

CBCS COURSE OF STUDIES

Microbiology (Honours)

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Microbiology is the study of microscopic organisms. These include single cell organisms (unicellular, cell colonies), multicellular, and lacking cells (acellular). Microbiology also includes subdisciplines such as mycology, parasitology, bacteriology and virology.

Why study microbiology?

The obvious answer is that it is a fascinating subject. More specifically, although not immediately obvious, microbiology has a huge impact on our lives. Microorganisms are everywhere. They are in our environment, on our body, everywhere we go.

- They help turning over soil and aquatic habitats.
- They can aid digestion. Ectosymbionts live outside the cells of the host. For example, bacteria that is on your skin and in your digestive tract.
- They break down dead and decaying matter.
- They can help in the environment. Bacteria are being used to help in clearing up after environmental incidents, such as oil spills.
- They may live with a host to the benefit of both organisms. These are called symbionts. A symbiont is an organism that is closely associated with a host, a larger organism. The symbiont will live on, in or near the host. Symbiotic relations are usually positive but can be negative.
- Endosymbionts live inside the host's cells. For example, in some plants the endosymbiotic bacteria lives in the root cells and helps the plant to grow.
- Microorganisms also include pathogens, which are organisms that cause diseases in plants and animals

Outcomes from Semester I

CC-1: MICROBIAL DIVERSITY

Microbial diversity can be defined as the range of different kinds of unicellular organisms, bacteria, archaea, protists, and fungi. Various different microbes thrive throughout the biosphere, defining the limits of life and creating conditions conducive for the survival and evolution of other living beings. The different kinds of microbes are distinguished by their differing characteristics of cellular metabolism, physiology, and morphology, by their various ecological distributions and activities, and by their distinct genomic structure, expression, and evolution. The diversity of microbes presently living on earth is known to be high and is thought to be enormous, but the true extent of microbial diversity is largely unknown. Students can learn new molecular tools that are now permitting the diversity of microbes to be explored rapidly and their evolutionary relationships and history to be defined.

CC-2: BACTERIOLOGY

The importance of bacteriology is undeniable; in fact, the study of the action of bacteria in health and in disease, inside and outside the animal body, has revealed so many new facts, it has already explained so many phenomena which formerly belonged to the realm of mystery and yet promises so much more, for the future “bacteriologists” to unravel.

SEMESTER II

PAPER -CC3

CC -3: BIOCHEMISTRY

Modern Biochemistry has two branches, descriptive Biochemistry and dynamic Biochemistry. Descriptive Biochemistry deals with the qualitative and quantitative characterization of the various cell components and the dynamic Biochemistry deals with the elucidation of the nature and the mechanism of the reactions involving these cell components. Many newer disciplines have been emerged from Biochemistry such of Enzymology (study of enzymes), Endocrinology (study of hormones) Clinical Biochemistry (study of diseases), Molecular Biochemistry (Study of Biomolecules and their functions). Along with these branches certain other specialties have also come up such as Agricultural Biochemistry, Pharmacological Biochemistry etc.

IMPORTANCE OF BIOCHEMISTRY IN MEDICINE

- **Physiology:** Biochemistry helps one understand the biochemical changes and related physiological alteration in the body.
- **Pathology:** Based on the symptoms described by the patient, physician can get clue on the biochemical change and the associated disorder. For example if a patient complains about stiffness in small joints, then physician may predict it to be gout and get confirmed by evaluating uric acid levels in the blood. As uric acid accumulation in blood results in gout.
- **Nursing and diagnosis:** In nursing importance of clinical biochemistry is invaluable. Also almost all the diseases or disorders have some biochemical involvement. So the diagnosis of any clinical condition is easily possible by biochemical estimations.

IMPORTANCE OF BIOCHEMISTRY IN AGRICULTURE

- **Prevent diseases and Enhance Yield/ growth:** It helps for prevention, treatment of diseases and also increase the production or yield. Some hormones promote growth, while other promote flowering, fruit formation etc. In fisheries, use of substances to promote fish growth, their reproduction etc can be understood.
- **Adulteration:** Even the composition of food material produced, their alteration or adulteration for example in honey can be found by biochemical tests. Biochemistry tests help prevent contamination.
- **Biochemical tests for the pesticide residues or other toxic waste in plant, food grain and soil can be evaluated.** Hence during import and export of food grains a biochemical check of the toxic residues is done to fix the quality.
- **In animal husbandry, the quality of milk can be checked by biochemical tests.** It also helps diagnose any disease condition in animals and birds.
- **In fisheries the water quality is regularly monitored by biochemical tests.** Any drastic change in water chemistry & composition of fishery ponds can lead to vast death of fishes and prawns, hence the tests are done on regular basis to see salt content (calcium content), pH, accumulation of waste due to not changing water for long etc.
- **In Plant/ Botany:** Biochemistry of plants gave way to breakthrough of how food is synthesized in them and the reason why they are autotrophs i.e. not dependent on other living beings for food.

Biochemistry in plants describes; Photosynthesis; Respiration; Different sugars; Plants secondary metabolites.

IMPORTANCE OF BIOCHEMISTRY IN NUTRITION

- Food chemistry gives an idea of what we eat. The nutrients value of food material can also be determined by biochemical tests.
- Role of nutrients: Due to biochemistry the importance of vitamins, minerals, essential fatty acids, their contribution to health were known. Hence there is frequent recommendation for inclusion of essential amino-acids, cod liver oil, salmon fish oil etc. by physicians and other health and fitness experts.
- Physician can prescribe to limit usage of certain food like excess sugar for diabetics, excess oil for heart & lung problem prone patients etc. As these carbohydrate and fat biochemical can inhibit the recovery rate from said disorder. This knowledge is due to their idea on food chemistry and related

IMPORTANCE OF BIOCHEMISTRY IN PHARMACY

- Drug Constitution: Biochemistry gives an idea of the constitution of the drug, its chances of degradation with varying temperature etc. How modification in the medicinal chemistry helps improve efficiency, minimize side effects etc.
- The half-life and Drug storage: This is a test done on biochemical drugs to know how long a drug is stable when kept at so and so temperature. For example, many enzymes, hormones are stored for dispensing. These get deteriorated over time due to temperature or oxidation, contamination and also due to improper storage.
- Drug metabolism: It also gives an idea of how drug molecules are metabolized by many biochemical reactions in presence of enzymes. This helps to avoid drugs which have poor metabolism or those with excessive side effects from being prescribed or dispensed to the patient.

PAPER -CC4

CELL BIOLOGY

- You may know of someone who has been ill with a disease or disorder such as meningitis, malaria, diabetes, a type of cancer, cystic fibrosis, or Alzheimer's disease. All these diseases and disorders are caused by problems at a cell or molecular level. Physical damage such as a burn or broken bone also causes damage at cell level.
- By understanding how cells work in healthy and diseased states, cell biologists working in animal, plant and medical science will be able to develop new vaccines, more effective medicines, plants with improved qualities and through increased knowledge a better understanding of how all living things live.
- Eventually it will be possible to produce a 'health forecast' by analysing your database of genetic and cell information. Using this you will be able to take more control over your health in a preventive way.
- But cell biology is not just about disease. It has greatly assisted the human fertility programme. DNA testing has been used in archaeology to provide evidence that a living person is related to a long dead ancestor.
- In plant science it has been used to show that two plants that look different have the same genetic origins.
- Forensic medicine uses cell biology and DNA fingerprinting to help solve murders and assaults. Neither the courts of law nor the criminals can escape the importance of cell biology.

- Biotechnology uses techniques and information from cell biology to genetically modify crops to produce alternative characteristics; to clone plants and animals; to produce and ensure high quality food is available at lower costs; to produce purer medicines and in time organs for the many people who need transplants.
- Cell biology is about all this and can make an exciting career.

It is also important that everyone feels informed about how the increase in knowledge about cell biology could affect him or her and society in general. Society will have to make informed decisions about such things as growing organs for transplanting into humans and, in those areas where vitamin 'A' deficiency causes blindness, growing rice modified to produce the vitamin.

A basic understanding of cell biology including genetics will be as important as having some knowledge about computers and the Internet.

SEM 3

CC5: VIROLOGY

General Overview of Viruses:

As viruses do not leave historical footprints such as fossils, it is not quite possible to track the origin of viruses. Modern viruses are thought to be a mosaic of bits and pieces of nucleic acids picked up from various sources along their respective evolutionary paths. Viruses are acellular, parasitic entities that are not classified within any kingdom. Unlike most living organisms, viruses are not cells and cannot divide. Instead, they infect a host cell and use the host's replication processes to produce identical progeny virus particles. Viruses infect organisms as diverse as bacteria, plants, and animals. They exist in a netherworld between a living organism and a nonliving entity.

The main objectives of the Theory Paper are:

- To study the discovery of viruses and the importance of Virology
- To know about the structure of viruses
- To study the classification of viruses.

In addition to these, the facts that make this Paper very interesting for the students are as follows:

- Studies of uniqueness of viruses with respect to their obligate parasitism, structural & genomic organisation, and replication cycle are included in this Paper.
- Viral diseases of plants and animals lead to huge economic losses unless effectively controlled. Also, very few effective and acceptable drugs for viral diseases exist even today. So, this Paper includes possible control measures of different viral diseases.
- Certain cancers are caused by oncogenic viruses. This paper includes a detailed study of such oncoviruses and oncogenes.
- Critical examination of virus-host interactions at the molecular level has led to fascinating insights into genetic mechanisms that may attract students for research on Molecular Virology.
- Viral vectors are used in Gene Therapy. This Unit will serve as a prelude to the Recombinant DNA Technology Paper (in Sem 4) that includes viral vectors.
- Virus-based vaccines represent a promising approach for vaccines against infectious and malignant diseases, like HIV and Hepatitis C, where traditional methodologies of using attenuated live pathogens or inactivated whole pathogens have been either ineffective or are at an acceptable risk.
- The Practical Paper will make the students aware of modern aspects of Virology, including detailed studies on the ultrastructure of different viruses, isolation and enumeration of bacteriophages from water/sewage sample, isolation and propagation of animal viruses, assay of plant viruses, and cytopathic effects of viruses.

CC6: MICROBIAL PHYSIOLOGY & METABOLISM

General Overview of Microbial Physiology & Metabolism:

Microbial physiology is defined as the study of how microbial cell structures, growth and metabolism function in living organisms. Microbial metabolism is the means by which a microbe obtains the energy and nutrients (e.g. carbon) it needs to live and reproduce. Microbes use many different types of metabolic strategies and species can often be differentiated from each other based on metabolic characteristics.

The main objectives of the Theory Paper are:

- To study microbial growth and the influence of environment on it.
- To know about their nutrient uptake and transport processes.
- To study the different facets of microbial metabolism, including chemolithotrophy, chemoheterotrophy, phototrophy and Nitrogen metabolism, besides the complex regulation of the metabolic processes.

In this Paper, students will learn about the details of microbial physiology and metabolism, which will motivate them for taking up research in Microbiology.

The Practical Paper will make the students learn how to plot a bacterial growth curve, and determine generation time and specific growth rate of bacteria graphically. The effect of different parameters on bacterial growth, including those of nutrients, temperature, pH, salinity etc. would also be taught to the students. Besides, they will also learn how to determine thermal death time and decimal reduction time of a bacterial population.

CC7: MOLECULAR BIOLOGY

General Overview of Molecular Biology:

Molecular Biology is the field of Biology that studies the composition, structure and interactions of cellular molecules – such as nucleic acids and proteins – that carry out the fundamental biological processes essential for the cell's functions and maintenance, like DNA replication, transcription, translation, and reverse transcription, through a controlled regulation of gene expression.

- To study the structure of DNA and RNA – that forms the basic understanding of the different processes of Central Dogma.
- To impart knowledge about the mechanisms and regulation of prokaryotic DNA replication, transcription and translation, along with a comparative account of these processes in eukaryotes.
- To make students familiar with DNA repair mechanisms.
- To impart knowledge about the gene expression control mechanisms in both prokaryotes and eukaryotes.

This Paper will certainly make the students familiar with the intricate mechanisms of vital biological processes and the cross-talk between different biomolecules as well.

The Practical Paper will make the students study different types of DNA and RNA molecules using micrographs and models and semiconservative model of DNA replication, carry out quantitative estimation of DNA and RNA, isolation of genomic DNA and its visualization by AGE, and resolution and visualization of proteins by SDS-PAGE. All these techniques will surely train the students for future research involving Molecular Biology.

SEC A-2: BIOFERTILIZERS AND BIOPESTICIDES

General Overview of Biofertilizers and Biopesticides:

Biopesticides are derived from natural materials such as animals, plants, bacteria, and certain minerals widely used for controlling insects and disease causing pathogens. A biofertilizer is a substance which contains living micro-organisms which, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.

The main objectives of this Paper are:

- To study in details about different kinds of biofertilizers, and their advantages over chemical ones.
- To impart knowledge about the symbiotic and non-symbiotic Nitrogen fixers.
- To make students familiar with phosphate-solubilising microbes and mycorrhizal biofertilizers.
- To impart a detailed knowledge about bioinsecticides.

This Paper will surely enrich the students with the detailed knowledge of different types of biofertilizers and biopesticides so that they can spread the awareness, which will particularly benefit the farmers through this knowledge on alternative and eco-friendly ways of improving crop yield.

SEM4

CC-8: MICROBIAL GENETICS

Sem 4 syllabus deals with Microbial Genetics, Environmental Microbiology and Recombinant DNA technology in Core Course papers and techniques, analysis of air, water, and food fermentation in SEC (skill enhancement course) paper.

- Core Course paper covers three important areas of microbiology.
- Microbial genetics paper covers all the genetically controlled events of bacteria, how these organisms reproduce, how new strains are produced and different experimental techniques that geneticists use to map bacterial genomes.

CC-9: ENVIRONMENTAL MICROBIOLOGY

- Environmental Microbiology deals with the interaction of microorganisms with other microbes as well as with humans and also interacts with natural environment like air, water and soil.

CC-10: MOLECULAR GENETICS

The field of molecular genetics changed radically in the 1970s when procedures were developed that enabled researchers to construct RDT molecules and to clone. RDT has huge application in the fields

of medicine and agriculture, in industry and forensics. So from this core course we are able to learn about some of the specific techniques, uses and applications of RDT in human life.

SEC: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

water MICRO Skill Enhancement course (SEC) is designed in such a way that provide students with some value based or skill based knowledge. Here it includes several techniques, analysis of factors and testing of soil, air water microorganisms and their beneficial and harmful effects on humans.

SEMESTER-5

CC-11: - FOOD AND DAIRY MICROBIOLOGY

This course is directly related to food, which is our basic requirement in day to day life. From this course we can able to understand the different techniques of food processing and the associated microorganism. We can get clear-cut practical knowledge of the food borne diseases and associated microorganisms, which we can able to apply in the food industry. After getting proper practical training students may be hired in food processing industry or can work as food inspector in both private and Govt. organisation.

CC-12: - INDUSTRIAL MICROBIOLOGY

This course is directly related to industry. Many microorganisms are the most important part of industrial process like in fermentation process, several vitamin and enzyme production process, enzyme immobilization process etc. fermentation industry is on of the largest industry worldwide. Students can get in depth knowledge and can get exposure to different fermentation techniques which will help them to get involved in the industry in future.

DSE-A-1: MICROBIAL BIOTECHNOLOGY

This course is directly related to application of microbial biotechnology. The in-depth theoretical knowledge and practical hands on in biotechnology is very much applicable in now a days. Students can get an idea how recombinant vaccine are generated and how it can save millions of life. Production of bio-fuel and sustainable energy management is now need of the hour. Students can also get brief exposure about interference RNA (RNAi) which is a key regulatory molecule in many biological reactions.

DSE-A-2: ADVANCES IN MICROBIOLOGY

In this course students will get a good exposure of several advance knowledge of microbiology like system biology. This course also disclose the several aspects of host -pathogen interactions which help them to design new projects for therapeutic development.

SEMESTER 6

CC13: IMMUNOLOGY

The main scope of this course is in the field of immunology and vaccines. It introduces the concept of immunity, antigens, antibodies and different immunological techniques. Students also learn the techniques of blood group determination, performing RBC and WBC counts and ouctercolony diffusion methods of identifying antigen and antibody along with ELISA technique.

CC14: MEDICAL MICROBIOLOGY

This course particularly is aimed at educating students about normal microflora of human body, different pathogenic diseases caused by virus, bacteria and fungi and also antimicrobial agents and their mode of action.

DSE A: PLANT PATHOLOGY INSTRUMENTATION AND BIOTECHNIQUES

In this course students learn about host pathogen interactions and different type of plant diseases and ways of identifying them along with their methods of control. This renders the students a vast knowledge about plant pathology which will be very beneficial to them in further studies on plants and their diseases.

DSE B: INSTRUMENTATION AND BIOTECHNIQUES

In this course of learning instrumentation and biotechniques, students learn about microscopy, chromatography and techniques like electrophoresis, spectrophotometry and centrifugation.