Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B++' Grade (CGPA 2.96)

Name of the Faculty: Science& Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: Microbiology

Name of the Course: B.Sc. II (Sem.– III & IV)

(Syllabus to be implemented June 2023)

Choice Based Credit System (CBCS) (W.e.f. June 2023):

Preamble: The Curriculum development plays a very vital role in the development of quality of education. The education system should be such that students will be able to compete locally, regionally, nationally as well as globally. The present situation demands developing "learner-centric approach while redesigning of curriculum. There is also need to allow the flexibility in education system. The choice based credit system (CBCS) allows students to choose inter-disciplinary, intra-disciplinary courses, skill oriented papers and thus offers more flexibility for student. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. In view of this, PAH Solapur University, Solapur has implemented Choice Based Credit System of Evaluation at Undergraduate level. While designing the syllabi of microbiology for undergraduate course for semester III and IV, an attempt has been made to follow the pattern given in the UGCs Undergraduate Template. This will help to bring a match across all the Indian universities.

Introduction: Microbiology deals with the study of microorganisms. This branch of life science has immensely grown up widening its horizons and opening new frontiers of knowledge. The scope of microbiology as a subject is immense due to its fruitful impact on many fields like medical, dairy, water, pharmaceutical, industrial, clinical, research, agriculture, nanotechnology, etc. A career in microbiology is lucrative option. There is demand of trained microbiologists in a vast range of industries and research and development laboratories of government and private hospitals, research organizations, pharmaceutical, food, beverage and chemical industries. To cater the needs, discipline specific papers on industrial, agricultural, environmental, medical microbiology, microbial biochemistry, virology and immunology have been included in the curriculum from semester I to VI. At the same time, the framework is so designed as to maintain standards of microbiology degree and the learning outcomes.

Learning Outcomes based approach to Curriculum Planning: The Learning Outcomes-based Curriculum Framework (LOCF) for the B.Sc. (Honors) degree in Microbiology is designed to suit the need of the hour, in keeping with the emergence of new areas of Microbiology. The framework is architected to allow for flexibility in program design and course content development, while at the same time maintaining a basic uniformity in structure in comparison with other universities across the country. The program is designed to build a strong microbiology knowledge base in the student and furthermore, acquaints the students with the applied aspects of this fascinating discipline as well. The student is thus equipped to pursue higher studies in an institution of her/his choice, and to apply the skills learnt in the program to solve societal problems. The program offers an elective course to the student for skill enhancement courses that prepares the student for an eventual job in academia or industry.

Outline of Choice Based Credit System: 1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course**. 2. Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course. **Discipline Specific Course (DSC) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. **3. Ability Enhancement Compulsory Course (AECC):** The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; (i) English and (ii) English/ Democracy, Elections and Good Governance. These are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. **• Credit:** Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 10 marks and University Evaluation for 40 marks for each paper in semester III and IV.

• Objectives of the course: The objectives of B. Sc. Microbiology course are: 1) To impart knowledge with respect to the subject and its practicable applicability. 2) To enhance understanding of basic and advanced concepts in microbiology. 3) To develop the awareness of various emerging areas of Microbiology. 4) To train students for further studies helping in their bright career in the subject 5) To expose the students to different processes used in industries and research field 6) To develop their ability to apply the knowledge of microbiology in day to day life. 7) To prepare the students to accept the challenges in life sciences. 8) To make students skillful to work in various industries, research labs and health sector.

Course outcome and Advantages: After completing the course students will be familiarized with the necessary laboratory techniques and tools of microbiology and provide an exposure in research, analytical and presentational skills. Microbiology has tremendous job potential. The successful students will be able to get various microbiology related jobs.

• Medium of Instruction: English • Syllabus Structure: • The University follows semester system. • An academic year shall consist of two semesters. • B.Sc. Part- II Microbiology shall consist of two semesters: Semester III and Semester IV. In semester III: there will be two DSC papers having paper V and VI of 50 marks each. In Semester IV: there will be two DSC papers having paper VII and VIII of 50 marks each. There will be one Compulsory paper on "Ability Enhancement Compulsory Course (AECC)" as a Environmental Studies • **Scheme of Evaluation:** As per the norms of the grading system of evaluation, for each paper out of 50 marks, the candidate has to appear for college internal assessment of 10 marks and external evaluation (University assessment) of 40 marks. Semester – III: Theory: (Paper V & VI =50+50=100 marks): Comprising DSC a) University Examination (UA) (40 marks): No. of theory papers: 2 (paper V and paper VI) b) Internal Continuous

Assessment (CA) (10 marks) No. of theory papers: 2 (paper V and paper VI) by conducting unit test/ open book test/ home assignment/ Group discussion. Semester – IV: Theory: (50+50 = 100 marks): Comprising DSC a) University Examination (UA) (40 marks): No. of theory papers: 2 (paper VII and paper VIII) b) Internal Continuous Assessment (CA) (10 marks) No. of theory papers: 2 (paper VII and paper VIII) by conducting unit test/ open book test/ home assignment/ Group discussion. c) Compulsory paper on "Ability Enhancement Compulsory Course (AECC)" on Environmental Studies. **Practical Examination:** (100 marks) University Examination (80 marks): Number of questions on practicals for exam: 08 Practical: Based on Papers- V, VI, VII, VIII (80 Marks UA) Internal Continuous Assessment: (20 Marks CA)

Passing Standard: The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in internal assessment and passed in University examination (theory) shall be given FR Grade. Such student will have to reappear for both University examination as well as internal assessment. In case of Annual pattern/old semester pattern students/candidates from the mark scheme the candidates shall appear for the same stipulated marks of external examination and his/her performance shall be scaled to 100 marks. • ATKT: Passed in all papers except 5 (Five) papers combined together of semester III and IV of B.Sc. Part-II Microbiology examination and clearly passed in B.Sc. Part-I-Microbiology shall be permitted to enter upon the course of Semester V of B.Sc. III Microbiology.

Equivalent Subject for Old Syllabus:

Sr. No.	**Name of Old Paper**	**Name of New Paper**
1.	Paper – V Bacterial Cytology and Physiology	Paper – V Bacterial Cytology, Physiology and Metabolism
2.	Paper – VI Bacterial Genetics	Paper – VI Fundamentals of Bacterial Genetics
3.	Paper VIII Immunology & Medical Microbiology	Paper VIII Immunology & Medical Microbiology
4.	Paper VIII - Industrial Microbiology	Paper VIII - Introduction to Industrial Microbiology

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Choice Based Credit System (CBCS)

(w.e.f. 2023-24)

Structure for B.Sc. II Microbiology (Semester III & IV)

Subject/ Core Course	**Name and Type of the Paper**		**No. of Papers/ Practicals**	**Hrs / Week**			**Total Marks per paper**	**UA**	**CA**	**Credits**
	Type	**Name**		**L**	**T**	**P**				
Class :	**B.Sc. II Semester III**									
Core courses: students can opt. any three subjects among the four subjects offered at B.Sc. I Or Students can opt any two subjects among the four subjects offered at B.Sc. I and any one from the additional interdisciplinary subjects.	DSC- 1C	C5	Paper – V Bacterial Cytology, Physiology and Metabolism	3.0	-	-	50	40	10	2.0
		C6	Paper – VI Fundamentals of Bacterial Genetics	3.0	-	-	50	40	10	2.0
Total				**6.0**			**100**	**80**	**20**	**4.0**
Class:	**B.Sc. II Semester IV**									
Core courses: students can opt. any three subjects among the four subjects offered at B.Sc. I Or Students can opt any two subjects among the four subjects offered at B.Sc. I and any one from the additional interdisciplinary subjects.	DSC – 1 D	C7	Paper VII Immunology & Medical Microbiology	3.0	-	-	50	40	10	2.0
		C8	Paper VIII Introduction to Industrial Microbiology	3.0	-	-	50	40	10	2.0
	Ability Enhancement Course (AECC)	Environmental Studies		3.0	-	-	50	40	10	**NC**
Total (Theory)				**6.0**	**-**	**-**	**100**	**80**	**20**	**4.0**
Practical	DSC – 1C & DSC -1 D	C5 & C6 C7 & C8	Paper V& VI	-	-	4.0	50	40	10	4.0
			Paper VII & VIII	-	-	4.0	50	40	10	4.0
Total Practical				**-**	**-**	**8.0**	**100**	**80**	**20**	**8.0**

Grand Total (Semester III & IV with Practicals)		**12.0**	**-**	**8.0**	**300**	**240**	**60**	**16.0**

B.Sc. II- Semester –III

Paper – V Bacterial Cytology, Physiology and Metabolism		
THEORY COURSE (02 Credits) **Total Lectures 30L**		
Unit No.	**Content of Unit**	**Lectures Allotted**
I	**Bacterial Cytology and Growth** **A. Bacterial Cytology** **1.Cell membrane and membrane transport:** a. Chemical composition, structure and function. b. Transport across cell membrane – simple diffusion, facilitated diffusion, active transport and group translocation **2. Flagella**- Mechanism of movement (Types of Motility and Chemiosmotic Hypothesis) and tactic behavior. **3.Cytoplasmic inclusions and reserve food materials -** Chlorobium vesicles, Gas vacuoles, Magnetosomes and Carboxysomes and their functions, Nitrogenous and non nitrogenous reserve food material and their role. **4.Bacterial endospore –** Sporulation and Germination . **B. Bacterial Growth and Effect of Environmental factors-** **a. Growth -** 1. Definitions of – Growth, Generation time, Growth rate 2.Growth phases 3. Concept of Diauxic growth, Continuous growth and Synchronous growth. **b. Effect of Environmental factors on Bacterial growth** 1. pH- Acidophiles, Basophiles, Neutrophils 2.Temperature - Psychrophiles,Mesophiles,Thermophiles, Thermodurics 3 Oxygen- Aerobic, Anaerobic, Facultative anaerobic and Microaerophilic 4. Osmotic pressure – Definition of Osmosis, Osmoregulation, Osmotic Balance, Osmophiles and Halophiles. 5.Heavy metal	**15 L**
II	**Bacterial Metabolism and Enzymes** **A. Metabolism –** 1.Modes of ATP generation a. Substrate Level Phosphorylation b. Oxidative Phosphorylation – Respiratory electron transport chain, components of ETC, aerobic and anaerobic respiration . c. Photophosphorylation: components of ETC (cyclic and noncyclic) **2. Metabolic Pathways** a. ED pathway b. Glyoxylate bypass c. Phosphoketolase pathway (pentose and hexoses) **B. Enzymes**	**15 L**

	a. Nomenclature and Classification of enzymes as per IUB b. Effect of factors on enzyme activity like – Substrate concentration, Enzyme concentration, Activators and Inhibitors .	

Reference Books:

1) Powar .C.B and Daginawala .H.F (1986) General Microbiology Vol.I and Ii (2 nd Edition), Himalaya Publishing House ,Mumbai
2) Stanier .R.Y.et.al,General Microbiology
3) Pelczar ,M.J Chan,E.C.S and Kreig .N.R (1993). Microbiology,5th Edition ,Tata Mc Graw Hill Publishing ComLtd,New Delhi.
4) Biochemistry by Fatima Dulsy.
5) Satynarayan, U (2013)., Biochemisty, Elsevier India.

Paper-VI Fundamentals of Bacterial Genetics		
THEORY COURSE (02 Credits) (30 L)		
Unit No.	**Content of Unit**	**Allotted Lectures**
I	**Structure of nucleic acids & Replication of Bacterial DNA, basic concepts of genetic code, transcription and translation** **A) 1.Experimental evidences for nucleic acid as genetic material-** • Griffith Experiment • Avery, Macleod and McCarty's experiment • Hershey and Chase experiment **2. Structure & forms or types of DNA-** • Watson and Crick's model of DNA • A, B,C and Z form of DNA **3. DNA replication-** • Modes of replication (Conservative, semi-conservative and Dispersive) • Meselson & Stahl's experimental proof of semi-conservative replication • Enzymes involved in replication • Mechanism of DNA replication **B) Basic concepts of genetic code, transcription and translation** 1) Definitions and concepts of Gene, Genome, Genotype, Phenotype, Cistron, Recon & Muton, Split gene-concept of intron and exons 2) Genetic code- Definition and properties of genetic code. 3) Basic concept of Transcription and translation	**15**
II	**Bacterial Mutation, DNA Repair and plasmids:** **A) 1.Mutations & Mutagenesis-** • Definition of mutation • Mutagen- physical and chemical Mutagens **2. Types of mutation-** • Base pair Substitution- Transition and Transversion • Missense mutation • Nonsense mutation • Neutral Mutation • Silent Mutation • Frame shift Mutation **3. Types of mutation on the basis of molecular mechanism-** • Spontaneous Mutation- Definition, Fluctuation Test, Replica plate technique • Definition and Mechanism of Induced Mutations caused by- • Physical Mutagen- U.V.rays • Chemical mutagens- 5-Bromouracil, 2-aminopurine, Hydroxylamine, Nitrous acid, alkylating agent and Acridine dyes.	**15**

	4. DNA repair- • Photo reactivation • Dark repair Mechanism- Excision repair (Base and Nucleotide) **B) Plasmid-** • Definition of plasmid and episome • Properties of plasmid • Types of plasmid-F plasmid, R plasmid, Col plasmid, Ti plasmid, Linear plasmid and Yeast 2µ plasmid Applications of plasmid	

References:

1] A J Salle: Fundamentals of Bacteriology

2] R Y Stainer, Roger et.al: General Microbiology

3] Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. 5th Edition, Tata Mc Graw Hill Publishing Co., Ltd., New Delhi

4] Powar and Daginawala: General microbiology Vol. I, II, Himalaya Publishing House

5] Avinash and Kakoli Upadhay: Molbio, Himalaya Publishing House

6] Freifelder David: Microbial genetics, Jones and Bartlett Publications

7] James D Watson: Molecular biology of the gene, W. A. Benjamin, Inc.

Semester IV

Paper-VII Immunology & Medical Microbiology		
THEORY COURSE (02Credits) **Total Lectures 30L**		
Unit No.	**Content of Unit**	**Lectures Allotted**
I	**Immunity, Antigen and Antibody** **1. Immunity**–Definition and concept a. Innate immunity – Definition, Levels of innate immunity – Individual, racial and species immunity , Mechanism of innate immunity-mechanical, chemical, biological barriers [role of normal flora, cells of innate immunity and their role], inflammation and fever b. Acquired immunity– definition, types-Active & passive 2.**Antigen** a. definition, concept of hapten, antigenic determinant, b. Types of antigen c. factors affecting antigenicity **3. Antibody**(immunoglobulin) a. Historical perspective-Immune sera and concept of immunoglobulin b. Basic structure of antibody (immunoglobulin) c. Classes of immunoglobulins, physicochemical & biological properties and functions of Immunoglobulins.	**(15)**
II	**Antigen Antibody reactions and Medical Microbiology** **A. Antigen Antibody reactions** : 1. Purpose of antigen-antibody reactions 2. General features of antigen-antibody reactions 3. Measurement of antigen-antibody reactions 4. Mechanism of antigen-antibody reactions 5. Types of antigen – antibody reactions: Agglutination, precipitation, flocculation. **B. Medical Microbiology**: 1. Collection, Handling and transportation of Specimen. 2. Microbial Diseases: i. Bacterial: enteric fever ii. Fungal: Candidiasis iii. Viral: Dengue.	**(15)**

ReferenceBooks:

1. Ananthanarayana R. and Paniker, C.K.J. (2000). Text Book of Microbiology, 9th Edition, Oriental Longman Publications, USA.
2. Roitt, I.M. (1998). Essentials of Immunology, ELBS and Black Well Scientific Publishers, England.
3. Prescott, M.J., Harley, J.P. and Klein, D.A. (2002). Microbiology. 5th Edition, WCB McGrawHill, New York.
4. Dugid, J.P., Medical Microbiology
5. Kubey-Immunology

Semester-IV

Paper VIII : Introduction to Industrial Microbiology		
THEORY COURSE (02Credits) **Total Lectures 30L**		
Unit No.	**Content of Unit**	**Lectures Allotted**
I	**Industrial Microbiology** **A. Fermentation**: Basic Concept, Types–Surface Culture Submerged Culture. Batch, Continuous culture (Chemostat & Turbidostat) , Dual and Multiple fermentation. Design of typical Fermenter/ Bioreactor: Parts and their functions **B. Fermentation media:** i. Media for industrial Fermentations ii. Media Components and Optimization iii. Use of Waste as a fermentation Media iv. Inoculum and Production media	**(15)**
II	**Screening, Inoculum Development and Scale up** **A.Screening**: Primary and Secondary Strain Improvement Preservation of industrially important microorganisms **B.** Inoculum Development **C.** Scale up of Fermentation **D.** Specific fermentations: i. Penicillin ii. Alcohol iii. SCP	**(15)**

ReferenceBooks:

1. Patel,A.H.(1984). Industrial Microbiology, MacMilan India Ltd., Hyderabad.
2. Cassida, L.E. (1968). Industrial Microbiology, Wiley Eastern Ltd. & New Age International Ltd., New Delhi.
3. Prescott & Dunn, Industrial Microbiology
4. Purohit, Microbiology- Fundamentals and Applications, sixth edition
5. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2ndedition,Elsevier ScienceLtd.

B. Sc. II Microbiology

Practical Course (Credits - 08)

1. Stains and Staining Procedures

   i. Spore Staining [Dorner's method]

   ii. Flagella Staining [Bailey's Method]

   iii. Nuclear material Staining [Giemsa's method]

   iv. Lipid granule staining by Burdon's method

   v. Metachromatic granule staining by Albert's method

2. Preparation of culture media

   a. Wilson and Blair's medium

   b. Gelatin Agar

   c. Amino Acid Decarboxylation Medium

   d. Peptone Nitrate Broth

   e. Hugh and Leifson's Medium

   f. Amino Acid Deamination medium

   g. Christensen's urea agar

3. Preparation of Reagents and Solutions

   a. 1N NaOH

   b. 1N HCl

   c.10%Ferric chloride

   d. Nitrate reduction test reagents (α naphthylamine & Sulphanilic acid)

   e.1%Tannic acid

   f. Phosphate buffer solution of pH 7.0

   g. Benedict's reagent

   h. Biuret reagent

4. Biochemical Tests

   a. Gelatin Hydrolysis

   b. Amino Acid Decarboxylation

   c. Amino Acid Deamination

d. Urea Hydrolysis

e. Nitrate Reduction

f. Oxidase

g. Hugh and Leifson's

h. Catalase

5. Effect of environmental factors on growth of microorganisms

a. UV light

b. Heavy Metals

c. Salt Concentration (NaCl)

d. pH

e. Temperature

f. Antibiotics [Penicillin & Streptomycin]

6. Primary Screening:

a. Antibiotic Producers – Crowded Plate Technique

b. Amylase Producers – Replica Plate Technique

7. Isolation & Identification of Pathogenic Microorganisms from Clinical Samples

a. *Salmonella* spp.

b. *Candida* spp.

c. *Proteus* spp.

8. Determination of Blood Groups – ABO & Rh

9. Widal test (slide test): Qualitative

10. Glucose Estimation (Benedict's Method)

11. Protein Estimation (Biuret Method).

12. Study of Growth phases of E.coli by optical density method.

13. Isolation of Lac-negative mutant

14. Industrial Visit.

Practical Question Paper for University Practical Examination

Total Marks: 80

Q.1 Identification of Pathogen	15
Q.2 Biochemical Tests	10
Q.3 Staining / Screening	10
Q.4 Effects/ Growth Curve [lag phase]	10
Q.5 Glucose /Protein / Widal test/ Blood Groups	10
Q.6 Spotting on Media components, reagents and stains (05 Spots)	10
Q.7 Journal	05
Q.8 Tour Report	10

The practical Examination will be conducted for two (2) successive days for 6 hours each day. There will be one batch of maximum 20 students.

Internal Practical examination:

Total Marks: 20

The internal practical examination shall be as per scheme given by Faculty of Science.

Practical Examination will be conducted at the end of Semester IV

References for Practical course

1]Cappuccino, J.G. and Sherman, N. (2005). Microbiology – A Laboratory Manual.7th Edition. Pearson Education. Published by Dorling Kindersley (India) Pvt. Ltd.

2] Mukherjee, K.L. (1996). Medical Laboratory Technology. Vol II. Tata Mc GrawHill Publishing Co. Ltd., New Delhi

3] Dubey, R.C. and Maheswari, D.K. (2002). Practical Microbiology, S. Chand & Co., New Delhi

4] Naik Sandesh, Handbook of Practical microbiology

6] Frobisher, H., Hinsdil, R.D., Crabtree, K.T. and Goodhert, D.R. (2005)

Fundamentals of Microbiology, Saunders and Company, London.

7] K.R.Aneja, Pranay Jain, Raman Aneja (2008). A Textbook of Basic and Applied Microbiology, New Age International Publishers