete this programme according to your convenience.

Learner Support Centres (LSCs)

To provide effective students support, we have set up LSCs for this programme. You will be allotted one of these study centres. The particulars of the LSC to which you are assigned will be communicated to you at the time of admission.

Each Learner Support Centre will have:

- A **Coordinator/Assistant Coordinator** who will coordinate all the activities, academic as wellas administrative, related to the programme and will be a guide/support to you at the centre.
- **Counsellors** in different courses, core as well as electives, to provide you counselling andguidance in that subject.
- Biochemistry laboratories where you will do the practicals of the laboratory courses of the programme.
- A **computer laboratory** where you will do your computer practicals.

In the LSC you will also have an opportunity to interact with fellow students. This may lead to the formation of self-help groups.

4. EVALUATION

The system of evaluation, both for theory courses and laboratory courses have two components i) continuous evaluation, and ii) term-end examination. For the theory courses the continuous assessment is through the tutor marked assignments (TMAs). The weightage of continuous evaluation and term-end examination of various courses of the programme are shown in the table below:

Type of Course	Weightage of	
	Continuous Assessment	Term End Examination
Theory Courses	30% **(Assignment)**	70%
Laboratory Courses	70% (Guided Experiments)	30%

For each course, you are required to score at least 40% marks in both the continuous assessment as well as the term-end examination separately. In the overall computation also, you must get at least '40% marks in each course to be eligible for the M.Sc. degree.

If you do not clear the term-end examination of all the courses taken in a particular semester, you can appear for the term-end examination of those courses again after 6 months, as per the University rules.The overall percentage wise division of the results is

Division	Percentage of Marks
Ist Division	**60% and above**
IInd Division	**50% and above; but below 60%**
IIIrd Division	**40% and above; but below 50%**
Fail	**Below 40%**

Assignments

Tutor Marked Assignments (TMA) are **compulsory** component of the course. You will need to do one tutor marked assignment for each theory course. There are no assignments for the laboratory courses of the programme. **Each assignment is valid for the dates printed on the assignment. If you fail in an assignment or are not able to submit the assignment before the validity date, you have to submit the assignment for the next year.**

The TMA for each semester can be downloaded from the Student Zone of the University website at https://webservices.ignou.ac.in/assignments/.

The main purpose of the assignments is to test your comprehension of the learning material you receive from us and also to identify the gaps in your understanding of the course by providing feedback to you. These assignments will be checked by your counselors, who will also explain to you where and how you can improve your understanding. The information given in the course material should be sufficient for answering the assignments. However, to take you a little further, youcan always refer to other books accessible to you. **You will not be allowed to appear for the term- end examination for a course if you have not submitted the assignments stipulated in time for** that course. If you appear in term-end examination without submitting the assignments, then the result of term-end examination is liable to be cancelled.

These assignments are to be submitted at the LSC according to the submission schedule provided in the assignments booklets. Before submission, you should ensure that you have answered all the questions in all assignments. Incomplete answer sheets bring you poor grades.

SPECIFIC INSTRUCTIONS FOR TUTOR MARKED ASSIGNMENTS

1. Write your Enrolment Number, Name, Full Address, Signature and Date on the top right had corner of the first page of your response sheet.

2. Write the Programme Title, Course Code, Course Title, Assignment Code and Name of your Study Centre on the left hand corner of the first page of your response sheet.

   Course Code and Assignment Code may be reproduced from the Assignment.

3. Read the assignments carefully and follow the specific instructions, if any, given on the assignment itself.

4. Use only foolscap size for your responses and tie all the pages carefully. Avoid using very thin paper. Allow a 4 cm. margin on the left and at least 4 lines in between each answer. This may facilitate the evaluator to write useful comments on the margins at appropriate places.

5. Write the response in your own hand writing. Do not print or type the answers. Write answers in your own words; do not reproduce your answers from the units sent to you by the University. If you reproduce from units, you will get poor marks for the respective question.

6. Do not copy from the response sheets of other students. If copying is noticed, the assignments of such students will be rejected.

7. Write each assignment separately. Write the question number with each answer.

8. **The completed assignments should be sent to the Coordinator of the LSC allotted to you. Under no circumstances you should sent the tutor marked response sheets to the Headquarters for evaluation. Please retain a copy of the assignment.**

9. After submitting the assignment at the LSC, get the acknowledgment from the Coordinator on the prescribed assignment remittance-cum-acknowledgment card.

10. Provision for online submission of assignments is also available. You will get more details about this on the website of your Regional Centre.

Term End Examination

As stated earlier, Term End examination is another component of the evaluation system. For non-laboratory courses, Term End Examination carries 70% weightage in the final result. For laboratory courses, assigned unguided experiments similar to term-end examination carry 30% weightage.You are eligible to appear for the Term End examinations for the theory courses one year after admission and every six months thereafter.

If you get a pass score in a course in the Term End Examination, you will not be allowed to reappearin the subsequent examinations in that course for improvement of marks. In case, you fail to get a passscore in the Tem-end Examination, you will be eligible to reappear in the next Term End Examination for that course as and when it is held, within the total span of the programme.

General Guidelines Regarding the Term-End Examination

1. To be eligible to appear the Term-end Examination in any course, the students are required tofulfill the following conditions:

   a) registration for the courses, in which they wish to appear is valid,

   b) they should have opted and pursued the prescribed courses

   c) they have also submitted the required number of assignment(s), if any.

   d) they have submitted the online examination form of IGNOU and have paid the requisiteexamination fees.

2. The University conducts term-end examination twice a year, in June and December. You are eligible to appear for the Term End examinations for the theory courses one year after admission and every six months thereafter. You can also appear for these exams in later cycles as per the validity of your program

3. .Examination schedule is also notified through the website of IGNOU www.ignou.ac.in. You are advised to see whether there is any clash in the examination dates of the courses you wish to take

   i.e. examination of any two courses you wish to take are scheduled on the same day at the same time. If there is any clash, you are advised to choose one of them in that examination and appear for the other course in the next examination (i.e. June or December as the case may be).

4. The online examination form is to be filled up from IGNOU website at http://exam.ignou.ac.in/, in general, as per the schedule given on the IGNOU website (**You MUST visit IGNOU website for actual cutoff dates**). The details of fee and late fee are displayed on the website.

5. You can pay examination fee online using Credit Card / Debit Card /Net Banking while filling up the form. It may also be noted that in case, examination fee needs to be returned to student due to technical reasons, the fee will be refunded to the same account (Credit card/ Debit card/ Net Banking) from which the payment was made.

6. **Hall Ticket for Term-End Examination**

- Hall Ticket will be uploaded on the University Website approximately 10 days before the commencement of the Term-end examinations. Please take print out of Hall Ticket from University website (www.ignou.ac.in) and report at the Examination Centre along with the Identity Card issued by the Regional Centre/University.
- You will be allowed to appear in Term-end Examination for the course(s) for which registration is valid and not time-barred and assignment(s) is/are submitted. Examination Fee once submitted will not be refunded.
- You must carry IGNOU Identity-Card in the Examination Hall for writing Examination. A digital copy of the student Identity Card is available in the student account (https://ignou.samarth.edu.in). It can be downloaded and printed whenever required.

Contact Details

In case of non-receipt of Control number or any query pertaining to Examination Form please contact **Phone No.(s) : 011-29572209 or send us an email at termendexam@ignou.ac.in**

7. **Early Declaration of Results:** In order to facilitate the students who have got an offer of admission to further courses of study or have been selected for employment etc. and are required to produce marks sheet/grade card by a specified given date provision of early declaration of result is made. Student may apply for early processing of their answer-scripts and declaration of the results for this purpose along with supporting documents and requisite fee. The students must submit their requests for early declaration before the commencement of the Term-end Examination i.e., before 1st June and 1st December respectively. In such cases, the University will make arrangements for processing the answer-scripts and early declaration of the results as a special case.

8. **Obtaining Photocopy of Answer Scripts:** After the declaration of result, if the students are not satisfied with the marks awarded, they can request the University for Photocopy of Answer Scripts. The request for obtaining Photocopy of Answer Scripts by the student must be made within 30 days from the date of declaration of result (i.e.) to the Evaluation Centre concerned in the prescribed format along with the requisite fee. The form is available on the IGNOU website.

9. **Re-evaluation of Answer-script(s):** In case the student is not satisfied with the marks obtained, a request for revaluation can be made then. The answer-scripts will be re-evaluated by another Evaluator. Students can apply for re-evaluation within one month from the date declaration of results i.e. the date on which the results are made available on the University Website using the prescribed application form available on the University Website along with the requisite fee . The better of the two scores among the original marks/grades and re-evaluated marks/grades will be considered and the revised marks/grades shall be incorporated in the students' record and the revised grade card/marks sheet will be sent to the students. Re-evaluation is not permissible for Assignments and Laboratory courses.

Examination for Laboratory Courses

Evaluation of laboratory courses is carried out at the time of conducting the laboratory courses at the study centre. Each and every experiment, which you perform, is evaluated. Evaluation of experiments, which you perform under the guidance of your counsellor, constitutes continuous evaluation and carries 70% weightage. On the other hand, the evaluation of unguided assigned experiment(s), which you perform during the last session of your lab course, carries 30% weightage and constitutes Term End evaluation.

5. DETAILS OF COURSES

Core Courses

MBC-001: CONCEPTS OF BIOCHEMISTRY 4 Credits

Block I : Basics of Biochemistry

History of Biochemistry and Chemical foundations of life. Water: Structure, Physico-Chemical properties, water as a universal solvent.

Definition and classification of carbohydrates, nomenclature, reactions of Mono-saccharides, Acid derivatives of Monosaccharides amino-sugars, Oligo saccharides, structure, properties. Carbohydrates: Brief review of configurationally and conformational aspects of carbohydrates.

Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), glycosaminoglycans, cardiac glycosides and bacterial cell wall polysaccharides. Structural elucidation of polysaccharides (starch, glycogen and cellulose).

Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates.

Carbohydrates as informational molecules, Blood group antigens and working with carbohydrates.

Block II: Lipids

Lipids classification, brief account of the chemical properties and structure of lipids.

Biological significance of the: fatty acids, acylglycerols,phospholipids, plasmalogens, sphingolipids, glycolipids, steroids, eicosanoids – prostaglandins,thromboxanes, & leukotrienes and visfatin.

Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids.

Lipids as signaling molecules, cofactors and pigments. Plant steroids

Block III: Proteins

Amino acids: Structure and classification of amino acids, acid – base properties of amino acids, chemical reactions of amino acids. Non – standard, non–protein and biologically active amino acids. Optical properties and stereoisomerism of amino acids, Naturally occurring peptides. Primary structure, Elucidation of primary structure of proteins.

Secondary structure: Peptide bond – structure and conformation, Ramachandran plot. Regular secondary structures (helix, loops and sheets). Structure of fibrous proteins: K-keratin, silk fibroin and collagen. Motifs (super secondary structure – triose phosphate isomerase, concanavalin-A and Rossmann fold) and domain structure (glyceraldehyde-3-phosphate dehydrogenase). Secondary structure of insulin, ribonuclease, lysozyme, myoglobin and chymotrypsin.

Tertiary structure: Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation. Quaternary structure and symmetry: Structure and function of myoglobin and hemoglobin. Classification of proteins. Abnormal hemoglobin– sickle-cell hemoglobin. Proteins as enzymes. Glycoproteins and lipoproteins. Significance of protein folding. Protein folding pathways: Protein dynamics. Disease related to protein folding– Neurodegenerative diseases.

Extraction, Purification and isolation of proteins, criteria of purity of proteins, physico-chemical properties, structural organization of proteins, Denaturation & renaturation of proteins.

Block IV: Nucleic acids and Vitamins

Structure of nucleic acids: purine and pyramidine bases, nucleosides, nucleotides, polynucleotides.Structure of nucleic acids– primary, secondary and tertiary structure of DNA. Properties of nucleic acids in solution. Structure of DNA- Watson Crick model.

Different forms of DNA. Right handed and left handed helix. Supercoiling, chromatin nucleosomes. Secondary structure of tRNA and role of secondary structure in mRNA stability.

Isolation, fractionation, characterization of nucleic acids, properties of nucleic acids in solution.

Chemical synthesis of oligonucleotides (phosphate and phosphite method). Nucleic acid sequencing – Maxam and Gilbert and Sanger's method. Rapid sequencing methods and new generation DNA sequences. Chemistry, sources, classification and functions of vitamins. Deficiency, symptoms, hypervitaminosis. Role of vitamins as coenzymes.

MBC-002: CELL AND MOLECULAR BIOLOGY **Credits 4**

Block I : Structural Organisation of Cells

Overview of cell organisation in pro- and eukaryotes. Cell organelles (nucleus, ER, Golgi, mitochondria, chloroplast, peroxisomes and lysosomes) structure and their role(s). Structure and assembly of major cytoskeletal proteins, dynamic behaviour; role in dividing and resting cells.

Extracellular matrix-proteins and polysaccharides; cell-cell and cell-matrix interactions; cell adhesion protein families-integrins, cadhreins, selectins and Ig superfamily. Types of cell junctions, tight junctions, anchoring junctions, gap junctions and plasmodesmata.

Cell division; phases of cell division cycle- mitosis and interphase (G1, S and G2); behaviour of chromosome during mitosis; cell cycle regulation at check points; Go phase; consequences of loss of cell cycle control; meiosis in specialised cells. Pathways of Cell death; Apoptosis and necrosis.

Organisation of cell membrane; Singer-Nicolson model of plasma membrane; movement of small and large molecules across cell membrane, factors affecting membrane fluidity and permeability; simple and facilitated diffusion; active transport-Unipart and symport; endocytosis, exocytosis and pinocytosis. Inhibitors of membrane transport. Overview of Cell Signaling, Signaling Molecules and Cellular Receptors-G-protein-linked receptors.

Block II: Molecular Biology

Nature of Genetic material, Circular and Linear Genomes. C-value Paradox, Variations in Genome Size, C0T curve, Genomic Complexity. Organization of Genome, Prokaryotic Gene, Eukaryotic Gene. Genome Sequence and Gene Numbers, Solitary and Multigene families, Pseudogenes, Interrupted gene. Simple and Complex Monocistronic genes

Nucleosomes, Histones Proteins, Types of Histone Proteins, Functions of Histone Proteins, Non-Histone Proteins, Types of Non-Histone Proteins, Functions of Non-Histone Proteins. Packaging of DNA into Higher Order Structures, Beads-on-a-String (Primary Structure), The 30 nm Fibre (Secondary Structure), Higher Order (Tertiary Structures), Looped Domains (Quaternary Structure). SMC Complexes. Regulation of Chromatin Condensation, Euchromatin and Heterochromatin, Dynamic changes in Chromatin Structure and Nuclear Positioning. Chromosome Structure and Banding

Chemistry of DNA synthesis; semi conservative model of DNA replication, Steps of DNA replication in prokaryotes, Replication origin, replication fork, replisome and primosome, E.coli DNA polymerases (I, II and III); Role of other enzymes involved in E.Coli replication: DNA helicases, topoisomerases, Single Stranded DNA binding proteins, primosome complex, DNA ligase and replisome.; Roling circle mechanism of replication, regulation of DNA replication initiation in prokaryotes; Mechanism of DNA replication in eukaryotes, and replication initiation, eukaryotic DNA polymerase enzymes Replication through nucleosomes End replication problem and telomere maintenance, comparison of DNA replication in prokaryotes and eukaryotes.

DNA binding proteins; common DNA binding motifs: Zinc finger, leucine zipper, and helix turn helix, homeodomain and helix turn helix.

Block III: Transcription And Translation

Organisation of bacterial genes; structure, characteristics and mechanism of RNA polymerase reaction; sigma factors; basic transcription unit- template and non template strands; steps of transcription; initiation; consensus sequences and strength of bacterial promoters; close and open initiation complex, promoter clearance; elongation and termination(rho-dependent and rho- independent); Polycistronic mRNA; Processing of RNA (tRNA and rRNA) and synthesis of CRISPER RNA; inhibitors of bacterial transcription. Eukaryotic RNA polymerases; upstream and internal promoters; enhancers, transcription factors (TF); steps of transcription and inhibitors of transcription. Post transcriptional processing; types of introns and RNA splicing; trans splicing; capping; poly adenylation; RNA editing; modification of base and sugar; processing of small RNAs; regulation of pre mRNA processing and transport, cytoplasmic mechanisms.

Central dogma of molecular biology; early ideas on genetic code (George Gamow); Cracking the genetic code: genetic and biochemical experiments (Nirenberg and Matthaei, Crick, Brenner, Ochoa, Khorana); nature of the genetic code and its significance; Wobble hypothesis; Co-linearity of gene and protein. Overview of protein synthesis in prokaryotes; amino acid synthetases and tRNA charging; ribosome structure, binding sites and their role; steps in protein synthesis; initiation, (Shine-Dalgarno sequence), elongation and termination factors;. Translation in eukaryotes; Kozak sequence, regulation of translation; inhibitors of translation. Post translational modification.

Block IV: Gene Regulation

DNA damage; spontaneous and induced mutations; base substitutions, frame shift mutations and chromosomal aberrations. DNA repair pathways: direct repair; nucleotide excision repair, base excision repair, mismatch repair, translesion synthesis, recombination repair and non homologous end joining of double strand breaks, SOS repair.Defects in DNA repair: Xeroderma pigmentosum, Cockayne syndrome, Fanconi anemia, Bloom syndrome and Ataxia Telangiectasia.

Operon concept; biphasic growth kinetics; Jacob and Monod hypothesis; inducible and repressible operons; lac and tryptophan Operon; positive and negative regulation; catabolite repression of glucose sensitive operons; attenuation; regulatory RNA; riboswitches.

Levels of control in eukaryotes- transcriptional, post-transcriptional, translational and post-translational; transcriptional regulators in switching genes in ON / OFF state;Chromatin remodeling; nucleosome remodeling; nucleosome removal; histone modifications and histone replacement; histone code and epigenetic memory, chromatin positioning in the nucleus; regulatory RNA and RNA interference; post transcriptional control mechanisms.

Translational and post translational control mechanisms; protein processing and modifications; alteration in protein stability; regulation of gene expression in tissue specific manner by hormones and second messengers; regulation of developmental genes.

MBC-003: BIOANALYTICAL TECHNIQUES 4 Credits

Block I: Biophysical Techniques I

Aqueous solution, types of solution-Stock solution and standard solution: Units of measurements- Molality, Molarity, Normality, % solution (%W/V, %W/W, %V/V) and parts per million (ppm), ionisation of water, pH and buffer, Laboratory Safety rules and laboratory waste disposal

Cell disruption method: Physical and chemical, sonication; cell lysis and cell/tissue perfusion, Liquid-liquid extraction, solid-liquid extraction method.

Introduction, Principle of sedimentation, RCF/RPM, Sedimentation unit (s). Ultra centrifugation-Preparative and Analytical centrifugation, Differential Centrifugation-subcellular fractionation, Isolation of DNA by Density Gradient Centrifugation, density media and Application of Centrifugation.

Introduction, Nature of Electromagnetic radiations, Principle-Beer-Lambert Law, Molecular extinction coefficient. Instrumentation and application of UV-Vis spectrophotometer and Fluorescence spectroscopy.

Block 2: Biophysical Techniques II

Principle, instrumentation and application of Nuclear Magnetic Resonance spectroscopy and ESR Optical rotatory dispersion spectroscopy (ORD) and Circular Dichroism spectroscopy (CD), XRD and Atomic absorption spectroscopy, Infra-Red spectroscopy, Raman spectroscopy, Mass spectrometry.

Introduction, History of the Microscope, Principle- Resolution and magnification, Tissue fixation and staining, Basic theory, instrumentation and application of Light microscopy, phase contrast microscopy, fluorescence microscopy, Fluorescence resonance energy transfer (FRET) imaging microscopy, confocal microscopy, super resolution microscopy, and Concept of bioluminescence

Introduction, Fixation & staining techniques for EM, ultramicrotome, Theory, basic parts and application of Electron microscopy-Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM)- Scanning probe microscopes: AFM and STM. Cryogenic electron microscopy.

Block III: Chromatographic Techniques

Introduction, General principles, Partition coefficient phase systems, liquid and solid phases, Types of chromatography. Basic theory, work flow and application of Adsorption and Partition chromatography, Paper and Thin-layer chromatography , Solvent system and detection of compounds;

Introduction, basic theory and application of column chromatography, Gel permeation chromatography, Ion exchange chromatography, Affinity chromatography, Gas-Liquid chromatography, High performance liquid chromatography (HPLC), Reversed phase HPLC and FPLC.

Basic theory, instrumentation and application of Liquid-mass spectrophotometry (LC-MS), Ultra performance Liquid chromatography (UPLC), High performance thin layer chromatography (HPTLC),

Block IV: Electrophoresis and Radioisotopic Techniques

Introduction, General principles, Types of Gel media, instrumentation and applications of electrophoresis- capillary electrophoresis, Polyacrylamide gel electrophoresis (PAGE), and SDS-PAGE, Electrophoresis of nucleic acids (Agarose gel and pulse-field), Isoelectric focusing and 2-dimentional gels.

Overview of blotting techniques, Basic theory, workflow and application of Southern, blotting, Northern blotting and Western blotting. FISH and GISH

Basic theory of Isotopes and Nature of radioactivity, Radioactive decay, Units of measurement of radioactivity-:the becquerel, gray, curie Types of radioactivity; Detection and measurement of radioactivity, Carbon dating, Geiger-Muller counting and liquid scintillation Counting, and autoradiography, Applications of radioisotopes in biological sciences, Radiolabeling and Safety measures.

MBCL-001: Biochemistry Lab-I **4 Credits**

1. Preparation and standardization of buffers; Acetate, phosphate and tris buffer
2. Qualitative analysis of amino acids, proteins and carbohydrates
3. Qualitative analysis oils and fats.
4. Quantitative analysis of proteins and carbohydrates.
5. Isolation of potato starch / liver glycogen.
6. Hydrolysis of starch / glycogen and estimation of its purity by Nelson Somogy's method.

7. solation of milk casein and determination of pI.
8. Estimation of vitamin C by dichlorophenol indophenol method.
9. To study on differential and cytological staining techniques
10. Isolation of nuclear faction
11. Agarose gel electrophoresis of plasmid DNA.
12. Assay of DNase and RNase.
13. Determination of Molar absorption coefficient of tyrosine.
14. Visualisation yogurt's bacteria by light microscope
15. Gram staining
16. To separate the amino acids in a mixture by paper chromatography/thin layer chromatography.
17. Native /SDS Electrophoresis of proteins and determination of molecular weight of protein (subunit/native
18. To study the separation of DNA by agarose gel electrophoresis
19. Isolation and estimation of plant pigments
20. Qualitative assay of phenolic compounds
21. Demonstration of Hill Reaction.

MBC-004: ENZYMES AND ITS APPLICATIONS 4 Credits

Block I: Introduction to Enzymes

Introduction, General characteristics of enzymes, Catalytic power and specificity of enzymes, Ribozymes; Abzymes; Classification and nomenclature of enzymes. Activation energy, Thermodynamics and Equilibrium; Active site and its importance, Enzyme activity; Specific activity and Units;

General features, Factors influencing catalytic efficiency – Effect of pH, Substrate and Temp. Fischer's lock and key hypothesis, Koshland's induced fit hypothesis. Enzyme assays: Types, Continuous and discontinuous assays; Optimization of enzyme assays. Coupled reactions and the mechanisms employed. Zymography.

Proximity and Orientation, Strain and Distortion, Acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes,

Block II: Enzyme Kinetics

Significance; Rapid Equilibrium and Steady State approach, HenryMichaelis-Menten's and Haldane equations, Significance of K_m and V_{max}, Catalytic efficiency and turnover number; Kinetic perfection. Order of kinetics. Methods of plotting enzyme kinetics data: Lineweaver-Burk, Hanes-Woolf, Woolf-Augustinsson-Hofstee, Eadie-Scatchard; Direct linear plot; Advantages and disadvantages; Integrated form of the Henry-Michaelis-Menten equation; Formation of E. S covalent intermediates, transient kinetics, flow techniques (continuous, stopped, quenched).

Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Models and types of inhibition; competitive, non-competitive and uncompetitive and Reversible inhibition and mixed inhibition, Kinetics and dixon plot Determination of Ki, diagnostic plots.

Block III: Enzyme Regulation And Extraction

Zymogens, reversible covalent modification, irreversible covalent modification, Feedback regulation and its different types, Allosteric enzymes

Allostery of enzyme action: Binding of ligands to proteins, Co-operativity, the Hill equation, Sigmoidal kinetics: MWC and KNF models. Significance of sigmoidal behavior. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation.

Isozymes: Introduction, Physiological role, Origin, Pharmacological role, Clinical importance of Isozymes.

Introduction, Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase).

Block IV: Purification And Application Of Enzymes

Choice of enzyme sources, extraction by physical and chemical methods, isolation of enzymes

Salt fractionation-salting-in and salting out, pH based protein precipitation, Criteria of homogenising and % yield, Exercise of any protein purification method. -

Application of enzymes in diagnostics and medicine, agriculture, research; Diagnostic enzymes (Amylase, SGPT, SGOT, creatine kinase, alkaline and acid phosphatases, LDH), enzyme immunoassay, enzyme therapy. Taq polymerase, Enzyme electrodes and enzyme as biosensors.

Industrial enzyme Application of enzymes in industry-Starch, food, beverages-wine, Fruit, leather, textile, detergent, paper and other industries. Immobilized enzymes and Introduction to immobilized enzymes, Types and Methods, Gel, fibre and microencapusaltion, Binding-covalent, physical adsorption and metal binding, Cross linked enzymes. Synthetic and artificial enzymes, Enzyme Engineering.

MBC-005: CONCEPTS AND CONNECTIONS IN METABOLISM 4 Credits

Block I : Carbohydrate Metabolism

Catabolism, anabolism, ATP as energy currency of the cell, reducing power of the cell. Bioenergetics, Electron transport chain-protein complex of ETC, chemiosmotic hypothesis. Aerobic and Anaerobic production of ATP.

Glycolysis, Fermentation, Regulation, Entry of sugar to other pathway. pentose phosphate pathway, TCA cycle, regulation, Oxidative phosphorylation and dephosphorylation.

Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases. Signalling pathways, Hormonal regulation of carbohydrate metabolism, Gluconeogenesis, reciprocal regulation of glycolysis and gluconeogenesis, Pentose phosphate pathway, glucuronic acid pathway.

Glycogen storage diseases, Primary cause and symptoms of galactosemia and lactose intolerance.

Block II: Lipid Metabolism and Associated Disorders

Mobilisation and transport of fatty acids and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated and unsaturated fatty acids (odd and even numbered), regulation of fatty acid oxidation,.Peroxisomal β oxidation, ω oxidation, α oxidation, Ketone bodies metabolism, regulation, ketoacidosis.

Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation,

Biosynthesis of triacylglycerol, cholesterol, apolipoproteins and their regulation. Lipid storage diseases (familial cholesterolemia)

Block III: Amino Acid Metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups and biosynthesis of amino acids, transamination, role of pyridoxal phosphate.

Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Interlinking of amino acids, glucose-alanine cycle, Kreb's bicycle, urea cycle and inherited defects of urea cycle.

Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation. Inborn errors of amino acids metabolism**.**

Block: Nucleotide Metabolism

Sources of components in purine ring system, De novo synthesis of purine nucleotides (AMP and GMP), Synthesis of pyrimidine- orotate UMP and its conversion to CTP. Regulation of de novo pathways of purine and pyrimidine pathways, salvage pathways.

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, Importance of Ribonucleotide reductase in deoxyribonucleotides. biosynthesis of nucleotides coenzyme (NAD, FAD; HSCoA).

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID.

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

MBC-006: RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS 4 Credits

Block I: Tools of recombinant DNA Technology

Overview of recombinant DNA technology. Restriction and modification systems, Classification of restriction endonucleases and their functions. Application of other enzymes such as, polynucleotide kinases, alkaline phosphatase, ligase, RNase H. DNA polymerase, Klenow fragment, Reverse transcriptase. DNA methylase, S1 nuclease. Ligation of DNA molecules: DNA ligase, sticky ends,

blunt ends, linkers and adapters.

Plasmids as cloning vectors: basic characteristics, replication, copy number, incompatibility and development of plasmid vectors. Examples of cloning vectors based on E.coli plasmids- pBR322, pUC18, pGEM3Z. Phage vectors- λ vector and M13 for gene cloning.

Limitations of plasmid and phage vectors. Vectors for cloning large DNA fragments; Phagemid YAC, Cosmids, and BAC.

Isolation of protoplast, Plant cloning vectors-*Agrobacterium tumefacience*- Ti plasmid. Plant viral vectors- Tobacco Mosaic virus (TMV), Tobacco rattle virus, Geminiviruses..

Block II: Formation of recombinants

Transformation, Transfection and transduction, Preparation of competent cells, Uptake of DNA by cells. Methods of gene transfer- microinjection, heat shock, shotgun, electroporation, calcium phosphate lipofection. Selection for transformant cells -antiobiotic resistance gene and alpha complementation. Restriction digestion of recombinant DNA and Visualization of ligated fragments- elactrophoresis

Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products.PCR based gene cloning methods. Real time and reverse transcriptase PCR, digital PCR. Application of PCR amplified fragment in cloning, mutagenesis.

Vectors for expression of heterogenous proteins in *E. coli*, yeast, Baculovirus, vaccinia virus and mammalian cells.Understanding of operons Lac, Trp, tetracycline and their applications in studying biological processes and development of vectors. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in solubility and purification of recombinant proteins.

Block III: Gene Cloning

Synthetic oligonucleotides, purification, and their application in screening of libraries, cloning and mutagenesis. Synthetic gene assembly.

Genomic, c-DNA libraries, identification of a clone from gene library. Strategies for constructing cDNA and genomic libraries and screening using nucleic acid and antibody probes. Substractive libraries, expression based strategies for cloning functional genes, differential mRNA display.

Maxam Gilbert's chemical method, Sanger's method, modifications based on Sanger's method, Automated DNA sequencing. RNA sequencing, Base calling, accuracy of sequencing, introduction to next generation sequencing.

Block IV: Applications of recombinant DNA Technology

Introduction to Site–directed mutagenesis and its applications in Biotechnology (Agriculture, Medicine, Veterinary, Industrial)

Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. DNA finger printing, Gene therapy. Applications of protein engineering in purification of enzymes, hormones and in Biopharmaceuticals. Role of rDNA in diagnostic and forensic laboratory.

Plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns. Fish and poultry animals for meat.

Biosafety and ethical guidelines and regulatory aspects of recombinant DNA technology.

MBCL-002: Biochemistry Lab-II **4 Credits**

1. Isolation of plasmid DNA from *E. coli* cells.
2. Digestion of plasmid DNA with restriction enzymes.
3. Primer designing and Amplification of a DNA fragment by PCR.
4. Preparation of competent cells.
5. Transformation of foreign DNA and screening of transformants
6. Precipitin reaction by double immunodiffusion and radial immunodiffusion (Ouchterlony and Mancini's methods)
7. Detection of antibodies or antigen by ELISA
8. Detection of antigens by immunoblotting technique.
9. Blood group identification by agglutination test
10. Extraction and partial purification of acid phosphatase
11. Determination of specific activity of purified enzyme
12. Determination of Km and Vmax of acid phosphatase
13. Effect of pH/temperature on enzyme activity
14. Coupled assay
15. Estimation of serum urea/uric acid
16. Estimation of creatinine
17. Determination of blood pressure and pulse rate
18. Blood cells counting
19. Identification of blood group

MBC-007: BIOINFORMATICS AND BIOSTATISTICS **4 Credits**

Block I: Introduction to Bioinformatics

Introductory Concepts: Bioinformatics as an Emerging Discipline, Applications of Bioinformatics in Various Areas, Overview of Available Bioinformatics Resources on the Web, Protein and Genome;

Information Resources and Analysis Tools; Established Techniques and Methods; Sequence File Formats FASTA, GenBank, FASTQ and Structured File Formats.

Protein Sequence and Structural Databases, Nucleotide Sequence

Databases; NCBI, PubMed, Protein Data Bank(PDB), PIR, UniProt, EMBL, GenBank, DDBJ, SRA, UniGene; Specialized Databases: Pfam, SCOP, GO, Metabolic Pathways.

Block II: Analysis

Pairwise sequence alignment methods;Heuristic Methods; BLAST and its variants, Statistics of Sequence Alignment Score; E-Value, P-Value, Scoring matrix, PAM, BLOSUM and Gap Penalty; Multiple Sequence Alignments; ClustalW, Hidden Markov Models, HMM Based Multiple-Sequence Alignment.

Distance and Character Based Methods and Software, Computing Tools

for Phylogenetic Analysis, Distances, GROWTREE, PAUP, PHYLIP and MEGA; Construction and Visualization Phylogenetic Tree; and Application of Phyolgenetic Analysis.

Sequence Motif Databases, Pfam, PROSITE, Protein

Structure Classification; SCOP, CATH, Other Relevant Databases, KEGG, Protein Structure

Alignments; Structure Superposition, RMSD, Different Structure Alignment Algorithms, DALI, and TM- align.

Block III: Systems Biology

System-level-Understanding of Biological Systems, Introduction, Measurement Technologies and experimental methods, Comprehensive Measurements, Measurement for Systems Biology, Next-generation Experimental Systems. System structure identification, Bottom-up-approach, Top-down-approach. Application areas of Systems Biology.

Simulation, Analysis Methods, Robustness of Biological Systems,

Lessons from Complex Engineering Systems. System Control; Redundancy, Modular Design, Control, Structural Stability, Impacts of systems Biology.

Why Modeling is necessary, What type of Modeling is appropriate, Modeling the activity of a single gene, Gene Regulatory Network(GRN) Understanding gene regulation, Understanding the Biology, Biochemical Processes; transcription, exons & introns, splicing, translation, post translation modification. Overview of Models; Boolean, Differential equation, stochastic Models, Kinetic Logic Model.

Separators, Identifications of separators in noisy data, Genetic algorithms, Statistical validation of separators extracted from gene expression matrices, Generative models, Randomization based generative models.

Block IV: Biostatistics

Scope of Biostatistics, variables in biology, Data, Types of Data, Collection, Classification and Tabulation of data. Frequency distribution, Types of Frequency Distribution, Diagrammatic and Graphical representation of data.

Population and Sample, Sampling Vs Census, Sampling, Sampling Methods-Simple Random Sampling, Stratified Random Sampling and Systematic Random Sampling.

Sampling Distribution. Estimation, Point Estimation and Interval Estimation: Basic idea

of Significance testing, Null and alternative hypotheses, Types of errors, p- values, level of significance.

Analysis of Quantitative Data, Measures of central tendency (Mean, Median, Mode) and Measures of dispersion, Simple measures of skewness and kurtosis. Probability, Conditional probability, Addition and Multiplication Theorms of Probability, Baye's Theorm. Normal Distribution. Least Square method of fitting of curves, Correlation and Regression: Correlation and regression coefficients.

Z-tests (Large Sample), Student 't' tests (Small Sample), Chi-square test and F-test for ratio for equality of two Variances, Analysis of variance (ANOVA) tests-One Way and Two Way ANOVA Tests.

MBC-008: GENETICS AND EVOLUTIONAY BIOLOGY 4 Credits

You have already performed several experiments in electronics in your college laboratory while doing

Block I: Introduction to Genetics

Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Caenorhabditis elegans, Danio rerio* and *Arabidopsis thaliana*

Model systems

i. *C. elegans*: Study of cell lineage, mosaic development and organogenesis (vulva formation).

ii. Mouse: Vertebrate development, determining function of genes during development by generation of knockout and knock-in models.

Mendelian Laws of inheritance, Gene and allele, Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism: experimental evidences.

Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy, gene interaction - epistatic and non epistatic, interaction between gene(s) and environment.Penetrance and expressivity, norm of reaction and phenocopy.

Block II : Deviations from Mendelian Genetics

Linked genes, Genes on sex-chromosomes, imprinted genes.Recombination, linkage and crossing over. Experimental evidences of crossing over of linked genes, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in Drosophila, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes. Complementation test, limitations of cis-trans test, intragenic complementation, rII locus of phage T4 and concept of cistron Morphogens and zygotic gene activity in development, sex chromosomes and sex determination, maternal effect genes, dosage compensation of X-linked genes.

Block III: Introduction to Evolutionary Biology

History and basic concepts of development, modification of development in evolution, identification

of developmental genes. Gametogenesis, fertilization, generation of multicellular embryo, formation of germ layers, and patterning of vertebrate body plan. Early embryonic development in Drosophila. Maternal inheritance, genetic basis of axis determination, regulatory cascade in development in Drosophila, Homeotic genes.

Pedigree analysis and basic inheritance patterns in humans. Definition, types and properties of stem cells, cultivation of stem cells, adult stem cells, cancer stem cells, stem cell markers, role of stem cells in development and applications of stem cells. Genetic errors of human development, gene expression and human diseases, induced pluripotency, in-vitro fertilization, environmental assaults on human development, design of future medicines like gene therapy, therapeutic cloning and regeneration therapy.

Block IV: Evolutionary genetics

Spontaneous occurrence of mutations in bacteria, Lederberg and Tatum experiment, Types of mutations i.e. point mutations, deletions, rearrangements, insertions, dynamic mutations (repeat expansions) with appropriate examples, Chromosomal anomalies. Mutation mapping using balancers, Clb technique in Drosophila. Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations.

Definition, aim and scope of population genetics, population structure, factors maintaining population boundaries, effective breeding size, gene pool. The Hardy-Weinberg Law and its application, factors affecting the Hardy-Weinberg equilibrium. Human polymorphism (transient and balanced), relationship between sickle cell polymorphism and malaria, other ploymorphisms that may be an adaptation to malaria eg. G6PD deficiency. Duffy blood groups, thalassemia and haptoglobins. X linked polymorphism (G6PD and colour blindness). Incompatibility Selection. Non-random mating, inbreeding and its consequences. Migration and Genetics, types of migration, models to study genetic effects of migration, gene flow, effects of gene flow, admixture and natural selection,

Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

MBC-009: Clinical Biochemistry 4 Credits

Block I: Biological sample collection and analysis

Autoanalyser and automation in clinical biochemistry laboratories safety regulations and first aid. Collection of sample and storage, types of specimen for biochemical analysis- Blood specimen (serum, plasma), Urine specimen, stool, CSF specimen, amniotic fluid,. Normal values, Precision, accuracy, quality control, precautions and limitations. Disposal of waste and Lab regulations. Handling of infected samples. Laboratory records and data management.

Diagnostic enzymes- enzyme assays in serum/plasma, urine and cells. Principle and assay of aspartate and alanine aminotransferase, alkaline phosphatase, acid phosphatase, streptokinase, asparaginase, α-hydroxybutyrate dehydrogenase, ceruloplasmin, γ-glutamyl transpeptidase, creatine kinase and lactate dehydrogenase.

Isoenzymes in disease diagnosis- LDH, method for isoenzyme analysis.

Species of blood cells, Estimation of hemoglobin, Hematocrit value, RBC, WBC,ESR and packed

cell volume, clotting time, ESR and their clinical significance.

Electrolytes and acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, Disorders of electrolyte, water and acid-base balance.

Block II: Metabolic Disorders

Brief of carbohydrate metabolic pathways and their role in regulation of glucose homeostasis. Disorders of carbohydrate metabolism - glucose tolerance test, Glycogen storage diseases, Diabetes mellitus, galactosemia, pentosuria. Measurement of blood and urine glucose levels- Principle of Glucometer, Dipstick. GOP-POD method

Brief of lipid profile- triglycerides, total cholesterol, HDL-cholesterol, LDL-chlesterol and their clinical significance. Composition and functions of lipoproteins and clinical significance of their blood levels. Hyperlipoproteinemia, Abetalipoproteinemia, Hyperlipidemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick Disease, Gaucher's Disease, Krabb's Disease, Metachromatic leukodystrophy and Fabry's Disease, Wolman's Disease,

Haemoglobinopathies- sickle cell anaemia, thalassemia and erythrocyte enzyme disorders.- Disorders of glycine, sulfur containing amino acids, aromatic amino acids, , disorders of propionate and methylmalonate metabolism. Disorders of urea biosynthesis. Inborn errors of metabolism-Phenylketonuria, alkaptonuria. Porphyrias

Disorders of purine and pyrimidine metabolism -Gout.

Block III: Organ function tests

Test related to LFT, Normal structure and functions of liver, diseases of the liver, hepatitis (types)- viral hepatitis, cirrhosis, alcoholic liver disease, hepatic tumor and biliary tract diseases, liver function tests, disorders of bilirubin metabolism- Jaundice. Hippuric acid, Liver toxicity.

Test related to acute and chronic renal failure, Composition of urine, glycosuria, protenuria, urinary tract obstruction and analysis of urinary calculi. Test for clearance, Glomerular filtration rate (GFR), inulin clearance test, C-reactive protein (CRP). Chemical nature of calculi.

Clinical identification of symptoms of CVD, Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, angiotensin converting enzyme, isoenzymes of creatine kinase and lactate dehydrogenase and troponin. Myocardial infarction and atherosclerosis. Relevance of bood clotting time.

Block IV: Other diseases

Obesity, Alcoholism, fatty liver- basis and diagnostic tests. Redox metabolism- role of free redicals. Endogenous and exogenous free radicals, Oxidative stress. Role of enzymatic and non-enzymatic antioxidants

Morphological and metabolic changes in tumor cells. Tumor markers - Alpha-fetoprotein (AFP), Carcinoembryonic antigen (CEA), Carcinogens.

Hormone associated to clinical conditions- Principle and clinical releveance of their levels:

TSH,PSA, Human chorionic gonadotropin (HCG). Pregnancy test

MBCL-003: Biochemistry Lab-III **4 Credits**

1. Retrieving and viewing of the specific protein sequence (by accession no. or name) using a public database site.
2. Exploring the NCBI, ExPASy, www.ebi.ac.uk/Tools etc. websites for information and tools available.
3. Retrieving DNA and/or protein sequences of a given item (by name or accession number) from GENBANK. Performing a sequence similarity search using the BLAST.
4. Retrieving protein sequence of a given organism and downloading the structure of this protein from existing database. Short-listing protein sequences of highest similarity from the list of BLAST search result and doing a multiple sequence alignment (Using CLUSTALW). Finding out the regions of exact/good match in the protein sequences of these sequences.
5. Construction of phylogenetic trees.
6. Searching and downloading protein structure data using Entrez. Viewing the structure using public domain software.
7. Protein structures: Visualizing and analysis of inter atomic distances, H-bond calculations, secondary structure analysis and salt bridge analysis of protein structures using different software. Prediction of 3D structure of protein -PyMol.
8. Bioinformatics analysis of genomics and proteomics
9. Calculation of standard deviation and correlation of biological data
10. Demonstration of SPSS software
11. Study of computational network of metabolites
12. Demonstration of molecular docking tools-(AutoDock 4.0)
13. Estimation of AST and ALT in serum by kit method
14. Estimation of BUN by kit method
15. Amylase assay
16. Lipid profile analysis
17. Assay of isoenzmes (LDH/CPK)
18. Blood sugar estimation
19. Demonstration of ADMET by virtual tool-SwissADME

20. Determination of hardness of water

21. Sterilization techniques/ Sterilization of culture media and glassware.

22. Isolation and propagation of bacteria.

23. Composition of various tissue culture media and preparation of MS nutrient medium.

Callus induction from various explants. Micro-propagation, hardening and acclimatization.

MBC-010: Research Methodology 4 Credits

Block I: Introduction to Research

Meaning and importance, Objectives, Nature and Types of Research, Methods versus Methodology, Research process, Areas of research in Biological Science. Research Process, Formulation of a Research Problem (Hypothesis) and Considerations in selecting a Research Problem, Sampling methods, Criteria of Good research, Dependent versus Independent variable, Extraneous variable, Experiment and control groups, Review of Literature, Objectives.Elements in Research Methodology; Preparing Research Designs, Research Designs [(Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD)], Experimental Method, Types of Sample, Tools for Data Collection.

Block II: Research Analysis, Presentation and Ethics

Data Collection, Primary and Secondary data, Editing, coding, classification, Tabulation, Analysis Methods-Qualitative and Quantitative, Reporting the Findings.

Writing of research report/Research paper/Thesis; Dissertation: Various components and their organization. Different steps in report writing, precautions for writing research reports.

Ethics with respect to Scientific Research, Intellectual Honesty and Research Integrity, Ethics Issues and Challenges in Scientific Research, Scientific Misconduct, Falsification, Fabrication and Plagiarism.

Introduction, Definition, Importance, Violation of Publication Ethics, Conflict of Interest, Authorship and Contribution ship, Publication Misconduct: Definition, Concepts, Types, Publication Problems, Issues and Challenges.

Block III: Bioethics and Biosafety

Role of institutional ethics committees (animals and humans), Constitution of ethics committees, WHO and ICMR guidelines. Introduction to hazardous materials used in biological research and safety measures, Disposal of hazardous waste and biohazards, Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety levels, Biosafety guidelines and regulations-Government of India, Roles of Institutional Biosafety Committee

Review Committee of Genetically Modified (RCGM), Genetic Engineering Approval Committee (GEAC) for GMO applications in food and agriculture, Environmental release of GMOs; Cross border movement of germplasm.

Block IV: IPR and patent

Introduction to IPR Emerging Issues – The Indian Scenario, Copyright issues and Plagiarism,

Basics of Patents, Types of Patent, Patent Rights and Infringement, Paris Convention, Patenting Inventions-Objective, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting inventions.

Biotechnology and Intellectual Property Rights, Plant varieties protection-Objectives, Justification. The International Convention for the Protection of New Varieties of Plants,

MBC-011: ANIMAL AND PLANT TISSUE CULTURE 4 Credits

Block I: Introduction to Tissue Culture

Introduction to Plant tissue culture, Basic requirement of plant tissue culture Preparation and sterilisation of solid and liquid culture media. Short- and long-term preservation of microbial strains (lyophilization and cryopreservation), revival of cultures. Isolation of pure cultures by streak plate, pour plate and sector plate methods.

Plant cell culture**:** tissue culture media, types of plant Tissue Culture (PCT), stages of tissue culture. Sterilisation methods and preparation culture media. Lab organisation

Tools of PTC: Prospects of improving crop productivity, gene isolation, gene transfer systems, T_i plasmid, plant virus vectors, electroporation, microinjection, microprojectile technology, gene expression, regeneration. Application in relation to protein quality, photosynthetic efficacy, nitrogen fixation efficiency and resistance to environmental stresses.

Plant vectors, $T_i$plasmids, Terminator technology, Anti sense RNA and DNA

Germplasm conservation, Molecular markers, and maps.

Principles of Micropropogation**:** Direct and indirect morphogenesis, somatic embryogenesis, caulogenesis, rhizogenesis, acclamatization. Synthetic seed production.

Block II: Animal Cell Culture

Animal Cell Culture: Sterilisation of animal cell culture, Biosafety, Primary culture and secondary culture media, **Cell lines**, a clone of mammalian cells, adherent Monolayer and suspensionculture, Preparation of primary culture from tissues or organs, cells counting method, cryopreservation and revival of cell lines- freezing and thawing. Cell viability assay.

Cloning of mammalian cells- importance of cloning, Hybridization of mammalian cells, Application of hybrid cells. Marker proteins on mammalian cells. embryo rescue, animal cell lines and organ culture.

Stem cell cultures: Origin of stem cells, stem cell markers, embryonic and adult stem cells, their isolation, culture, generation and applications.

Block III: GMO

Transgenic, conventional and Conditional Gene knockout, gene knock-in, gene silencing, Mammalian virus vectors, Gene constructs. Advances in producing transgenics, Cloning of mammalian species (Dolly - Polly, and Molly,)

Transgenic plants: insect resistance, virus resistance, abiotic stress tolerance, longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice). Transgenic plants- Case studies (genes involved, commercial value, problems) of StarLink corn, Bt cotton, Zeneca tomato paste, FlavrSavr tomato, Golden rice, Herbicide resistant plants (Roundup Ready), Virus resistant plants (papaya).

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-isotopic procedures; Benefits of transgenics to human health, society and the environment.

Block IV: Applications of Tissue culture

Hybridoma technology – Monoclonal antibodies, selection of hybrids,hybridomas, purification and application of monoclonal antibodies.

Production of viral vaccines, high value therapeutics, interferon, Plaminogen activator, urokinase.

Antibody therapy: Chimeric antibodies and antibody engineering, Immunotoxins as therapeutic agents.

Gene Therapy: Human gene therapy, “Humanized” animals as organ farms, CRISPR-CAS9, Stem cell therapy: Tissue engineering and Regenerative medicine to be elaborated

MBCE-012: Plant Biochemistry 4 Credits

Block I: Introduction to Plant Biochemistry

Ultra structure of a plant cell and their functions with emphasis to plastids and plant pigments, vacuoles, peroxisomes, and plant cell wall.

mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory, ATP synthase and mechanism of ATP synthesis, Oxidative phosphorylation.

Photosynthetic apparatus: photosystems I and II (light harvesting complexes, reaction centre and antenna pigments). Pigments: chlorophyll and carotenoids, their in photosynthesis. photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photo-phosphorylations, Hill reaction.

C_3, C_4, and CAM pathway of carbon reduction and its regulation, Photorespiration, synthesis of sucrose and starch, and their regulation.

Block II : Nitrogen and Sulphate assimilation

Overview of Nitrogen cycle, biological and non-biological nitrogen fixation, nitrogenase complex, source of reductant and role of ATP, Protection from oxygen, regulation of nitrogen fixation. Symbiotic nitrogen fixation.

Overview of nitrate uptake and reduction, Nitrate and nitrite reductases, incorporation of ammonia into organic compounds by GS-GOGAT pathway and regulation, Interaction between nitrate assimilation and carbon metabolism.

Overview of sulpher uptake and transport, reductive sulphur assimilation pathway, synthesis and function of glutathione and its derivative.

Block III : Introduction to Plant Stress Biochemistry

Abiotic stresses- salinity, water stress, drought : adaptation and tolerance, Freezing and Heat stress. Impact of heavy metals and radiations on plant growth and metabolism.

Oxidative stress, reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defense mechanism, plant response to abiotic stresses. Introduction to biotic stresses (insects,k pathogens), Responses of plants to biotic stress (pathogen and insects), genetic basis of plant pathogen interactions, plant defense mechanisms (secondary metabolites and expression of gene and modification of cells wall and transgenic plants as MR).

Block IV: Plant Hormones And Secondary Metabolites

Introduction to classical hormones **(**Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid) and novel growth regulators **(**like salicylic acid, jasmonates, NO) in regulation of seed dormancy, germination, growth and development.

Basic concepts and terminology; tropic effects, regulatory plant pigments, phytochromes, cryptochromes (circadian rhythms). Photoperiodism: general principles, response types (long and short day plants, flowering).

Classification and functions terpenoids, alkaloids and phenolics. Biosynthesis of some representative secondary metabolites. Mycotoxins, phytohemagglutinins, lathyrogens, nitriles, Glycosides, protease inhibitors, protein toxins.

MBCE-013: Human Physiology 4 Credits

Block I: Thermoregulation

Formation of different kinds of tissues from primary germ layers. Types and functions of epithelial tissue, inter-cellular junctions. Connective tissue – extra cellular matrix, Collagens – types, composition, structure and synthesis, Elastin, fibronectins, and other proteins of the extra – cellular matrix. Basal lamina; laminins and associated proteins and their functions.

Homeostatic control system, Thermoregulation, Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Respiration: Principles of gaseous exchange during respiration, Bohr effect, transport of oxygen and carbon dioxide in the blood, regulation of respiration.

Block II: Digestive and Excretory system

Secretion, regulation of secretion, composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Function of different parts- peristalsis, regulation of saliva, gastric, pancreatic, Intestinal and bile secretion (i.e. digestion), Absorption – (carbohydrate, protein, lipid, minerals and vitamin) transport of nutrients. Role of liver and panaceas in digestion.

Excretory system, kidney, Kidney hormones. Mechanism of urine formation and composition of urine, waste elimination, micturition.

Renal regulation of acid-base balance, electrolyte and water balance. Renal regulation of blood volume and blood pressure. Role of kidney in metabolic acidosis and alkalosis.

Block III: Circulatory system

Heart as a pump, cardiac cycle, cardiac tissue, ECG – its principle and significance, blood pressure, neural and chemical regulation. Heart and it associated blood vessels.

Composition of Blood, blood circulation, blood corpuscles, haemopoiesis, plasma function, blood volume, blood volume regulation, blood groups, role of haemoglobin.

Biochemistry of blood clotting ,clotting factors, intrinsic and extrinsic pathways, mechanism of formation of thrombin, fibrin, fibrin clot, role of vitamin K clotting process, lysis of fibrin clot.

Intra and extra cellular fluids, Lymph, Cerebro spinal fluid (CSF); composition and analysis in diagnosis.

Block IV: Neuromuscular system

Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types and structure of neuron. Myelin sheath; composition and functions.

Neurotransmitters and receptors; synaptic transmission, post-synaptic potentials. Resting membrane and action potential. Mechanism of initiation and propagation of action potential – voltage gated ion channels, ionophores and toxins in study membrane transport.

Ultra structure of smooth, skeletal and cardiac muscle fibers. Contractile and other proteins of muscle. Organization of sarcolemma, transverse-tubular system and sarcoplasmic reticulum. Energy metabolism in muscle;

Mechanism of muscle contraction. Neuro-muscular junctions, excitation of striated muscles. Regulation of contraction in striated and smooth muscle. Calmodulin and its regulatory role, phosphagens, muscular dystrophies.

MBCE-014: Microbiology 4 Credits

Block I: History Of Microbiology And Microbial Classification

Landmark events in the development of microbiology, discovery of microbes, Spontaneous generation vs. biogenesis, Robert Koch and Germ theory of diseases, Role of microorganisms in fermentation, Development of various microbiological techniques.

Introduction to taxonomy and classification systems. Binomial Nomenclature, Whittaker's and Carl Woese's classification systems and their utility. Introduction to phylogeny.

General structure of Prokaryotic and eukaryotic microorganisms. Viruses, virusoids Viroids, Prions and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction.

Block II: Microbial Techniques

Common Nutrient requirements, growth factors, uptake of nutrients by cell. Growth curve and

measurement of microbial growth. Definititon of sterilization and disinfection. Methods of sterilization- physical, heat- dry and moist, filtration, radiation and chemical methods.

Culture media and its types. Methods for enumeration and isolation of microorganisms using pou plate, spread plate and streak plate; isolation of anaerobic microorganisms. Maintenance and storage of pure culture.

Staining techniques, procedures and applications of simple staining, negative staining. Differential staining- Gram's staining, acid fast staining, Leishman's staining, Giemsa's staining, Ziehl Neelsen staining. Structural staining- cell wall, capsule, endospore and flagella staining.

Principles, construction and applications of- Centrifuge, bacteriological incubator, shakers, laminar flow, spectrophotometer (UV/Vis).Microscope- compound, Bright field, dark field, phase contrast, fluorescence and electron microscope

Block III: Microbial Interactions

Types of pathogens, host-parasite relationships. Pathogenesis of microorganisms-bacterial and viral diseases. Toxigenecity

Innate immunity of host to microbes- host defence cells and system. Adaptive immunity- Antigens, antibody, immunoglobulins, T cell and B cells. Action of antibodies.

Host evasion mechanisms of bacteria and viruses

Antimicrobial agents, such as growth factors analogs, antibiotics, germicides, disinfectants and antiseptics. Evaluation of antimicrobial effectiveness- phenol index

Block IV: Interaction Of Microbes With Environment

Gnotobiotic animals. Micorbiota- relationship between host and microbiota. Interaction of microbes with other living organisms and non living entities, symbiotic and non symbiotic interactions. Biofilm formation.

Isolation and identification of microbes in a clinical lab, rapid methods of identification, immunologic techniques, bacteriophage typing, molecular methods and analysis of metabolic products

Applications of microbes in biotechnology, industry, environment, agriculture and medicine.

MBCE-015: IMMUNOLOGY AND IMMUNOLOGICAL TECHNIQUES 4 Credits

Block I: Introduction to Immunology

Introduction to immune system: Historical development of the branch "Immunology". Overview of the immune system. Cells and organs of immune system: Lymphoid cells, natural killer cells, Phagocytes, granulocytes, Lymphoid organs and lymphatic system. Introduction to Antigens, Immunogens, Haptens, Epitopes.

Innate Immunity: Component of innate immunity, Barriers against infection. Discovery of immunoglobulins, Structure, function and classification of various classes of immunoglobulins. MR: Blood group substances.

The complement systems: mechanism of complement activation, pathology related to complement

proteins, avidity. Cytokines: properties, receptors, and antagonists. Therapeutic uses of cytokines and cytokine related diseases. immunological role of cytokines,

Diversity in Immune system: Immunogenetics, Generation of antibody diversity, class switching among constant-region genes.

Block II: Cellular and Humoral Immunity

Cell mediated immunity, Generation of B and T cells Responses, Immunological memory. T-cell receptors, maturation, activation and differentiation. B-cell activation and differentiation, B-cell receptor and the immunoglobulin superfamily.

Humoral immune response: Antibodies, Concept of neutralizing antibodies. Antigen-Antibody interactions. Epitope mapping, Development of monoclonal antibodies, single chain antibodies. Clonal selection theory - concept of antigen specific receptor. T-cell receptor diversity.

MHC complex and antigen presentation, MHC restriction and mechanism of graft rejection.

Block III: Immunotechniques

Immunisation and production of antibodies

Immunisation methods: Production, isolation and preparation of polyclonal antibodies. Titration of antibodies in antiserum, production of monoclonal antibody by Hybridoma technique.

Immunotechnique I Applications of antibodies in diagnostics and routine laboratory assay systems. Agglutination reaction, precipitation and opsonization, gel diffusion (Ouchterlony double immunodiffusion and Mancini's Radial immunodiffusion), immunoblotting, immunoelectrophoresis, andImmunodiagnostics.

Immunotechnique II: RIA, ELISA. immunohistochemistry, immunoelectron microscopy, Flow cytometry- cell sorting

Block IV: Immunological Disorders and Vaccines

Immune response to infectious agents: Viral and bacterial infections, emerging infectious diseases. Immunodeficiency (AIDS), Mechanisms of induction of autoimmunity, treatment of autoimmune diseases

Allergy and asthama, biology of hypersensitivity reactions: Antibody-Mediated Cytotoxic (Type II) Hypersensitivity, Immune Complex–Mediated (Type III) Hypersensitivity and Type IV or Delayed-Type Hypersensitivity (DTH).

Tumor antigens and cancer immunotherapy: Oncogenes and Cancer Induction, Tumors of the Immune System, Tumor Antigens, Immune Response to Tumors, Tumor Evasion and Cancer Immunotherapy.

BOX/MR; Plasma therapy and immunological relevance

Concepts of vaccines, Designing vaccines for active immunization, whole-organism vaccines, recombinant vaccines, DNA and RNA vaccines. Case studies: Polio, BCG and corona vaccine. Synthetic peptide and multivalent sub unit vaccines. Vaccine delivery. Challenges in development of vaccines against tuberculosis, malaria, leishmania etc.

MBCE-016: Toxicology 4 Credits

Block I: Overview of toxicology

Historical account of **toxicology,** scope and relationship of Toxicology to other sciences. Nature of toxic effects. Acute and chronic exposure. Reversible and irreversible effects. Environmentally biodegradable toxicants.

Definition-toxicity, class and nature of Toxicants-chemical, physical, artificial and natural Solvents, Pesticides, Cosmetics-food additives and preservatives, food colors and dyes, Chemical additives in food Chemicals, Drugs of abuse. Inorganic chemicals: Industrial and chemical environmental inorganic toxicants polluting air/ water/ food. Naturally occurring poisons: Mycotoxins, Bacterial toxins, Plant toxins and Animal toxins. Occupation health hazards.

Types of toxicity and its measurement: Acute, Sub-acute or Chronic and its manifestations. Acute toxicity: *in-vitro* tests, Dose response relationship, Determination of TD 50/ TC 50 and LD 50/ LC 50, no observable effect level (NOEL), acceptable daily intake, bioavailability, distribution, half life, total body burden, total body clearance. Synergism and Antagonism Subacute and chronic toxicity.

- Ames test-S9, Host mediated assay and dominant lethal test, Drosophillia sex linked recessive lethal test, COMET assay, Special toxicity studies: Carcinogenecity, teratogenicity, in-vitro mutagenicity tests.

Block II: ADME of toxicants

Introduction to ADME- Absorption, Distribution, Metabolism and Excretion of drugs and chemicals, Role of liver, kidney, lung, GI tract, skin and their role in entry, activation and detoxification of drugs and chemicals. Factors affecting metabolism, detoxification and toxic responses of drugs and chemicals- Physiological (route of exposure, species, sex and age), Nutritional and environmental (temperature, altitude and circadian rhythms related)

Introduction to xenobiotics, Phase-I Cytochorome P-450- (redox reaction, hydroxylation, transamination, isomerization, epoxidation, racemisation etc). Microsomal and Non-microsomal oxidation system and their role in xenobiotic metabolism. Phase-II reactions,-conjugation reaction such as Glucornylasation, sulphonylation, methylation, and acetyl transferases, Glutathione conjugation and Amino acid conjugations. PVC

Population variation in drug metabolism- graded and Quintal response. genetic variability; polymorphism relating to receptors and genes in drug metabolism; molecular markers and Single nucleotide polymorphism as markers for emerging concepts in pharmacogenetics.

Block III: Organ Toxicity

Basics of organ toxicity- target organs, organ selectivity and specificity. Morphological and histological changes of skin on exposure to toxic agents- Allergy, dermatitis, cutaneous carcinogenesis.

Broncho-pulmonary (inhalation) toxicity. Structure of lung, systematic lung toxins and lung pathology. Tests for evaluation of toxicities in different organs. Therapeutic aspects- EC-50, General measures and treatment of poisoning cases, Specific antidotes, Agents of first choice, Contraindications. markers of toxicity.

A brief description of morphological and functional aspects of liver with special reference to

hepatotoxicity, various hepatotoxic agents, types of liver injuries- Fatty liver formation, Necrosis, Cholastosis, Hepatitis, Fibrosis, Cirrhosis.

A brief description of morphological and functional aspects of kidney in relation of nephrotoxicity, nephrotoxic agents.

A brief description of cardiovascular toxicity and cardiotioxic agents and indicatior of cardiotoxicity, Neurotoxic agents and types of neurotoxic effects- Axanopathy, Neuronopathy, Mylenopathy, Antivenom .

Block IV : Environmental toxicology

Introduction to ecotoxicology, sources and types of pollutants, entry, movement and fate of pollutants in ecosystems.

Classes of pesticides: Organochlorine, Organophosphates , pyrethrans and carbamates. DDT: Metabolism, toxicity, persistence and bioaccumulation. Organophosphate-Metabolism and mechanism of insecticidal action. poithrine,

Toxicity and various forms of mercury and lead toxicity, effect of lead on heme synthesis. Toxicology of various forms of mercury, and Arsenic Toxicity. Drug Toxicity-Paracetamol, Metabolism and its Toxic effects,

Sources and exposure to radiation, biological effects of radiation, Various accidents leading to radioactive pollution, protective strategies.

MBCE-017: OMICS 4 Credits

Block I: Genomics

Overview of OMICS: Aims and need. Applications of OMICS to human diseases. Structural organisation of virus, prokaryotic, and eukaryotic genomes, genome organisation (intron, exon, promotor, intergenic region, ORF), Genome mapping: Physical and Genetic Map, Polymorphisms in DNA sequence, Genome Sequencing, Genome Annotation and Gene finding. Concept of genomics, Functional genomic studies with model systems such as Drosophila, Yeast or C. elegans. Genome projects on E.coli., Arabidopsis and rice; Ovrview of Human genome project and the genetic map. Overview of comparative genomics- Homology, homologous, orthologous, paralogous, Paralogous, Xenologous and Probabilistic. Concepts of genome assembly and the first Human genome, High throughput DNA sequencing, shot-gun sequencing, sequencing editing, contig assembly, Next generation sequencing methods (NSGs), software available for NSGs, Methods of comparative genomics.

Introduction to Data Bases, types of Data Bases. software Plat form for data analysis INSD-International Nucleotide Sequence Database, Gen Bank, EMBL, DDBJ, special focus on NCBI, gene bank, Concepts of sequence alignments and its importance. Pairwise and multiple sequence alignment. Molecular phylogeny concept. Gene visulisation tools such as CRISPOR, Gene Structure Display Server (GSDS2.0). Visualization tools including Artemis and Vista, CGView Server for genome comparison;

Block II: Transcriptomics

Transcript of RNA, Single-cell transcriptomics, Search for transcription factor binding sites, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, Darkmatter

RNA and noncoding RNA. Transcriptome databases, Application of Transcriptomics Isolation of RNA, RNA Deep Sequencing, Single-end Sequencing, Paired-end Sequencing , Small RNA sequencing, Adapter Trimming, Long RNA sequencing, Transcriptome Assembly, Methods of Mapping, Transcription Start Sites (TSSs) , Cap Analysis of Gene Expression (CAGE), Serial analysis of gene expression (SAGE)

Overview of DNA microarray, steps and experimental setup of DNA microarrays: photolithograpinc printing and synthesis of arrays, Design and execution. Data collection, analysis and image processing: Analysis of Microarray gene expression data and its application.

Block III: Proteomics

Introduction of protein, proteom and proteomics, Overview of proteomics technology, Evolution from protein chemistry to proteomics, Protein modifications in proteomics; Protein sequencing, Protein chips and functional proteomics; Protein-protein interaction;

Quantitative interaction networks in proteomics, Clinical and biomedical application of proteomics; Challenges in proteomics.

Gel based proteomics- two-dimensional gel electrophoresis (2-DE) and two dimensional fluorescence difference in-gel electrophoresis (DIGE) Mass spectrometry based proteomics technology (ESI-MALDI, MALDI- TOF/TOF, Q –TOF), tagging methods for MS-based proteomics, Proteomic strategies for protein identification and Post Translation Modification of characterization. Introduction to quantitative proteomics and techniques (i-TRAQ and SILAC). FABS Understanding structure of proteins from protein data bank (PDB). Computational models of proteomics networks. Protein structure visualization and modeling software (Swiss PDB viewer and software O); Application of proteomics for drug discovery, Tools of analyzing Proteomics data (ExPASy server) and GCG utilities and EMBOSS. String and Gene ontology. Case studies of proteomics

Block IV: Metabolomics

Fundamental concept of metabolomics, small molecules, The metabolome and metabolomics. The importance of metabolomics, Metabolic pathway analysis and metabolic networks, Single Cell Metabolomics, metabolite identification, metabolic fingerprinting, Applications of metabolomics, Clinical implications of Metabolomics- Table. Plant metabolomics. Overview of analytical techniques-MS & NMR; LC-MS, commonly used in metabolic profiling, HPLC and FPLC based approaches in metabolomics. Overview of complete analysis workflow. Data analysis and metabolite identification. Metabolomics standards and database e.g. KEGG, BioCyc, MetExplore and Cytoscape for metabolic pathway and network analysis. Introduction to drug desinging–ligand based drug designing and target structure based drug designing, Pharmacopore modeling (pharmaGist software) and Method and application of docking approach in drug discovery - target identification and validation ,energy minimization, analyzing active site, Protein-ligand interaction and binding energy analysis.

6. OTHER USEFUL INFORMATION

Refund of Fee

Refund of fee is governed by the Fee Refund Policy of the University. The same is available on the University Admission Portal (https://ignouadmission.samarth.edu.in). Fee paid for one

programme is not adjustable against any other programme of the University. In case the University denies admission, the programme fee will be refunded after deduction of registration fee, through online mode.

Reservation

The University provides reservation of seats for Scheduled Castes, Scheduled Tribes, Non-Creamy Layer of OBC, Economically Weaker Sections, War Widows, Kashmiri Migrants and Physically Handicapped learners, as per the Government of India rules, for admission to its various programmes. However, submission of forged certificate under any category shall be liable for not only cancellation of admission but also to be legally implicated as per Government of India rules. Eligible students can apply for Government of India scholarship on the National Scholarship Portal(**https://scholarships.gov.in/**) after confirmation of their admission.

Correction of Address and Study /Regional Centre Change

Learners can initiate the request for change of address, Learner Support Centre and Regional Centre online from their user account. The user account is to be created at https://ignou.samarth.edu in by clicking'New Registration. They can also make a request to the Regional Centre.

Correction/Change of Name/Surname of Learner

Spelling mistakes, if any, committed at the time of data entry stage will be rectified at the Regional Centre. In case there is a change in the name (other than the one mentioned in his/her High School Certificate), then it is mandatory to furnish legal evidence of having changed his/her name/ surname while submitting the admission form.

For 'Change of Name/Surname', after confirmation of admission, the learners are required to submit thefollowing documents at the Regional Centre:

a) Original copy of Notification in a daily newspaper notifying the change of name;

b) Affidavit, in original, on non-judicial Stamp Paper of the appropriate value sworn in before 1stClass Magistrate specifying the change in the name;

c) Marriage Card/ Marriage Certificate in case of women candidates for change in surname;

d) Gazette Notification, in original, reflecting the change of name/surname; and

e) The requisite fee.

Request for correction and/or change of Name / Surname will be entertained only before completion of the programme.

Disputes on Admission & other University Matters

The place of jurisdiction of filing of suit, if necessary, will be New Delhi/Delhi ONLY.

Prevention of Malpractice/Notice for General Public

Learners seeking admission to various academic programmes of Indira Gandhi National Open University are advised to directly contact IGNOU headquarters at New Delhi or Regional Centres of IGNOU only. Learners interacting with intermediaries shall do so at their own risk and cost. However, in case of any specific complaint regarding fraudulent institutions, fleecing learners etc., please contactthe University through:

Email: ignouregistrar@ignou.ac.in

As per directions of Hon'ble Supreme Court of India ragging is prohibited. If any incident of ragging comes to the notice of the authority the concerned learner shall be given liberty to explain and if his explanation is not found satisfactory, authority would expel him from the University. IGNOU admissions are made strictly on the basis of merit. Only those learners who satisfy the eligibility criteria fixed by the university will be admitted. Learners will not be admitted if they are not eligible as per the eligibility criteria. Therefore, the candidates should not be misled by the false promises of admission made by any private individuals or institution.

Placement Services

In order to further extend learner support services to its geographically distributed learner population who are pursuing various IT and Non-IT related Degree, Diploma and Masters Programme, theuniversity hasestablished the Campus Placement Cell (CPC). The mission and endeavour of CPC is to enhance and facilitate the process of prospective suitable employment opportunities that are commensurate with the personal profiles of our learners. All learners interested in seeking the assistance of CPC for procuring suitable job opportunities are requested to send their current resume/bio-data to campusplacement@ignou.ac.in. They are further advised to visit our home page www.ignou.ac.in for regular updates on placement related activities.

Some Useful Contact Addresses:

1.	Identity Card, Fee Receipt, Bonafide Certificate, MigrationCertificate, Scholarship forms, Change of Courses / Electives / Opting of left over electives	Concerned Regional Centre. The demand Draft for the requisite should be drawn in favour of 'IGNOU' payable at city of the Regional Centre.
3.	Schedule/Information regardingExam-form, Entrance Test, Date-sheet, Hall Ticket	Asst. Registrar (Exam. II), SED, Block-12, Room No. 02, IGNOU, Maidan Garhi, New Delhi-110068. Ph.: 011-29536743, 29572202, 29572209
4.	Result, Re-evaluation, Grade Card. Provisional Certificate, Early Declaration of Result, Transcript	Deputy Registrar (Exam.III), SED, Block-12, Room No. 01, IGNOU, Maidan Garhi, New Delhi-110068. Ph.: 011-29536103, 29572201, 29571316
5.	Non-reflection of AssignmentGrades/marks	Assistant Registrar (Assignment), SED, Block-03, IGNOU, Maidan Garhi, New Delhi-110068. assignment@ignou.ac.in. Ph.: 011-29571312, 29571319, 29571325
7.	Original Degree/Diploma/ verification of degree/diploma	Deputy Registrar (Exam. I), SED, Block-9, IGNOU, Maidan Garhi, New Delhi-110068. Ph.: 011-29535438, 29572224, 29572213
8.	Student Grievance (SED)	Asst. Registrar (Student Grievance), SED, Block-3, Room No.13, IGNOU, Maidan Garhi, New Delhi-110068. Ph.: 011-29532294, 29571313

9.	Academic Content	Director, School of Sciences, IGNOU, Maidan Garhi, New Delhi-110068. sos@ignou.ac.in. Ph.: 011-29532167; 29572832
10.	Student Support Services	Regional Director, Student Service Centre, IGNOU, Maidan Garhi, New Delhi-110068.ssc@ignou.ac.in, Ph.: 011-29535714, 29533869,2953380, Fax: 011-29533129

7. LINKS TO FORMS AND ENCLOSURES

In this section, we are listing the IGNOU website links to various forms, which are useful for you. Whenever you have to correspond with the university, please **download the form from the IGNOU website**, fill it carefully and send it as per the instructions in the form. The detailed instructions for all these forms are provided in the form itself. Some of these links may change, in that case please usethe search option to find the desired link. An important page for all students is the following:

http://ignou.ac.in/ignou/studentzoneYou must familiarize yourself with all the links on this page.

Note: You may download the Forms from the Website

1. **Assignment related links Link to Latest Assignment(s): https://webservices.ignou.ac.in/assignments/**

2. **Re-registration**

   Link to Online Re-Registration https://onlinerr.ignou.ac.in/

   Last date of Re-Registration is announced on the IGNOU website. In general, the re-registration is to be done 2-3 months prior to the start of Session. For example, the last date of re-registration for the session starting from July cycle is typically the end of May. Similarly, the last date for session starting January cycle may be in the last of November.

   You must verify the cut off dates and fees from the website prior to filling up form.

3. **Term-end Examination and Related Links**

   The link to the **online Term End Examination form** is available on https://exam.ignou.ac.in/

   Links to application forms for

   - Early Declaration of Result
   - Obtaining Photocopy of the Answer Script
   - Re-evaluation of Answer script
   - Duplicate Grade Card/Mark-sheet

- Issue of Official Transcript **are all available** on: http://ignou.ac.in/ignou/studentzone/forms/1

  The form for **the Issue of Migration Certificate** is available at http://ignou.ac.in/ignou/studentzone/download/Applicationformc

Please keep checking the **News and Announcements** section of the IGNOU website for all important announcements regarding admissions, assignment submission dates, term-end examination schedules and re-registration.

4. Other Important Links

Link for Checking Study Material Status
http://www.ignou.ac.in/ignou/aboutignou/division/mpdd/material