



C. U. SHAH UNIVERSITY

Generic Elective (GE) subject pool Biotechnology

ENTREPRENEURSHIP DEVELOPMENT

Sr. No.	Course contents	Teaching Hours
1	INTRODUCTION: Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.	10
2	ESTABLISHING AN ENTERPRISE: Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.	12
3	FINANCING THE ENTERPRISE: Importance of finance/loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.	15
4	MARKETING MANAGEMENT: Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.	13
5	ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS: Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.	10
Total Hours		60

Project Report on a selected product should be prepared and submitted.

SUGGESTED READING

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons



C. U. SHAH UNIVERSITY

BIOTECHNOLOGY AND HUMAN WELFARE

Sr. No .	Course contents	Teaching Hours
1	Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.	10
2	Agriculture: N ₂ fixation; transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.	10
3	Environments: e.g. chlorinated and non-chlorinated organic pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.	15
4	Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.	12
5	Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in <i>E. coli</i> , human genome project.	13
Total Hours		60

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

S.No	Experiment
1	Performance of ethanolic fermentation using Baker's yeast
2	Study of a plant part infected with a microbe
3	To perform quantitative estimation of residual chlorine in water samples
4	Isolation and analysis of DNA from minimal available biological samples
5	Case studies on Bioethics (any two)

Suggested Readings

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers



C. U. SHAH UNIVERSITY

MICROBIAL METABOLISM (THEORY) SEMESTER-III

Sr. No.		Teaching Hours
1	Microbial Growth and Effect of Environment on Microbial Growth: Definitions of growth, Batchculture, Continuousculture, generation time and specific growth rate, effect of Temperature and pH. Effect of oxygen concentration on growth Nutritional categories of microorganisms	12
2	Nutrient uptake and Transport: Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Grouptranslocation, Ironuptake	10
3	Chemoheterotrophic Metabolism-AerobicRespiration: Conceptofaerobicrespiration, anaerobicrespirationand fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway Electron transport chain: componentsofrespiratorychain, comparisonofmitochondrialandbacterial ETC, electron transportphosphorylation. TCAcycle,	16
4	Chemoheterotrophic Metabolism-Anaerobicrespirationandfermentation: Anaerobicrespirationwithspecialreferencetodissimilatorynitratereduction (Denitrification; nitrate/nitriteandnitrate/ammoniarespiration; fermentativenitratereduction) Fermentation- AlcoholfermentationandPasteureffect; Lactatefermentation(homofermentativeand heterofermentativepathways), conceptoflinearandbranched fermentationpathways	6
5	Chemolithotrophic andPhototrophicMetabolism: Introductiontoaerobicandanaerobicchemolithotrophywithanexampleeach. Hydrogenoxidationn (definitionandreaction) and methanogenesis (definitionandreaction) Introductiontophototrophicmetabolism-groupsofphototrophicmicroorganisms, anoxygenicvs. oxygenicphotosynthesiswithreferencetophotosynthesisingreenbacteria andcyanobacteria	10
6	NitrogenMetabolism-anoverview IntroductiontobiologicalnitrogenfixationAmmoniaassimilationAssimilatorynitratereduction	6
Total Hours		60



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MICROBIAL METABOLISM (PRACTICAL) SEMESTER–III

S.No	Experiment
1	Study and plot the growth curve of <i>E. coli</i> by turbidimetric and standard plate count methods
2	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3	Effect of temperature on growth of <i>E. coli</i>
4	Effect of pH on growth of <i>E. coli</i>
5	Effect of Nitrogen and Carbon sources on <i>E. Coli</i>
6	Effect of salt on growth of <i>E. coli</i>
7	Demonstration of alcoholic fermentation
8	Demonstration of the thermal death time and decimal reduction time of <i>E. coli</i> .

SUGGESTED READINGS

1. **Madigan MT, and Martinko JM** (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. **Moat AG and Foster JW**. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. **Reddy SR and Reddy SM**. (2005). Microbial Physiology. Scientific Publishers India
4. **Gottschalk G**. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. **Stanier RY, Ingraham JI, Wheelis ML and Painter PR**. (1987). General Microbiology. 5th edition, McMillan Press.
6. **Wiley JM, Sherwood LM, and Woolverton CJ**. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.



C. U. SHAH UNIVERSITY

MICROBES IN ENVIRONMENT (THEORY) SEMESTER-IV

Sr. No.	Course contents	Teaching Hours
1	Microorganisms and their Habitats: Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, High hydrostatic & osmotic pressures, salinity and low nutrient levels.	14
2	Microbial Interactions: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagous fungi and symbiotic luminescent bacteria	12
3	Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, de-nitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese	12
4	Waste Management: Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment	12
5	Microbial Bioremediation: Principles and degradation of common pesticides, hydrocarbons (oil spills).	5
6	Water Potability: Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests	5
Total Hours		60



C. U. SHAH UNIVERSITY

MICROBES IN ENVIRONMENT (PRACTICAL) SEMESTER-IV

S.No	Experiment
1	Analysis of soil-pH, moisture content, water holding capacity, percolation, capillary action.
2	Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3	Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4	Assessment of microbiological quality of water.
5	Determination of BOD of wastewater sample.
6	Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7	Isolation of <i>Rhizobium</i> from root nodules.

SUGGESTED READINGS

1. **Atlas RM and Bartha R.** (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. **Madigan MT, Martinko JM and Parker J.** (2014). Brock Biology of Microorganisms. 14th edition. Pearson/Benjamin Cummings
3. **Maier RM, Pepper IL and Gerba CP.** (2009). Environmental Microbiology. 2nd edition, Academic Press
4. **Okafor, N.** (2011). Environmental Microbiology of Aquatic & Waste Systems. 1st edition, Springer, New York
5. **Singh A, Kuhad, RC & Ward OP.** (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg
6. **Barton LL & Northup DE.** (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. **Campbell RE.** (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. **Coyne MS.** (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. **Lynch JM & Hobbie JE.** (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
10. **Martin A.** (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
11. **Stolp H.** (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
12. **Subba Rao NS.** (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
13. **Wiley JM, Sherwood LM, and Woolverton CJ.** (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.



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13. **Atlas RM and Bartha R.** (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
14. **Madigan MT, Martinko JM and Parker J.** (2014). Brock Biology of Microorganisms. 14th edition. Pearson/Benjamin Cummings
15. **Maier RM, Pepper IL and Gerba CP.** (2009). Environmental Microbiology. 2nd edition, Academic Press
16. **Okafor, N** (2011). Environmental Microbiology of Aquatic & Waste Systems. 1st edition, Springer, New York
17. **Singh A, Kuhad, RC & Ward OP** (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg
18. **Barton LL & Northup DE** (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
19. **Campbell RE.** (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
19. **Coyne MS.** (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
20. **Lynch JM & Hobbie JE.** (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
21. **Martin A.** (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
22. **Stolp H.** (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
23. **Subba Rao NS.** (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
24. **Wiley JM, Sherwood LM, and Woolverton CJ.** (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.



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MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY) SEMESTER-IV

Sr. No.	Course contents	Teaching Hours
1	Normal microflora of the human body and host pathogen interaction: Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions-Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection,	10
2	Sample collection, transport and diagnosis: Collection, transport and culturing of clinical samples and their identification characteristics.	5
3	Bacterial diseases: List of diseases of various organ systems and their causative agents. Viral diseases : List of diseases of various organ systems and their causative agents. Protozoan diseases: List of diseases of various organ systems and their causative agents. Fungal diseases : Brief description of various types of mycoses.	10
4	Antimicrobial agents: General characteristics and mode of action: Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.	10
5	Immune Cells and Organs : Structure, Functions and Properties of: Immune Cells—Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs—Bone Marrow, Thymus, Lymph Node, Spleen	10
6	Antigens and Antibodies: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies. Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT.	15
Total Hours		60



C. U. SHAH UNIVERSITY

MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL) SEMESTER-V

S.No	Experiment
1	Identify bacteria on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2	Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3	Study of bacterial flora of skin by swab method
4	Performantibacterial sensitivity by Kirby-Bauer method
5	Identification of human blood groups.
6	To perform Total Leukocyte Count of the given blood sample.
7	To perform Differential Leukocyte Count of the given blood sample.
8	To separate serum from the blood sample (demonstration).
9	To perform immunodiffusion by Ouchterlony method.

SUGGESTED READING

1. **Ananthanarayan R. and Paniker C.K.J.** (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. **Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A.** (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. **Goering R., Dockrell H., Zuckerman M. and Wakelin D.** (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. **Willey J.M., Sherwood L.M. and Woolverton C.J.** (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. **Abbas A.K., Lichtman A.H., Pillai S.** (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
6. **Delves P., Martin S., Burton D., Roitt I.M.** (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
7. **Goldsby R.A., Kindt T.J., Osborne B.A.** (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. **Richard C. and Geffrey S.** (2009). Immunology. 6th edition. Wiley Blackwell Publication.



C. U. SHAH UNIVERSITY

GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY) SEMESTER–VI

Sr. No.	Course contents	Teaching Hours
1	Introduction to genetic engineering : Milestones in genetic engineering and biotechnology, Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering, DNA modifying enzymes and their applications: DNA polymerases, Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases, Cloning: Use of linkers and adaptors, Transformation of DNA: Chemical method, Electroporation, Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern- and Northern- blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.	16
2	Vectors: Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs, Expression vectors: <i>E. coli</i> lac and T7 promoter-based vectors, yeast YIp, YE and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors	16
3	DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR, Genomic and cDNA libraries: Preparation and uses, Genome sequencing, Sanger's method of DNA Sequencing: traditional and automated sequencing	10
4	Application of Genetic Engineering and Biotechnology : Gene delivery: Microinjection, electroporation, biolistic method (genegun), liposome and viral-mediated delivery, <i>Agrobacterium</i> -mediated delivery, Products of recombinant DNA technology: Products of human therapeutic interest- insulin, hGH, antisense molecules. Bt transgenic- cotton, brinjal, flavo-savtomato, Gene therapy, recombinant vaccine, protein engineering	14
5	Intellectual Property Rights: Patents, Copyrights, Trademarks	4
Total Hours		60



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GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL) SEMESTER–VI

S.No	Experiment
1	Isolation of Plasmid DNA from <i>E. coli</i>
2	Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3	Ligation of DNA fragments
4	Interpretation of sequencing gel electropherograms
5	Designing of primers for DNA amplification
6	Amplification of DNA by PCR
7	Demonstration of Southern blotting

SUGGESTED READING

1. **Brown TA.** (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. **Clark DP and Pasternik NJ.** (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. **Primrose SB and Twyman RM.** (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. **Sambrook J and Russell D.** (2001). Molecular Cloning- A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. **Wiley JM, Sherwood LM and Woolverton CJ.** (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education
6. **Brown TA.** (2007). Genomes-3. Garland Science Publishers
7. **Primrose SB and Twyman RM.** (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.



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DEVELOPMENTAL BIOLOGY

Sr. No.	Course contents	Teaching Hours
1	Gametogenesis and Fertilization: Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.	10
2	Early embryonic development Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.	20
3	Embryonic Differentiation (Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens	20
4	Organogenesis Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extraembryonic membranes, placenta in Mammals.	10
Total Hours		60

PRACTICALS

S.No	Experiment
1	Identification of developmental stages of chick and frog embryo using permanent mounts
2	Preparation of a temporary stained mount of chick embryo
3	Study of developmental stages of <i>Anopheles</i> .
4	Study of the developmental stages of <i>Drosophila</i> from stock culture/ photographs.
5	Study of different types of placenta.

SUGGESTED READING

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.