TUMKUR UNIVERSITY NATIONAL EDUCATION POLICY 2020

MODEL CURRICULUM CONTENTS
IN
MICROBIOLOGY

MODEL CURRICULUM

Name of the Degree Program : BSc
(Basic/Hons.)Discipline Core : Microbiology
Starting year of implementation : 2021-22

Program Outcomes:
Competencies need to be acquired by the candidate
securing B.Sc. (Basic) or B.Sc. (Hons)

By the end of the program the students will be able to:

1. Knowledge and understanding of concepts of microbiology and its application in **pharma, food, agriculture, beverages, nutraceutical industries**.
2. Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.
3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
5. Exploring the microbial world and analyzing the specific benefits and challenges.
6. Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
9. Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.
11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.
12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

Curriculum Structure for the Undergraduate Degree Program
BSc (Basic / Hons.)

Starting year of implementation : 2021-22
Name of the Degree Program : B.Sc. (Basic/Hons.)

MicrobiologyProgram Articulation Matrix:

Semester	Title /Name Of the course	Program outcomes that the course addresses(not more than3 per course)	Pre-requisite course(s)	Pedagogy##	Assessment$
1	MBDSC01 General Microbiology 4 Credits 100 Marks	1. Knowledge and understanding of concepts of microbiology. 2. Learning and practicing professional skills in handling microbes. 3. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.	PUC or +2 (Life sciences as one of the core disciplines)	The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.	LSSSDC (NSDC) assessment and certification for lab technician or Lab assistant job role
	MBDSC01P General Microbiology 2 Credits 50 Marks				
2	MBDSC0 2 Microbial Biochemistry and Physiology 4 Credits 100 Marks	Thorough knowledgeand understanding of concepts of microbiology and its application in different microbiological industries.		The general pedagogy to be followed for theory and practicals are as under. Lecturing, Tutorials, Group/Individual Discussions, Seminars, Assignments, Counseling, Remedial Coaching. Field/Institution/Industrial	LSSSD C (NSDC) assessment and certification for lab technician or Lab assistant job role

				visits, Hands on training, Case observations, Models/charts preparations, Problem solving mechanism, Demonstrations, Project presentations, Experiential documentation and Innovative methods.	
	MBDSC02P Microbial Biochemistryand Physiology 2 Credits 50 Marks				

3	MBDSC03 Microbial diversity 4 Credits 100 Marks				
	MBDSC03P Microbial diversity 2 Credits 50 Marks				

4	MBDSC04 Microbial Enzymology and Metabolism 4 Credits 100 Marks				
	MBDSC04P Microbial Enzymology and Metabolism 2 Credits 50 Marks				

5	MBDSC05 Microbial genetics and Molecular biology 3 Credits 100 Marks				
	MBDSC05P Microbial genetics and Molecular biology 2 Credits 50 Marks				
	MBDSC06 Immunology and Medical microbiology 3 Credits 100 Marks				
	MBDSC06P Immunology and Medical microbiology 2 Credits 50 Marks				

6	MBDSC0 7 Food and Dairy Microbiology 3 Credits 100 Marks				
	MBDSC0 7P Food and Dairy Microbiology 2 Credits 50 Marks				
	MBDSC0 8 Industrial Microbiology and Bioprocess Technology 3 Credits 100 Marks				

	MBDSCo 8P Industrial Microbiology and Bioprocess Technology 2 Credits 50 Marks				

7	MBDSCo 9 Microbial Genetic Engineering 3 Credits 100 Marks				
	MBDSCo 9P Microbial Genetic Engineering 2 Credits 50 Marks				
	MBDSC10 Environmental and Agricultural Microbiology 3 Credits 100 Marks				
	MBDSC10P Environmental and Agricultural Microbiology 2 Credits 50 Marks				
	MBDSC11 Pharmaceutical and Forensic Microbiology 4 Credits 100 Marks				

8	MBDSC12 Biosafety, Bioetics & IRP 4 Credits 100 Marks				
	MBDSC13 Genomics, Proteomics and Metabolomics 4 Credits 100 Marks				
	MBDSC14 Aquatic Microbiology 3 Credits 100 Marks				

9	MBDSC15 Microbial Genetic Engineering 3 Credits 100 Marks				
	MBDSC15P Microbial Genetic Engineering 2 Credits 50 Marks				
	MBDSC16 Environmental And Agricultural Microbiology3 Credits 100 Marks				

	MBDSC1 6P Environmental and Agricultural Microbiology 2 Credits 50 Marks				
	MBDSC1 7 Pharmaceutical and Forensic Microbiology 4 Credits 100 Marks				

10	MBDSC18 Emerging Microbial Technologies 4 Credits 100 Marks				
	MBDSC19 Extremophylic Microbes and Extremolytes 4 Credits 100 Marks				
	MBDSC20 Molecular Diagnosis, Drug Designingand Advanced Vaccines 3 Credits 100 Marks				

 # Note:

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes activelearning/ course projects/ problem or project based learning/ case studies/self study like seminar,term paper or MOOC.

$ Every course needs to include assessment for higher order thinking skills (Applying/ Analyzing/ Evaluating/ Creating). However, this column may contain alternate assessment methods that helpformative assessment (i.e. assessment for learning).

BSc Microbiology (Basic / Hons.)Semester 1

Course Title: MBDSC01, General Microbiology	
Total Contact Hours: **56**	Course Credits: **4+2**

Course Pre-requisite(s): *Mention only course titles from the curriculum that are neededto be taken by the students before registering for this course.*

Course Outcomes (COs):
At the end of the course the student should be able to:
(Write 3-7 course outcomes. Course outcomes are statements of observable student actions that serve as evidence of knowledge, skills and values acquired in this course)

1. **Thorough knowledge and understanding of concepts of microbiology.**
2. **Learning and practicing professional skills in handling microbes.**
3. **Thorough knowledge and application of good laboratory and good manufacturingpractices in microbial quality control.**

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes(POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6	7	8	9	10	11	12
1. Thorough knowledge and understanding of concepts of microbiology	[	[		[								
2. Learning and practicing professional skills in handling microbes		[		[			[					
3. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.		[		[			[					

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

BSc Microbiology (Basic / Hons.)Semester 1

Title of the ourses:

Course 1: MBDSC01, General Microbiology
Course 2: MBOEC01, Microbial Technology for Human Welfare
Course 3: MBSEC01, Microbiological Methods and Analytical Techniques

Course 1 : MBDSC01, General Microbiology		Course 2 : MBOEC01, Microbial Technology for Human Welfare		Course 3 : MBSEC01, Microbiological Methods and Analytical Techniques	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**	**1**	**14**

Content of Course 1: Theory: MBDSC01, General Microbiology	**56 Hrs**
Unit – 1: Historical development, major contributions, origin of microorganisms and microscopy	14Hrs
Historical development of microbiology -Theory of spontaneous generation,Biogenesis and Abiogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Edward Jenner, Alexander Fleming, Martinus Beijirinic, Segei Winogrodsky, Elei Metechnikoff. Contributions of Indian scientists in the field of Microbiology. Fossil evidences of microorganisms. Origin of life, primitive cells and evolution of microorganisms. Microcopy- working principle, construction and operation of simple and compound microscopes.	
Unit – 2: Staining, sterilization and preservation of microorganisms	14Hrs
Staining: Nature of strains, principles, mechanism, methods and types of staining-Simple, Differential-Gram staining, Acid fast staining, staining of capsule, cell wall, endospore, inclusion bodies. Sterilization: Principles, types and techniques, Physical, chemical, radiation and mechanical Preservation of microorganisms: Methods of preservation of microorganism, slant culture, stab culture, soil culture mineral oil overlaying, glycerol preservation.	

Unit – 3: Types, structure, organisation and reproduction of prokaryotic microorganisms:	14Hrs
Overview of Prokaryotic Cell Structure: Size, shape, arrangement. Diagram of Prokaryotic cell organisation, cell wall structure and Gram staining, cell membrane; Bacterial and Archaeal, Cytoplasmic matrix- Cytoskeleton, ribosome, inclusion granules: Composition and function. Nuclear Materials – Bacterial chromosomes structure (its differences with the Eukaryotic chromosome); Extra Chromosomal materials. Components external to cell wall- capsule, slime, s-layer, pilli, fimbriae, flagella; structure, motility, chemotaxis. Bacterial Endospore - Examples of spore forming organisms, habitats, function, formation and germination. Reproduction in bacteria and bacterial cell cycle.	
Unit – 4: Types, structure, organisation and reproduction of eukaryoticmicroorganisms	14Hrs
Over view of eukaryotic cell structure: General structure and types of cells; External cell coverings and cell membrane. Structure and function of Cytoplasmic matrix-cytoskeleton: Structure and function; single Membrane organelles- Endoplasmic reticulum, Golgi complex, Lysosomos, Vesicles and Ribosomes; Double Membrane organelles- Nucleus, Mitochondrion and Chloroplast: Structure and Functions; Peroxisomes; Organelles of motility- Structure and movement of flagella and cilia.	

Course 1: Practical: MBDSC01P, General Microbiology

1. Microbiological laboratory standards and safety protocols.
2. Standard aseptic conditions of Microbiological laboratory.
3. Operation and working principles of Light/ Compound microscope.
4. Working principles and operations of basic equipments of microbiological laboratory (Autoclave, Oven, Incubator, pH meter, Spectrophotometer, Colorimeter, vortex, magnetic stirrer etc.).
5. Applications of basic microbiological tools (Pipettes, Micropipette, Bunsen burner, Inoculation loop, Spreader).
6. Demonstration and observations of microorganisms from natural sources under light microscope (Algae, Yeast and Protozoa).
7. Demonstration of bacterial motility by hanging drop method.
8. Simple staining.
9. Differential staining - Gram staining.
10. Acid fast staining.
11. Structural staining - Flagella and Capsule.
12. Bacterial endospore staining.
13. Staining of reserved food materials.
14. Staining of fungi by Lactophenol cotton blue.
15. Negative staining.

Text Books / References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.
6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
7. Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill.
8. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
9. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
10. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
11. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudburry, 835 pp.
12. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
13. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.

Course 2: Theory: MBOEC01, Microbial Technology for HumanWelfare

Course 2 : MBOEC01, Microbial Technology for Human Welfare	**42Hrs**
Unit – 1: Food and Fermentation Microbial Technology	14Hrs
Fermented Foods – Types, Nutritional Values, Advantages and Health Benefits Prebiotics, Probiotics, Synbiotics and Nutraceutical Foods Fermented Products – Alcoholic and nonalcoholic beverages, fermented dairy products, Fruit fermented drinks,	
Unit – 2: Agriculture Microbial Technology	14Hrs
Microbial Fertilizers, Microbial Pesticides, Mushroom Cultivation, BiogasProduction	
Unit – 3: Pharmaceutical Microbial Technology	14Hrs
Microbial Drugs – Types and Development of Drug Resistance Antibiotics – Types, Functions and Antibiotic Therapy Vaccines – Types, Properties, Functions and Schedules	

Course 3: Theory: MBSEC01,
Microbiological Methods and Analytical Techniques

LEARNING OUTCOMES

- Demonstrate skills as per National Occupational Standards (NOS) of "Lab Technician/ Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council - LFS/Q0509, Level 3.
- Perform microbiology and analytical techniques. Knowledge about environment, health, and safety (EHS), good laboratory practices (GLP), good manufacturing practices (GMP) and standard operating procedures (SOP)
- Demonstrate professional skills at work, such as decision making, planning, and organizing, Problem solving, analytical thinking, critical thinking, and documentation.

1. Principles which underlies sterilization of culture media, glassware and plastic wareto be used for microbiological work.
2. Principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.
3. Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced a variety of modifications in the microscopes for specialized viewing.
4. Several separation techniques which may be required to be handled later as microbiologists.

Course 3: Theory: MBSEC01,
Microbiological Methods and Analytical Techniques

MBSEC01, Microbiological Methods and Analytical Techniques	14Hrs
DIGITAL SKILLS: **The components of digital skills provided by KSHEC,will be followed accordingly.** **Microbiological Skills** Microbiological culture media: Types, Composition, Preparation, Application and storage**;** Ingredients of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.	
Isolation and cultivation of microorganisms: Collection of samples, processing of samples, serial dilution, technique, inoculation of samples, incubation and observations of microbial colonies. Morphological characterization of microorganisms - Colony characteristics, Microscopic characters, biochemical/physiological tests or properties and identification. Subculturing of microorganisms and pure culture techniques. Preservation of microorganisms. Advanced Microscopic Skills: Different types of microscopes - Phase contrast, Bright Field, Dark Field, Fluorescent, Confocal, Scanning and Transmission Electron Microscopy, Scanning Probe Microscopy **Analytical Skills** Centrifugation, Chromatography and Spectroscopy: Principles, Types, Instrumentation, Operation and applications.	

Course 3: Practical: MBSEC01P,
Microbiological Methods and Analytical Techniques

1. Preparation of different microbiological culture media
2. Isolation and cultivation of bacteria, actinobacteria, fungi and algae
3. Characterization and identification of bacteria, actinobacteria, fungi and algae – colony characters and microscopic characters
4. Biochemical and physiological tests for identification of bacteria
5. Methods and practices in microbiology lab: MSDS (Material Safety Data Sheet), Good clinical Practices (GCP), Standard Operating Procedure (SOP), Good Laboratory Practices (GLP), Good Manufacturing Practices**.**
6. Usage and maintenance of basic equipment of microbiology lab: Principles, calibrations, and SOPs of balances (Types), pH meter (Types), Autoclaves (Types), Laminar flows and biosafety cabinets, basic Microscopes, homogenizers, stirrers.
7. Procedures for documentation, lab maintenance, repair reporting
8. Separation of mixtures of biomolecules by paper / thin layer chromatography.
9. Demonstration of column packing in column chromatography.

Pedagogy:

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Active learning as per LSSSDC (NSDC) LFS/Q0509 guidelines, at skill training Level 3. Case studies about application of microbial biomolecules in various industries. Seminar on topics of microbial biochemistry

BSc Microbiology (Basic /Hons.)

Semester 2

Title of the Courses:

Course 1: MBDSC02, Microbial Biochemistry and Physiology
Course 2: MBOEC02, Environmental and Sanitary Microbiology

Course 1: MBDSC02, Microbial Biochemistry and Physiology		Course 2: MBOEC02, Environmental and Sanitary Microbiology	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**

Content of Course: MBDSC02, Microbial Biochemistry and Physiology	**56 Hrs**
Unit - 1 Biochemical Concepts	14Hrs
Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic bonds and molecules – bonding properties of carbon, chemical bonds- covalent and non covalent, Hydrogen bonds and Vander Waal Forces. Biological Solvents: Structure and properties of water molecule, Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system, Handerson – Hasselbatch equation.	
Unit - 2 Macromolecules – Types, Structure and Properties	14Hrs
Carbohydrates: Definition, classification, structure and properties. Amino acids and proteins: Definition, structure, classification and properties of amino acids, Structure and classification of proteins. Lipids and Fats: Definition, classification, structure, properties and importance of lipids. Porphyrins and Vitamins: Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin.	
Unit – 3 Microbial Physiology	14Hrs
Microbial Growth: Definition of growth, Mathematical expression, Growth curve, phases of growth, calculation of generation time and specific growth rate. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth. Measurement of Growth: Direct Microscopic count - Haemocytometer; Viable count, Membrane filtration; Electronic Counting; Measurement of cell mass;Turbidity measurements-Nephelometer and spectrophotometer techniques;Measurements of cell constituents. Growth Yield (definition of terms). Influence of environmental factors on growth. Microbial growth in natural environments. viable non-culturable organisms. Quorum sensing. Microbial Nutrition: Microbial nutrients, Classification of organisms based on carbon source, energy source and electron source, Macro and micronutrients. Membrane Transport: Structure and organization of biological membranes, Types of Cellular transport, Passive, Facilitated, Active, Group Translocation, Membrane bound and binding protein transport system, Carrier models, Liposomes, Ion transduction Na K^+, ATPase.	

Unit – 4: Microbial Physiology- Bioenergetics, Microbial Respiration,Microbial Photosynthesis	14Hrs
Bioenergetics: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Law of thermodynamics. Microbial Respiration:Respiratory electron transport chain in bacteria, oxidation – reduction reactions, protein translocation, oxidative and substrate level phosphorylation – inhibitors and mechanism, chemiosmotic coupling. Fermentation reactions (homo and hetero) Microbial Photosynthesis: Light reaction:Light harvesting pigments Photophosphorylation, CO_2 fixation pathways: Calvin cycle, CODH pathway, Reductive TCA pathway.	

Course 1: Practical: MBDSC02P, Microbial Biochemistry and Physiology

1. Preparation of Solution: Normal and Molar solutions
2. Calibration of pH meter and determination of pH of natural samples
3. Preparation of Buffer Solutions
4. Qualitative determination and identification of Carbohydrates
5. Qualitative determination and identification of Proteins
6. Qualitative determination and identification of Amino Acids
7. Qualitative determination and identification of Fatty Acids
8. Quantitative estimation of Reducing Sugur by DNS method
9. Quantitative estimation of Proteins by Biuret and Lowry's method
10. Determination of lipid saponification values of fats and iodine number of fatty acids
11. Determination of bacterial growth by spectrophotometric method & calculation of generation time
12. Effect of pH, temperature and Salt concentration on bacterial growth
13. Effect of Salt concentration on bacterial growth
14. Effect of Temperature on bacterial growth
15. Demonstration of aerobic and anaerobic respiration in microbes

Text Books / References

1. Felix Franks, 1993; Protein Biotechnology, Humana Press, New Jersey.
2. Stryer L, 1995; Biochemistry, Freeman and Company, New York.
3. Voet & Voet, 1995; Biochemistry, John Wiley and Sons, New York.
4. Nelson and Cox, 2000; Lehninger Principles of Biochemistry, Elsevier Publ.
5. Harper, 1999; Biochemistry, McGraw Hill, New York.
6. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry, Harwood Publication, Chichester.
7. Boyer R. (2002), Concepts in Biochemistry 2nd Edition, Brook/ Cole, Australia.
8. Moat A. G., Foster J.W. Spector. (2004), Microbial Physiology 4th Edition Panama Book Distributors.
9. Caldwell, D. R. (1995) – Microbial Physiology and Metabolism. Brown Publishers.
10. Lodish H, T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and J. Darnell. (2004) – Molecular Cell Biology, Scientific American Books, Inc. Newyork.

Course 2: Theory: MBOEC02, Environmental and Sanitary Microbiology

Course 2 :Theory: MBOEC02, Environmental and Sanitary Microbiology	**42 Hrs**
Unit – 1: Soil and Air Microbiology	14 Hrs
Soil and Air as a major component of environment. Types, properties and uses of soil and air. Distribution of microorganisms in soil and air. Major types of beneficial microorganisms in soil. Major types of harmful microorganisms in soil	
Unit – 2: Water Microbiology	14 Hrs
Water as a major component of environment. Types, properties and uses of water. Microorganisms of different water bodies. Standard qualities of drinking water	
Unit – 3: Sanitary Microbiology	14 Hrs
Public health hygiene and communicable diseases. Survey and surveillance of microbial infections. Airborne microbial infections, waterborne microbial infections, Food borne microbial infections. Epidemiology of microbial infections, their detection and control.	

Text Books / References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
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6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
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Pedagogy :

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