SYLLABUS

FOR

M.Sc. SEMESTER PATTERN IN

MICROBIOLOGY

GONDWANA UNIVERSITY

GADCHIROLI

INDIA
SYLLABUS FOR M.Sc. SEMESTER PATTERN IN MICROBIOLOGY SUBJECT, GONDWANA UNIVERSITY, GADCHIROLI (M.S.) INDIA

SEMESTER – I (THEORY)

<table>
<thead>
<tr>
<th>Paper</th>
<th>Code</th>
<th>Course Title</th>
<th>Marks</th>
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<tbody>
<tr>
<td>I</td>
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<td>MICROBIAL DIVERSITY AND EVOLUTION (MDE)</td>
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<td>MB1-T004</td>
<td>MICROBIAL ECOLOGY (ME)</td>
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PRACTICALS

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SEMESTER – II (THEORY)

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<td>ADVANCE TECHNIQUES IN MICROBIOLOGY (ATM)</td>
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PRACTICALS

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Distribution of Marks for M. Sc. Microbiology (Semester Pattern)

<table>
<thead>
<tr>
<th>Semester</th>
<th>Theory (T) papers &amp; practicals(P) &amp; marks/Seminar(S)/Project</th>
<th>Credit</th>
<th>Total Mark/credit</th>
<th>Grand Total Mark &amp; Credit</th>
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<td>I</td>
<td>T-4 x 100= 400 P-2 x 100= 200 S-1 x 25= 25</td>
<td>4 x 4= 16 2 x 4= 08 1 x 1= 01</td>
<td>625/25</td>
<td>2500 marks 100 credits</td>
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<td>4 x 4= 16 2 x 4= 08 1 x 1= 01</td>
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GONDWANA UNIVERSITY, GADCHIROLI

SEMESTER SYSTEM SYLLABUS

FOR M. Sc. Microbiology (Semester I & II)

(With effect from Academic Session 2012-13)

Structure of M. Sc. Microbiology Syllabus, Semester System, Theory

<table>
<thead>
<tr>
<th>Semester</th>
<th>Title of Paper</th>
<th>Work Hrs.</th>
<th>Marks</th>
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<tbody>
<tr>
<td>Semester I</td>
<td>Paper I: Microbial Diversity and Evolution (MDE)</td>
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<td>Paper II: Microbial Physiology and Metabolism (MPM)</td>
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<td>Paper III: Enzymology and Techniques (ET)</td>
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GONDWANA UNIVERSITY, GADCHIROLI

SEMESTER SYSTEM SYLLABUS

FOR M. Sc. Microbiology (Semester I & II)

(With effect from Academic Session 2012-13)

Structure of M. Sc. Microbiology Syllabus, Semester System, Practical & Seminar

<table>
<thead>
<tr>
<th>Semester</th>
<th>Practical &amp; Seminar</th>
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<th>Marks</th>
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<td>16</td>
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Note: T= Theory; P= Practical/lab, * = If required, for two days.

Minimum marks for passing 40 out of 100 in each Theory paper

Minimum marks for passing 40 out of 100 in each Practical/lab and Project work and minimum of 10 out of 25 in the internal(seminar) examination of that semester.
APPENDIX B

MASTER OF SCIENCE (MICROBIOLOGY)

TWO YEAR (FOUR SEMESTERS) DEGREE COURSE

A) Pattern of Question Paper

1. Four units in each paper.
2. One question on each unit.
3. Fifth question on all units.
4. Maximum marks of each paper 100
5. Projects shall be evaluated by internal and external examiners. 50% marks of project shall be given by internal and external examiners each.
6. Duration of question paper is 3 hours.
7. Practical/lab examination of 100 marks. Distribution of marks shall be 20 internal and 80 external.

General Instructions/Directions.

Each paper is supposed to cover minimum 60 clock hours of teaching and 240 clock hours per semester for all the four papers.

Each Question paper shall have five questions with equal marks/credits.

There will be four long questions one question from each unit. A long question can be subdivided into two short questions.

Fifth question shall comprise of four very short question one question of each unit.

There shall be internal choice from each unit.

Practical examination shall be of minimum 12 hours and may spread over two days,

There shall be at least one major and two minor experiments in the practical examination

Minimum passing marks are per the marks/credit annexure.

Every student shall be required to participate in educational/industrial tour atleast once during PG course.
UNIT-I: - Microbial Evolution and Systematic

Evolution of Earth and early life forms.
**Primitive life forms:**-RNA world, molecular coding, energy and carbon metabolism, origin of Eukaryotes, endosymbiosis.
**Methods for determining evolutionary relationships:**-Evolutionary chronometers, Ribosomal RNA sequencing, signature sequences, phylogenetic probes, microbial community analysis.
**Derivation of Microbial Phylogeny:**- characteristics of domain of life, classical taxonomy, chemotaxonomy, bacterial speciation.

UNIT-II: -Microbial Diversity: Archea

General Metabolism and Autotrophy in archea
**Phylum Euryarchaeota:**-Halophilic archaea, methanogens, thermoplasma.
**Phylum Crenarchaeota:**-Energy metabolism, Thermoproteales, sulfolobales, desulfolobales.
**Phylum Nanoarchaeota:**- Nanoarchaeum.
Heat stable biomolecules and extremophiles, Evolutionary significance of hyperthermophiles.

UNIT-III :-Microbial Diversity: Bacteria

**Phylum Proteobacteria:**-Free living N2 fixing bacteria, purple phototrophic bacteria nitrifying bacteria, sulphur and iron oxidizing bacteria, sulphate and sulphur reducing bacteria.
**Phylum prochlorophytes** and cyanobacteria,
**Phylum:Planctomyces,**
**Phylum;Verrucomicrobia.**

UNIT-IV :- Microbial Diversity.
Phylum: Green non –sulfur bacteria.
Phylum: Branching Hyperthermophiles, Thermotoga and Aquifex.
Phylum: Nitrospira and Deferrribacter.
UNIT-I BIOENERGETICS
Basic concept of bioenergetics and metabolism.
Substrate level phosphorylation and oxidative phosphorylation, electron transfer reaction in mitochondria, electron carriers and multienzyme complex I to IV.
ATP synthesis: chemiosmotic theory, shuttle system, regulation of oxidative phosphorylation and uncouplers, inhibitors of oxidative phosphorylation.

UNIT-II PHOTOSYNTHESIS AND LIPID METABOLISM
Photosynthesis: structure of chloroplast, light reaction and dark reaction; Kelvin cycle, C3 and C4 pathway.
Mechanism of energy generation in cyanobacteria, green bacteria and purple sulphur bacteria and chemolithotrops.
Lipid metabolism digestion absorption; oxidation of unsaturated fatty acid and odd chain fatty acid, ketone bodies.
Lipid biosynthesis: biosynthesis of fatty acids, triacylglycerol and phospholipids and regulation of fatty acid metabolism.

UNIT-III PROTEIN AND NUCLEIC ACID METABOLISM
Amino acid metabolism: biosynthetic families of amino acids, Breakdown of amino acids into six common intermediates and urea cycle and regulation of amino acid metabolism.
Nucleotide metabolism; biosynthesis of purines and pyrimidines nucleotide by de novo and salvage pathways, Degradation of purines and pyrimidines nucleotides.

UNIT-IV NITROGEN METABOLISM
Biochemistry of nitrogen fixation: nitrogenase complex, function of nitrogenase, regulation of nitrogenase by oxygen and combined nitrogen sources, Genetics of nitrogen fixation; nif genes and their regulation.
UNIT-I: - Enzymes kinetics
Overview of Michaelis-Menten equation and its transformation, Evaluation of kinetic parameters, Kinetics of bisubstrate reaction, multistep reactions, kinetics of enzyme inhibition, Classification of enzymes

UNIT-II: - Catalytic mechanisms
Concept of active site, determination of active site, acid –base catalysis, covalent catalysis, metal ion cofactors, proximity and orientation effects, preferential binding.
Active site determination and mechanism of ribonuclease, lysozyme, Active site determination and mechanism of serine protease.

UNIT-III: - Regulation of Enzyme activity
Allosterism, Kinetic analysis of allostERIC enzymes
Covalent Modification, Feed -back inhibition
Membrane bound enzymes, isoenzymes and marker enzymes-LDH,multienzyme complex with mechanism
Constituitive and inducible enzymes.

UNIT-IV: - Techniques
Enzyme isolation and purification- Importance of purification, methods of purification and fractionation, crieteria of purity
Protein: ligand binding studies: association and dissociation constants, co-operative ligand binding MWC or concerted model, sequential model.
Enzyme biosensors: General concept, glucose biosensor. Industrial applications of enzymes. Immobilized enzymes, Protein engineering.
SEMESTER-I
Paper-IV
Microbial Ecology (ME)

UNIT-I: - Microbial Ecosystems
Population, guilds, communities, homeostatis, Environment and microenvironment.
Biofilms. Terrestrial environment, deep surface microbiology. Fresh water environment,
lake and river microbiology. Marine Microbiology and Hydrothermal vents.

UNIT-II: - Diversity, stability and succession
Diversity indices, dominance indices, information statistics indices, Shannon index,
Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis. Community stability, stability hypothesis, Intermediate-disturbance hypothesis.
Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession.

UNIT-III: - Ecology and Genetics
Genetic structure of population:- Genotype frequency, allele frequencies.
Hardy-Weinberg Law: - Assumptions, predictions, derivation, extension and natural selection.
Measuring genetic variation at protein level, measuring genetic variation at DNA level.
Factors effecting gene frequencies:-Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating, Inbreeding.

UNIT-IV: - Interactions and Ecosystem Management
Microbial Interactions: Competetion and coexistence, Gause hypothesis, syntrophy,
commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals.
Concept of sustainable development: microbial technology and sustainable development.
Management and improvement of waste land/barren land.
Oil spills, damage and management petroleum and oil shore management.
PRACTICAL-I
MB1-LAB1
LABORATORY EXERCISE 1

1) Detection of enzyme activity of lipase, Urease, invertase, protease, Tween 80 hydrolysis.
2) Determination of kinetic constant of amylase: Amylase activity, Vmax.Km.
3) Effect of pH and temperature on amylase activity.
4) Effect of inhibitors on amylase activity.
5) Estimation of protein:
6) Production, isolation and purification of enzyme and determination of fold purification (any one enzyme)
7) Estimation of sucrose in presence of glucose.
8) UV absorption of proteins, DNA and RNA.
9) Estimation of L-leucine by colourimetric method.
10) Determination of pka of an amino acid.

Minimum seven experiments must be performed in the semester.

PRACTICAL-I
MB1-LAB1
LABORATORY EXERCISE 2

1) Isolation and microscopic examination of Myxobacteria, Thiobacteria and Ferrobacteria.
2) Isolation of microflora from different ecological nitches such as freshwater, mangroves, salt pan bed, hot water spring, acid zone soil, rhizosphere etc. (any two nitches)
3) Demonstration microbial Interactions: competition, syntrophy, antagonism and isolation of nitrogen fixing bacteria.
4) Development of biofilm on metal strips.
5) Microbial production and processing of polysaccharide schizophyllan.
6) Production of protoplast.
7) Isolation and purification of Photosynthetic pigments.
8) Determination of Shannon index as a measure of evenness H/Hmax from garden soil.
9) Isolation of sulphate reducing bacteria.
10) Isolation of bacteria capable of degrading polycyclic aromatic hydrocarbons from oil contaminated earth.

Minimum seven experiments must be performed in the semester.
UNIT-I: - Biophysical Techniques-I
Determination of size, shape and Molecular weight of Macromolecules:- by Viscosity, CD/ORD, Light scattering, diffusion sedimentation and Centrifugation techniques.

UNIT-II: - Biophysical Techniques-II
Electrophoresis: Agarose Gel, SDS-page, two-dimensional gel electrophoresis, capillary electrophoresis, immune-electrophoresis.


UNIT-IV: - Other advance techniques
Blotting techniques: Western, southern, northern, Radioimmunoassay. NMR and its biological importance. Site-directed mutagenesis, transcriptional start point mapping.
UNIT-I: - Structure and organization of membranes
Mitochondria, endoplasmic reticulum, prokaryotic membrane, membrane junctions (Gap & tight junctions), techniques for membrane study: electron microscopic method, membrane vesicles, differential scanning colorimetry, fluorescent photobleaching recovery, flow cytometry.

UNIT-II: - Membrane Transport
Active and Passive transport, uniport, ATP powered pumps, non-gated ion channels, cotransport by symporters and antiporters, transepithelial transport.

UNIT-III: - Signal Transduction
General concept of cell signaling, G-protein coupled receptors and their effectors. RTK and MAP Kinases. Down regulations of pathways. Cytokine receptors and their mechanism (JAK-STAT pathway).

UNIT-IV: - Bacterial signal transduction
SEMESTER-II
Paper-III
Microbial Methods for Environment Management (MMEM)
MB2-T007

UNIT-I: - Eutrophication, Biodeterioration and Biomagnification
Eutrophication: Microbial changes induced by organic and inorganic pollutants, factors influencing eutrophication process and control of eutrophication.
Biodeterioration: Definition and concept of biodeterioration, biodeterioration of woods and pharmaceutical products.
Biomagnification: concept and consequences, Biomagnifications of chlorinated hydrocarbons and pesticides.

UNIT-II: - Biotransformation and Bioleaching, Biodegradation
Biotransformations: metals and metalloids, mercury transformations, biotransformation of pesticides such as hexachlorobenzene.
Bioleaching: Bioleaching of ores, leaching techniques and applications.
Biodegradation: Biodegradation of plastics.

UNIT-III: - Pollution Management
Waste water management using activated sludge, aerated lagoons, trickling filter, rotary biological contractors, fluidized bed reactors, stabilization ponds. Concept of phytoremediation and applications.

UNIT-IV: - Global Environmental Problems
Ozone depletion, UV-B, green house effect, acid rain, their impact and biotechnological approaches for management. Acid mine drainage and associated problems. Global warming and climate change.
UNIT-I: Overview of metabolites


Biopolymers: Polypeptides (collagen, casein and serum albumin), Polynucleotides and polysaccharides (amylose, amylopectin, alginate, cellulose) and other biopolymers like chitin, Xanthan, dextrin, Gellan, Pullulan, curdlan and hyluronic acid.


UNIT-II: Antimicrobial drugs: Secondary metabolites

Antibiotics: History and discovery of antibiotics, Antibiotic resistance, Mechanisms of antibiotic resistance.

Structure and mode of action of antibiotics: Aminoglycosides (Amikacin), Carbapenems (Imipenim), microlids (Azithromycin), Nitrofur an (nitrofurantoin), Penicillin (Amoxicillin), Quinolones (gatifloxacin/Ciprofloxacin), Sulphonamides (sulfamethoxazole), Tetracyclines (doxycyclines), Chloramphenicol, Fucanazole.

UNIT-III: Pigments as secondary metabolites


UNIT-IV: Microbial vitamins

Characteristics of fats and water soluble vitamins.

Structure, function and chemistry of: Retinol (vitamin A), Riboflavin (vitamin B_2_), Cynocobalamine (Vitamin B_12_) and ascorbic acid (vitamin C).

PRACTICAL-III
MB2-LAB3
LABORATORY EXERCISE 3

1) Separation of DNA by agarose gel electrophoresis and estimation of DNA by Diphenylamine method.
2) Estimation of RNA by Orcinol method.
3) Separation of amino acids by paper chromatography.
4) Separation of serum proteins by paper electrophoresis.
5) Thin layer chromatography of mycotoxins
6) SDS-Page of proteins.

7) Performance of affinity chromatography.
8) Performance of Gel filtration chromatography.
9) Demonstration of blotting technique.[any one].
10) Ion exchange chromatography

Minimum seven experiments must be performed in the semester.

PRACTICAL-IV
MB2-LAB4
LABORATORY EXERCISE 4

1) Estimation of Riboflavin/Thiamine by fluorometric method.
2) Production of antibiotic as secondary metabolite and its assay[any one antibiotic].
3) Microbial production of Dextran/xanthan as secondary metabolites.
4) Membrane disruption and separation subcellular organelles.
5) Production of microbial pigments using any pigment producing organism.
6) Biotransformation of toxic chromium(+6) into nontoxic(+3) by pseudomonas species.
7) Microbial dye decolourization.
8) Isolation of Mercury resistant bacteria.
9) Isolation of salmonella and bacteriphages from waste water/sewage.
10) Determination of Laboratory bioleaching process.

Minimum seven experiments must be performed in the semester.
List of recommended books

- The Biochemistry of copper By: Jack Peisach, Phillip Aisen.
- Biochemistry:- By: Rex Montgomery.
- Lehninger Principles of Biochemistry By: David L. Nelson and Cox
- Metabolic Pathways By: David M. Greenberg.
- Enzymes: By: Trevor Palmer.
- Enzyme structure and mechanism: By: Alan Fersht.
- Immobilization of Enzymes and cells By: Gordon Bickerstaff.
- Environmental Microbiology By: Ralph Mitchell, John Wiley and Sons Inc.
- Environmental Biotechnology By: C. F. Froster and D. A. John Wase, Elis Horwood.
- Biocatalysis and Biodegradation: Microbial Transformation of organic compounds By: Lawrence P. Wacekett.
- A manual of environment Microbiology By: Christon J. Hurst, ASM publication.
- Biodegradation and bioremediation Academic press By: San Diego.
- Environmental Microbiology By: R. M. Maier, I. C. Papper and C. P. Gerba.
- Methods in Microbiology: Lynch and Hobbie.
- Advances in Applied microbiology By: D. Pearlman academic press.
- Principles of Biochemistry By: Donald J. Voet, Judith G. Voet, Charlotte W. Pratt.
- Brock Biology of Microorganisms By: John M. Martinco.
- Introduction to Genetic analysis By: Griffiths, Wessler, Lewontin, Gelbart, Suzuki, Miller.
- Environmental Science working with the Earth By: Miller.
- Microbial Biotechnology, Principles and Applications By: Lee Yuan Kun.
- Biophysical Chemistry By: Upadhyaya Upadhyaya Nath.
- Microbial Ecology by Lynch et al.
- Experimental microbial ecology by Burns et al.
- Ecology, Theories and applications. By: Peter Stiling.
- Basic Bacteriology, 3rd Ed., Lamanna C., Mallette F., the Willium and Wilkins company, Calcutta.
- The Yeast - A.H. Rose
- General Microbiology, 5th Ed. - R.Y. Stanier
- Text book of biochemistry 4th edn by West, Tood, Mason and Burgen
- Principles of biochemistry 5th edn, by White, Handler, Smith
- Lehninger's principles of biochemistry by Nelson kocs.
- Biochemistry by Zubay
- Elements pf Biochemistry by O.P. Agrawal
- Bacterioal metabolism by Doelle
- Bacterial metabolism by Gotschalk
- Advances in general microbiology by Shrivastava
- Biochemistry by Strior
- Bacterial Systematics, by Logan, A., Niall A. Logan, Wiley-blackwell; 1994
- Principles of Microbiology by R.M. Atlas, Mosby publishers, St. Louis; 1995
- Textbook of Microbiology-Ananthnarayan and Panikers-University press(8th ed.)
- Cell Biology-Channarayappa- University Press, Hyderabad