ORDINANCES FOR

3- year-Degree Course

B.Sc. (Food-Microbiology, Safety and Quality Control)

(under Self Finance Scheme)

From the session 2016-17

Department of Microbiology
Ch. Charan Singh University
Meerut
Overview

Food microbiology, safety and quality control is the basic requirement of public health and hygiene. Food microbiology is the necessary and essential requirement of every food industry. The consumers, retailers, manufacturers and regulators are greatly concerned about food safety and quality control/management. Changing global pattern of food production; international trade, technological advancement, public awareness and their expectations; health and hygiene; new Food Safety Act of Government of India and many other related factors have created huge demand for trained personnel in food microbiology, safety and quality control.

B.Sc. (Food Microbiology, Safety and Quality Control) has been designed after carefully going through the requirements of various industries like-Food, soft drink, beverages, and the requirements of Agricultural and Processed Food Products Export Development Authority (APEDA), Ministry of Commerce, Government of India and the newly developed concept of nutritional therapy. This programme is expected to meet the increasing requirements of human resources for food microbiology, safety and quality control/management professionals in agriculture and food sector.

Objectives of the Course:

Main objective of the course is to prepare well qualified professionals for application of microbes in food industry, auditing of Food Safety and Quality control/management system in the country so that India may compete with developed countries in global food safety and quality requirements. It will also ensure consumer safety within and outside the country and will improve public health and reduce medical expenses.

Exit points:

If a candidate leaves the course after one year, he/she shall be awarded UG Certificate in “Food Microbiology & Food Chemistry”. If a candidate drops out after completing two years of course, he/she will be awarded an additional “UG Diploma in Food Safety”. Full degree of B.Sc. (Food-Microbiology, Safety and Quality Control) shall be awarded only after completion of full three years courses including all practical and compulsory industrial training/project/thesis.

ORDINANCES
All rules for conduct of examination pattern, pass percentage and admissions shall be the same as for other undergraduate three year courses in the Faculty of Science on the University campus. Maximum marks given in the Table are only tentative and each course may be allotted different marks if necessary, as per other professional UG courses of the University. A candidate will have to complete a project in the third year for a period 4 to 6 months. Project/Practical work related to testing of food samples may be completed either in the Department of Microbiology and/or in collaboration with other laboratories/industries if the adequate facilities are available there. Course Coordinator may identify and select the laboratories/industries/other institutes and may undergo any M.o.U. if required. One of the supervisors for project work may be opted from outside the University/Institute/laboratory where the candidate shall complete the project work. After the completion of Project work/internship the candidate shall submit a detailed project report/thesis and will make an open presentation for 20-30 minutes. He will defend his/her experimental design, results and conclusions before the Board of Examiners, to be appointed by the competent body/officer of the University who shall be normally the Vice-Chancellor.

**Number of seats and fee structure**

Initially there should be only 30 seats which may be altered depending upon the facilities available in the Department. Reservation shall apply as per the policy of the University for other courses on the campus. This course is approved under self finance scheme of the University/State Govt. and annual tuition fee of Rs. 50,000/- (Rs. Fifty thousand only) is suggested which shall include the project fee if any. However, the fee structure may be altered by the University depending upon the resources available.

**Eligibility for Admission**

Minimum eligibility for admission in this three year B.Sc. (Food-Microbiology, Safety and Quality Control) course shall be 10 + 2 (Biology / Agriculture).

**Appointment of Examiners**

Course Coordinator is authorized to make a proposal of the examiners (both for theory and practical examination) in consultation with the members of Board of Studies either through telephonic conversation or through electronic media. Alternately, a meeting of Board of Studies may be convened.

**COURSE STRUCTURE**
Following course structure is approved. The Department shall be at liberty to change/alter the sequence of the courses depending upon the resources available.

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Code No.</th>
<th>Title of Course</th>
<th>Maximum Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>FM-101</td>
<td>Instrumentation</td>
<td>50</td>
</tr>
<tr>
<td>2.</td>
<td>FM-102</td>
<td>Microbial Techniques in Food &amp; Water Industry</td>
<td>50</td>
</tr>
<tr>
<td>3.</td>
<td>FM-103</td>
<td>Microbial Diversity - Prokaryotes</td>
<td>50</td>
</tr>
<tr>
<td>4.</td>
<td>FM-104</td>
<td>Microbial Diversity - Eukaryotes</td>
<td>50</td>
</tr>
<tr>
<td>5.</td>
<td>FM-105</td>
<td>Food and Food Sources</td>
<td>50</td>
</tr>
<tr>
<td>6.</td>
<td>FM-106</td>
<td>Food Microbiology</td>
<td>50</td>
</tr>
<tr>
<td>7.</td>
<td>FM-107</td>
<td>Food Chemistry</td>
<td>50</td>
</tr>
<tr>
<td>8.</td>
<td>FM-108</td>
<td>Dairy Technology and Microbiology of Dairy Products</td>
<td>50</td>
</tr>
<tr>
<td>9.</td>
<td>FM-109</td>
<td>Biostatistics, Computer Applications &amp; Bioinformatics</td>
<td>50</td>
</tr>
<tr>
<td>10.</td>
<td>FM-110</td>
<td>Practical – I (Food Chemistry)</td>
<td>50</td>
</tr>
<tr>
<td>11.</td>
<td>FM-111</td>
<td>Practical – II (Microbiological Analysis)</td>
<td>50</td>
</tr>
<tr>
<td>12.</td>
<td>FM-112</td>
<td>Practical – III (Biostatistics, Computer Applications &amp; Bioinformatics)</td>
<td>50</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>Food Processing &amp; Preservation</td>
<td>50</td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td>Food Laws &amp; Standards</td>
<td>50</td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td>Principles of Food Safety</td>
<td>50</td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td>Principles of Food Quality</td>
<td>50</td>
</tr>
<tr>
<td>17.</td>
<td></td>
<td>Fermentation Technology</td>
<td>50</td>
</tr>
<tr>
<td>18.</td>
<td></td>
<td>Water &amp; Food Borne Disease</td>
<td>50</td>
</tr>
<tr>
<td>19.</td>
<td></td>
<td>Public Health Engineering &amp; Hygiene</td>
<td>50</td>
</tr>
<tr>
<td>20.</td>
<td></td>
<td>Microbial Genetics, Molecular Biology &amp; Genetic Engineering</td>
<td>50</td>
</tr>
<tr>
<td>21.</td>
<td></td>
<td>Nutritional Therapy</td>
<td>50</td>
</tr>
<tr>
<td>22.</td>
<td></td>
<td>Practical – I</td>
<td>50</td>
</tr>
<tr>
<td>23.</td>
<td></td>
<td>Practical – II</td>
<td>50</td>
</tr>
<tr>
<td>24.</td>
<td></td>
<td>Practical – III</td>
<td>50</td>
</tr>
<tr>
<td>25.</td>
<td></td>
<td>Environmental Microbiology</td>
<td>50</td>
</tr>
<tr>
<td>26.</td>
<td></td>
<td>Food Quality Management Systems</td>
<td>50</td>
</tr>
<tr>
<td>27.</td>
<td></td>
<td>Packaging &amp; Marketing</td>
<td>50</td>
</tr>
<tr>
<td>28.</td>
<td></td>
<td>Practical: Food Microbiology - I</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Practical: Food Microbiology – II</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Practical: Food Safety</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Practical: Food Safety Quality Assurance</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Practical: Food Chemical Analysis</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Practical: Food Chemical Quality Assurance</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Project Report</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>
Course-1, Code FM-101: INSTRUMENTATION

Unit I- Instrumentation Technology- Fermenter design, Immobilization, Relevance of Microbial biotechnology to mankind.

Unit II- Basic principles and applications of -UV-VisibleSpectrophotometer, pH meter, LovibondTintometer, Flame photometer, Atomic Absorption Spectrophotometer, Pyknometer, Oven, melting point apparatus,

Unit III- Chromatography (paper, thin layer, column, gel filtration, ion exchange, and affinity chromatography), HPLC, FPLC, Basic Principle and functioning of GC/LC/MS Instrument, Mass Spectrometer, inductively coupled plasma spectrometry (ICP-MS).

Unit IV- Principles and applications of Electrophoresis for Proteins and DNA; Iso-electric focusing and 2-D gel electrophoresis; Autoradiography, X-Ray diffraction; PCR, Real time PCR, DNA probes, Centrifugation; Ultra-centrifugation; Dialysis, Ultrafiltration; Lyophilization and

Unit V- Basic principles and method of sterilization: principles and functioning of LAF (Laminar Air Flow), control of microorganism by physical methods: heat, filtration, and radiation; chemical methods: phenolics, alcohols, halogen, organic compound, aldehydes, and sterilizing gases: evaluation of antimicrobial agents, effectiveness.

Suggested Readings (Latest Editions):


Course-2, Code FM-102: MICROBIAL TECHNIQUES IN FOOD AND WATER INDUSTRY
Unit I – Basic principles and Culture methods: Types of culture media, simple, complex, synthetic, enriched, selective and differential, pH and buffers, pure culture methods; steak plate, pour plate, and spread plate, maintenance and preservation of microbial cultures.

Unit II- Aerobic plate count, ATP bioluminescence, aseptic technique, coliforms, colony forming units, differential and selective culture media, dilution plate, spiral plating and other related techniques.

Unit III & IV- Basic principles for Aerobic Mesophilic Plate count, Aciduric Flat Sour Spore-formers, Bacillus cereus, detection and determination of anaerobic mesophiles, sporeformers in food, (Clostridium perfringens), detection and determination of coliforms, fecal coliforms, and E.coli in food and beverages, direct microscopic count for sauce and tomato puree and paste, fermentation test (Incubation test), detection and confirmation of Salmonella species in food, rope producing spores in food, detection and confirmation of Shigella species in food, detection and confirmation of Staphylococcus aurius in food, detection and confirmation of sulfide spoilage spore formers in processed food, detection and determination of thermophilic flat sour spore formers in food, detection and confirmation of pathogenic vibrios in food, estimation of yeast and molds in food, detection and confirmation of Listeria monocytogenes in food,

Unit V- Molecular and Immuno-assays for identification of common food and water borne pathogens.

Suggested Readings (Latest Editions):

Course-3, Code FM-103: MICROBIAL DIVERSITY-PROKARYOTES

Unit I: History, Scope and relevance of Microbiology; Current thoughts on microbial evolution including the origin of life; Introduction to microbial biodiversity – distribution, abundance, ecological niche of bacteria and archaea.

Unit II: Current status of microbes in the living world, Emergence of Three Domains of living world; Modern trends in Microbial taxonomy including RNA world; Classification and salient features of bacteria according to the Bergey’s Manual of Determinative bacteriology. Morphology and ultra-structure of bacterial cell.


Unit IV: General characters, nomenclature, classification, morphology and ultrastructure of viruses; Capsid and their arrangement; Purification of viruses by adsorption, precipitation, enzymes, serological methods (haeme agglutination and ELISA). Assay of viruses (physical and chemical methods).

Unit V: Bacteriophages: Structure and life cycle patterns of T-even phages; one step growth curve; Bacteriophage typing; Structure of Cyanophages, Mycophages; General characters and structure of viroids, Satellites and prions, their structure and major diseases caused by them, controversies about their nature.

Suggested Readings (Latest Editions):

Course-4, Code FM-104: MICROBIAL DIVERSITY-EUKARYOTES

Unit I: General characteristics of eukaryotic microbes; Ultrastructure and organization of a typical eukaryotic cell (membrane structure and functions, cytoskeleton, intracellular compartments- nucleus, mitochondria, chloroplast and their genetic organization); Structure and organization of chromatin; cell cycle; Diversity among Eukaryotic microbes.

Unit II: Current status of fungi; organisms studied by mycologists; General characters, somatic structure, asexual and sexual reproduction of microbiologically important genera of Protozoa, Straminipila, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

Unit III: Mycotoxins their identification and determination from food samples; Culture of microfungi from different food samples by damp chamber technique and their identification; examination of various solid and soft foods including water samples for fungal contamination by different cultural methods.

Unit IV: General characteristics of algae; Somatic structure, asexual and sexual reproduction of microbiologically important genera of Chlorophyceae, Phaeophyceae, Bacillariophyceae, Rhodophyceae and Dinophyceae. Culture of algal contaminations from various food and water samples; Economic importance of algae.

Unit V: General characteristics of Protozoans; Nematodes; Difference between protozoans and nematodes; Structure and reproduction of microbiologically important genera of protozoans (Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma, Plasmodium) and Nematodes: Ancylostoma, Ascaris lumbricoides, Necator; Cestodes: Taeniasolium, Taeniasaginata, Diphyllobothrium, Echinococcus granulosus and Trematodes: Paragonimus, Fasciola hepatica, Schistosoma; Difference between Protozoans and Nematodes.

Suggested Readings (Latest Editions):

Course-5, Code FM-105: FOOD AND FOOD SOURCES
Unit I: Food basic, food chain, food constituents, food texture, food and its functions, food source as nutrient, carbohydrates rich, protein rich, fat and oil rich, vitamins rich, cuisine, consummation trends, processing and value addition, national food processing policy, food trade.

Unit II: Food as source of nutrient, food is more than nutrient, food intake and its regulation, food pattern, population and food production, population growth, food production, food and future, genetically modified food (GMO), infants foods, organic foods.

Unit III: Characteristics of the food industry, components of the food industry, allied industries, international activities of food industry, constituents of foods and their significance, carbohydrates, proteins, sugars, starch, modified starch, fats and oils, additional food constituents, analog new ingredients.

Unit IV: Oxidants, enzymes, pigments, color, flavor, vitamins, minerals, natural toxicant, water, fiber, beverages, fruits, vegetables, cereals, cereal products, pulses, nuts, oils and fats in food, spices, milk and milk product, eggs & egg products, fish and fishery products, meat, poultry, Lipids, food additives, diet and chronic diseases.

Unit V: Nutritive aspect of food constituents, additional roles of carbohydrates, proteins, oils and fats in nutrition, bioavailability of nutrients, vitamins.

Suggested Readings (Latest Editions):


Course-6, Code FM-106: FOOD MICROBIOLOGY

Unit I-Important microbes involved in spoilage of food, meat, poultry, vegetables and dairy products; factors affecting food spoilage, deteriorative effect of
microorganism, different types of spoilage, food preservation; Microbial deterioration of cereals, pulses, fish and sea-foods during storage.

**Unit II-Bio-deterioration of food items, Bacterial and mycotoxins, Important microbes secreting toxins, chemical nature of important toxins; their role in food poisoning; physiology and mechanism of action, modification and detoxification; prevention and control of toxin contamination.**

**Unit III-Microbial biomass and Single cell proteins:** Uses of microbes in meats and poultry products, vegetables *etc.* Use of microbial enzymes in food; low calorie sweetners, Flavour modifiers; Food additives; Food quality monitoring, biosensors and immuno assays, Indian fermented foods.

**Unit IV-Role of microbes in milk and dairy products:** Microbiological examination of milk, standard plate count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, types of microbes in milk, pasteurization of milk, ability of milk to cause disease; Manufacture of cheeses, butter, yoghurt and fermented milk.

**Unit V:** Common food borne pathogens, diseases caused by them and their symptoms, Disease caused by bacteria, molds and yeasts, viral contamination of foods, parasites, natural toxins, and disease caused by prions, factor responsible for food borne diseases, emerging food pathogens, antimicrobial resistance and food borne-pathogens; food borne illness, prevention and complication of food borne disease outbreaks, epidemiology, Surveillance system for tracking of food borne disease.

**Suggested Readings (Latest Editions):**

Course-7, Code FM-107: FOOD CHEMISTRY

Unit I- Food basics, food from plant sources, food from animal sources, other foods, food safety, food constituents, food its function- physiological, body buildings, social function, psychological functions and social function, scared foods and food taboos, food source as nutrients, carbohydrates, proteins, vitamins, mineral rich foods.

Unit II- Food grains, cereals, composition of cereals, post harvesting processing, grain legumes, processing of pulses, oilseeds characteristics, processing of oilseeds, horticulture crops; structure and composition, food from animal origin meat and meat products, live stocks poultry and meat production, wholesome of meat production, method of slaughtering, processed meats, egg and egg products, milk and milk products, dairy by products. Fish and fishery products, comfort foods, energy drinks, stimulating drinks, carbonated non alcoholic beverages/ soft drinks, health food, nutraceuticals, ayurvedic medicinal foods.

Unit III- Food chemistry, water, carbohydrates, proteins and enzymes, lipids, vitamins and minerals, food additives, vegetables and fruits, sugar and related products, spices and herbs, preservatives, color, emulsifiers and stabilizers,

Unit IV- Organic foods, advantage of organic food, packaging and labeling according of food composition, emerging in food technology, biotechnology in food, bifortification, nutraceuticals, low-cost nutrients supplement, processed and convenience food, space food, food fortification.

Unit V- Evaluation of food quality, sensory evolution, evaluation card, types of test, objective evaluation, and instrument used for texture evaluation, food adulteration, types of adulteration, intentional adulteration, incidental adulteration, food laws, food standardization and regulation agencies in India, international standards.

Suggested Readings (Latest Editions):

Course-8, Code FM-108: DAIRY TECHNOLOGY AND MICROBIOLOGY OF DAIRY PRODUCTS

Unit I- Overview of Dairy industry, Basic functioning of Dairy plant (retention pond-irrigation, retention pond, second – stage lagoon, irrigation, vegetative filter, settling basin, vegetative filter, overland flow, distribution channelized terrace), Dairy industry in India, Dairy management economics(challenges and benchmark of dairy farm practices), policy, milk processing, domestics, consumption trade, current dairy policies to assist producers, dairy market and policy issues, sensory evolution of dairy products, dairy operation (importance of calcium standards testing procedure) and waste management, HACCP.

Unit II- fermented milk, yeast and lactic fermentation, mould lactic fermentation, natural Fermented Foods microflora of dairy industry, pro-biotics products, functional food stuffs, industrial production of healthier food stuffs, modification of food tastes and healthier production, microbiological hazards in dairy industry

Unit III- Dairy products types(concentrated and dried milk products), health risk of consuming dairy products, back drop of milk preservation methods, refrigeration, milk production level, breeding of milk animals, hormone use, nutrition, pesticide use.

Unit IV- Microbiology of spoilage of dairy products, types of spoilage microorganism, source of spoilage, factor affecting spoilage, prevention and control measure, method and detection.

Unit V- Significance of milk and dairy products for humans, consumption of milk hygiene, contamination of milk with extraneous matter, starter culture, component of milk food, role of microorganism in milk base products, sensory evolution of dairy products.

Suggested Readings (Latest Editions):

Course-9, Code FM-109: Biostatistics, Computer Applications & Bioinformatics

Unit I: Introduction to Biostatistics: Definition, Types of statistics, Applications and uses of Biostatistics, Identification and types of variable, Tabulation of data, Graphical presentation (categorical and metric data), charting of data using MS-Excel; Sampling techniques; Frequency distribution; Measures of central tendency (mean, median and mode); Measures of dispersion: mean deviation and standard deviation; Correlation and regression.

Unit II: Probability & Testing of Hypotheses: Basic concepts related to probability theory, classical probability. Probability distributions: Introduction and simple properties of Binomial, Poisson, Normal and skewed distribution and their applications in biology. Sampling: Concept of sampling and sampling techniques; Basic concepts of hypothesis testing; critical region, Students t-test for the significance of population mean and the difference between two population means; Paired t-test; Chi square test for testing of goodness of fit, F-test for the equality of two population variance; Analysis of variance- One-way and two-way.

Unit III: Overview of computer systems: Introduction and classification; Components of computer; generation of computers; Number system; Flow chart; Basics for operating system (MS-DOS, WINDOWS, Unix and Linux); Introduction to softwares; MS-Office (MS-WORD, Power Point, MS-Excel).

Unit IV: Introduction to networking (LAN, WAN, MAN) servers, application of networking, Topologies (Bus Network, Ring Network, Star Network, Mesh Network, Tree Network) and their advantages & disadvantages; Transmission Medias (Coaxial Cable, Fiber Optics, Twisted Pair); Internet, downloading files with anonymous FTP, Gopher, Mosaic.

Unit V: Introduction to Bioinformatics, Role of Bioinformatics; Biological databases: Nucleic Acid Sequence Database, Protein Sequence Database and Protein Structure Database); obtaining BLAST Documentation and Help; Important bioinformatics websites (NCBI, EBI, SIB).

Suggested Readings (Latest Editions):
Course 10, Code- FM-110: Practical-I (Food Chemistry)

Unit I- Calibration of glassware, preparation of standards volumetric solution,

Unit II- Determination of moisture in food products by hot air oven method, determination of moisture in food products using Karl fisher titration method, determination of moisture in food products by dean stark method.

Unit III- Determination of protein content in food product by Kjeldahl method, determination of crude fat in food by Soxhlet extraction method, determination of total fat in food by rose Gottleib method. Determination of volatile oils in spices, determination of starch content in cereals product by acid hydrolysis method, determination of crude fiber in food sample.

Unit IV- Determination of total ash content in food products, determination of ash insoluble ash in food products, determination of pH of foods products by using ph meter. Determination of free fatty acid and acid value in oils and fats, determination unsaponifiable matter in oils and fats, determination of refractive index of oils and fats, determination of specific gravity of oils and fats, milk, honey. Determination of color of oils and fats by lovibond tintometer, determination of iodine value in oils and fats, determination of saponification value in oils and fats, determination of acetyl value hydroxyl value in oils and fats.

Unit V- Determination of allyl Isothiocyanate in mustard oil, determination of reichert value (RM), and polenske value (PV) in oils and fats, determination of peroxide value of oils and fats, determination of gluten content in wheat flour, determination of sodium chloride and iodine content in salt, determination of sorbic acid in food products.

Unit VI- Determination of metals in food products by ICP-MS, Determination of cholesterol content in oils and fats by GC. Determination of vitamin A content in ghee/oils and fats by HPLC, Sensory evaluation laboratory.

Note: A part of the aforesaid practical may be shifted to second or third year
Course 11, Code-FM111: Practical II (Microbiological Analysis)

Unit I- Cleaning and methods of sterilization, assessment of surface sterilization using swab and rinse method, Microbiological media preparation, direct microscopic count, standards plate count, spiral plate count, dye reduction test, microscopic examination of bacterial culture, simple staining, negative staining, Gram’s staining, Endospore staining.

Unit II- Detection and enumeration of spoilage microorganism, standards plate count (psychrotropic, thermoduric, lipolytic, proteolytic count, pectinolytic, halophilic, osmophilic and acidophilic counts). Cultivating and sub-culturing of microbes.

Unit III- Direct microscopic examination of food, Detection of pathogens in food and their biochemical characterization, enumeration of fungi (yeast and molds), assessment of air using surface impingement method,

Unit IV- Detection of coli forms and indicator organism, most probable number, confirmed, completed test; Bacteriological examination of waterfor Salmonella and Shigella, Clostridium perfringens, Bacillus cereus, Pseudomonas aeruginosa. Membrane filter techniques.

Unit VI- Detection of viral pathogen by real time PCR, PCR, Immuno-assay, ELSIA, and nucleic acid probes methods.

VII- Interpretation of microbiological data and its interferences.

Note: A part of the aforesaid practical may be shifted to second or third year
Course 12, Code-FM 112: Practical III-Biostatistics, Computer Applications & Bioinformatics

Unit I: Tabulation of data, Graphical presentation of the data, charting of data using MS-Excel; Frequency distribution; Computational aspects of Measures of central tendency for Individual series, discrete frequency distribution and continuous frequency distribution. Computational aspects of Measures of dispersion, Different techniques of correlation analysis and regression analysis.

Unit II: Probability & Testing of Hypotheses: Computation of uncertainty by using permutation and combination Probability distributions: Binomial, Poisson, Normal, Students t-test for the significance of population mean and the difference between two population means; Paired t-test; Chi square test for testing the goodness of fit, F-test for the equality of two population variance.

Unit III: Overview of computer systems: Conversion of Number system; Programming through Flow chart; MS-DOS commands, WINDOWS, Unix commands; Introduction to softwares; Computer Applications, Use of Computer in preparation of charts, graphics, designs and Data Interpretation by using MS-excel, Power point and MS-Word.

Unit IV: Use of Internet, Internet services, E-mail, Net surfing, File searching, downloading files with different web sites.

Unit V: Computational aspects of Bioinformatics, Study of various Biological databases: (Nucleic Acid Sequence Database, Protein Sequence Database and Protein Structure Database); obtaining BLAST Documentation and Help; Important bioinformatics websites (NCBI, EBI, SIB).

Note: A part of the aforesaid practical may be shifted to second or third year.