

## UNIVERSITY OF PUNE

### SYLLABUS: Vocational biotechnology

#### Objectives of the course :

- 1) To give the exposure to the student as to be self employed
- 2) To develop skills to handle instruments and entrepreneurship development
- 3) To train the student in various techniques related to Agricultural ,Environmental,industrial and medical biotechnology.

#### Course Structure

Paper Total	Year	Semester/ Term	Name of the paper	Subject Code	Lecture(Lecture/Subject)	Total Lecture
1	FY	Paper I	Biochemistry and Microbiology	Voc biotech 101	48L + 48L	96L
2	FY	Paper II	Biophysics,Instrumentation and Mathamatics,statistics,computers for biologist	Voc biotech 102	48L + 48L	96L
3	FY	Annual	Practicals based on theory paper and key competency course	Voc biotech 103	39 Practicals	
4	SY	Sem I Paper I	Cell and Molecular biology, Microbial genetics	Voc biotech 211	48L	48L
5	SY	Sem I Paper II	Recombinant DNA Technology	Voc biotech 212	48L	48L
6	SY	Sem II Paper I	Plant tissue culture and Animal tissue culture	Voc biotech 221	48L	48L
7	SY	Sem II Paper II	Immunology and Medical Microbiology	Voc biotech 222	48L	48L
8	SY	Annual	Practicals based on theory paper and key competency course	Voc biotech 203	31 Practicals	
9	TY	Sem III Paper I	Plant and Animal Biotechnology	Voc biotech 335	48L	48L
10	TY	Sem III Paper II	Microbial Biotechnology and Fermantation	Voc biotech336	48L	48L
11	TY	Sem IV Paper I	Environmental Biotechnology and Bioinformatics	Voc biotech 345	48L	48L
12	TY	Sem IV Paper II	Entrepreneurship Development	Voc biotech 346	48L	48L
13	TY	Annual	Practicals based on theory paper and key competency course	Voc biotech 349	30 Practicals +	

## **PROPOSED SYLLBUS**

**Subject Title: VOCATIONAL BIOTECHNOLOGY**

**Class: F. Y. B. Sc.**

**Paper-I: ): voc- biotech 101**

**Biochemistry and Microbiology (Theory)**

**Paper-1: Section I: Biochemistry : (48-L)**

**Unit-1 Introduction to Biochemistry: (01)**

History and development of subject, cell and organism and biochemical entities

**Unit-2 Properties of water : (01)**

Polarity, Hydrogen bond formation, Heat of vaporization, Heat of fusion, melting point, boiling point.

**Unit-3 Carbohydrates : (08)**

Defination, classification, properties of carbohydrates, monosaccharides, disaccharides, and polysaccharide and their functions.

**Unit-4 Amino acids and proteins: (08)**

Defination ,properties and classification of amino acids. Defination, physical and chemical properties of proteins, structure of protein, Classification of proteins based on their functions. Role of proteins.

**Unit –5 Lipids : (05)**

Defination, Classification, properties , functions of lipids, Behaviour of lipids in water, bile salts bile acids and plasma lipoproteins

**Unit-6 Enzymes : (08)**

Defination, classification, properties, Lock and key hypothesis ,factors affecting activity of enzymes ,Kinetics, role of enzymes in industry,

Coenzymes and role in biological systems.  
Isoenzymes and their role.

### **Unit-7 Nucleic acids : (02)**

Definition, components of nucleic acids, structure of DNA and RNA, forms of DNA (A,B,C,D,E,Z)  
Biological functions.

### **Unit –8 Introduction to metabolism : (02)**

Concept of free energy, energy rich compounds,  
free energy and oxidation reduction reactions.

### **Unit-9 metabolic pathways : (13)**

Glycolysis and pentose phosphate pathway, Regulation  
of glycolysis, TCA cycle,  $\beta$ -Oxidation of fatty acids, proteolysis(aerobic & anaerobic)

### **List of reference books:**

- 1) Principles of Biochemistry by Nelson and Cox
- 2) Outlines of biochemistry, Conn, Stumph, Bruening, Doi by Wiley  
international publication.
- 3) **Biochemistry by Harper**

### **Paper-1: Section II: Microbiology (48L)**

#### **Unit-1 Introduction to Microbial World (10-L)**

- i. Biocomplexity of Microorganisms.
- ii. Historical Account – Important developments leading to major discoveries. Path breaking discoveries. Product Development (18th – 20th Century including pregolden, golden and post golden era)

**Unit-2 Outline Classification ( 10-L)** of all 5 major groups of Microorganisms Procaryotic and Eukaryotic Bacteria, Fungi, **Algae,cynobacteria** and viruses.  
(Life cycle, Nutrition and Growth)

#### **Unit-3 Microscopy: ( 5-L)**

- i. Wet mount and dry mount.
- ii. Staining Techniques :Definations ,Classifications of stains(Basic ,Acidic ,Neutral ), Fixative ,Mordant,Decolouriser ,Accentuator ,
- iii. Pricipals of Staining Techniques for following : Theory of staining –  
A)Simple staining ( Monochrome, Negative)

- B) Differential (Gram ,Acid fast ,Blood staining )  
C) Special staining( spore,Flagella ,Cell wall, Nucliec Acid ,Capsule)

#### **Unit-4 Enrichment culture techniques (08)**

Extremophiles- Thermophiles, Acidophiles,  
Algae, Fungi, Blue green algae-  
(Phosphate solubalising organisms, Rhizobium,  
Azotobacter)  
Colliforms (MPN/Presumptive)  
Screening of antibiotic producer by crowded plate

#### **Unit-5 Culturing of microorganisms. (06)**

Preparation of media, Nutritional classification, Types  
of media, Different components of media, Simple media,  
enrichment media, selective media, differential media  
NA, PDA, BAP, MAC, SS)  
Cultivation In Vitro : (Streak plate ,pour plate method)  
Concept of pure culture,Co-culture and Mix Culture ,Colony characteristics and biofilm formation &  
quorum sensing  
Cell Enumeration and quantification of growth- Direct Microscopic count , haemocytometer  
,turbidity. Vial count- spread plate and pour plate method.

#### **Unit –6 Sterilization and disinfection (04)**

Physical agents, Chemical agents (Aldehydes ,Helogens ,Quaternary ammonium compounds, Heavy  
metals, alcohol,dyes,detergents, ethylene oxide) ,Radiation and their mode of action

#### **Unit-7 Symbiosis (02)**

Commensalism, amensalism, Mutuslism, Co-operation,  
Syntropism, antagonism, predation, infection.

#### **Unit-8 Viruses (03)**

Structure of viruses, Classification,cultivation with representative example.

#### **List of reference books:**

1. Ingraham J. L. and Ingraham C.A. (2004). Introduction to Microbiology. 3<sup>rd</sup> Edition. Thomson Brooks / Cole.
2. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11<sup>th</sup> Edition. Pearson Education Inc.
3. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8<sup>th</sup> Edition. Pearson Education Inc
4. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5<sup>th</sup> Edition. Macmillan Press Ltd.
- 5) Biswas and Biswas "Introduction to viruses."

**Paper II : voc -bio tech 102**

**Biophysics and instrumentation , Mathematics, statistics and computer for Biologists: (Theory):**

**Paper II : Section I : Biophysics and instrumentation: 48L**

**Unit -1** Introduction to Biophysics (02)

**Unit -2** Chromatographic techniques (08)

- 1) Adsorption techniques- ( thin layer and column chromatographic )
- 2) Partition chromatography ( Paper ,gas chromatography )
- 3) Ion exchange chromatography
- 4) Affinity chromatography
- 5) Gel filtration chromatography

**Unit –3** Spectrophotometry (12)

- 1) uv and visible spectrophotometry - With Basics
- 2) Infra-red spectrophotometry
- 3) Nephelometry
- 4) Turbidometry

**Unit-4** Centrifugation (06)

- 1) Theory ,
- 2) Preparative and zonal centrifugation – density gradient
- 3) Tubular and disc bowl centrifugation
- 4) Analytical centrifugation

**Unit –5** Microscopy (04)

- 1) Introduction to microscopy
- 2) Compound microscopy
- 3) Dark field, phase contrast microscopy,

- 4) Fluorescence microscopy
- 4) SEM and TEM.

**Unit –6 Radioisotopic techniques (05)**

Radioisotopes in biology and their applications, detection & estimation of radioactivity (Geiger-Muller counter, Solid and liquid scintillation counters)

**Unit - 7 Miscellaneous methods (02)**

- 1) pH and Eh measurements
- 2) Conductivity measurements
- 3) Filtration as a lab tool -Ultrafiltration

**Unit-4 Electrophoretic Technique(04)**

- 1) factor affecting electrophoretic mobility
- 2) SDS-PAGE, Paper electrophoresis, agarose gel electrophoresis

**List of reference books:**

- 1) Wilson Keith and Kenneth H. Goulding (1994) principles of techniques of practical biochemistry. 4TH Edn. Cambridge University Press, London.
- 2) Biophysical chemistry principals and techniques by Upadhyay & Nath
- 2) Khandpur R.S. (1989) Handbook of Analytical Instruments Tmh Pub Co. Ltd. New

**Paper2 : Section II : Mathematics, statistics and computer for Biologists:**

**1) Mathematics: (20-L):**

**Unit -1** Concept of differentiation and integration

**Unit-2** Concepts of scales and variables

**Unit -3** Sequence and series

**Unit -4** Limits and derivatives

**Unit-4** Trigonometric functions

**Unit -5** Permutations and combinations

## 2) Statistics: (20-L) :

### Unit-1

Descriptive statistics

### Unit -2

Frequency distribution- Introduction to normal, binomial and poisson distribution.  
Test for goodness of fit.

### Unit-3

Comparison of two sample means, T-Tests, nonparametric tests,

### Unit-4

Regression and correlation

**Unit-5** Experimental design and sampling

## 3) Computers (08)

**Unit -1:** General introduction to computers, organization of computers, digital and analogue,

Programming.

**Unit -2:** Applications of computers in industry.

**Unit -3:** Introduction of internet and accessing databases.

### List of reference books:

- 1) Wardlaw A.C. Practical statistics for experimental biologists.
- 2) Cochran W.G. and G.W. Snedeco statistical methods –Sixth Ed.

## F.Y.B.Sc. Paper-III: Practical Course voc -biotech 103

**Based on theory papers and key competency course**

**Practicals based on Paper-1, section I: Biochemistry**

- 1) Qualitative tests for carbohydrates-1X3H
- 2) Quantitative estimation of reducing sugars from a given  
Sample-1X3H

3) Quantitative estimation of carbohydrates by using anthrone reagent -1X3H

4) Quantitative estimation of proteins by using Folin Lowry method-1X3H

5) Quantitative estimation of proteins by using Biurate method -1X3H

6) Quantitative estimation of DNA using Diphenyl amine reagent-1X3H

7) Quantitative estimation of RNA using Orcinol reagent-1X3H

8) Paper / TLC chromatographic technique for amino acids.-2X3H

9) TLC of chlorophyll pigments-1X3H

10) TLC of sugars-1X3H

11) Assay of Amylase enzyme-1X3H

12) Column chromatography(Gel filtration)-1X3H

### **Practicals based on Paper-I, section II : Microbiology**

1. Cleaning of glassware ,Preparation of media, cotton plugging & sterilization -1X3H
2. Monochrome & Gram staining.2X3H
3. Capsule and Spore staining-2X3H
4. Isolation of micro organisms by Streak Plate method,pour plate method,spread plate method,cell count by Neubauer's chamber and study of colony characteristics- 2X3H
- 5.
6. Isolation of bacteria from food sample by pour plate method-3X3H
7. Enrichment & Isolation of Rhizobium from root nodule-2X3H

8. Enrichment & Isolation of Azotobacter from soil using Ashby's mannitol agar-2X3H
9. Isolation of antibiotic producers using Crowded plate method-2X3H
10. Potability Test for water. Presumptive, Confirmed, Completed.IMViC & Eijkman tests-3X3H
11. Enrichment of different organisms using Winogradsky's column-2X3H
12. Observation of bacterial motility – Hanging drop, Cragie tube, Swarming growth-2X3H
13. Growth curve-2X3H

**Practicals based on Paper-II, section I: Biophysics and instrumentation**

- 1) Determination of molar extinction coefficient using colorimeter, visible spectrometer -1X3H
- 2) Estimation of PH, Eh and conductivity of natural and commercial preparations-1X3H
- 3) Determination of dry weight, total solids and moisture content by gravimetric method -1X3H
- 4) Demonstration of instruments : 1X3H

Ultracentrifuge

SEM

TEM

Gas chromatography

IR spectroscopy

- 5) SDS-PAGE-1X3H

**Practicals based on Paper-II, section II : Mathematics, statistics and computer for**

**Biologists**

- 1) Data entry and statistical analysis using excel -1X3H
- 2) Data sorting -1X3H
- 3) Tabulation -1X3H
- 4) Plotting frequency distribution-1X3H
- 5) T-Test -1X3H
- 6) Regression and correlation-1X3H

Practicals based on Key Competency Course :

- 1) Listening skill component-1X3H
- 2) Reading skill component -1X3H
- 3) Writing skill component-1X3H

**Sem I Paper I voc-biotech 211**

**Cell & molecular biology and Microbial Genetics(Theory)**

**48 L**

**Section I- Cell biology**

- 1) Cell structure & functional organization (5)
- 2) Fractionation of subcellular organelles. (1)
- 3) Membrane structure and membrane transport (3)
- 4) Cell signaling (5)
- 5) Cell differentiation , neoplasia & cell death (5)
- 6) Cell junctions , cell adhesion & ECM (5)

**Molecular biology :**

- 1) structure & organization of Pro-& eukaryotic genome (3)  
Structure & function of chromatin
- 3) Concept of gene (1)
- 4) DNA replication , transcription & translation (8)
- 5) Post translational modification & transport of proteins (2)
- 6) DNA damage & repair (2)

**Section II - Microbial Genetics (10)**

A)Transformation(2)

- Discovery of transformation – Griffith’s experiment
- Detailed Process of transformation in Gram positive (*S. Pneumonia* and *B.subtilis*) and Gram negative bacteria (*H. influenzae*)

B. Transduction(2)

- i. Discovery of transduction – Lederberg and Tatum’s experiment
- ii. Introduction to Generalized and Specialized transduction

C. Conjugation (2)

- i. Discovery of conjugation
- ii.Types of conjugation (F+ ,F-, Hfr)

D. Recombination (2)

- i. Definition of recombination
- ii. Types of recombination
- iii. Homologous recombination (Holliday model)
- iv. Site specific recombination (Lambda phage)

E) Mobile elements (Prokaryotes and Eukaryotes) (2)

**Reference books suggested:**

- 1) Cell and molecular biology by Lodish
- 2) Cell: a molecular. –Bruce Alberts,
- 3) Gene VIII- Benjamin Lewin

- 4) Cell and molecular biology – D Robertis and D. Robertis.
- 5) Lehninger. A.L Principles of Biochemistry 2<sup>nd</sup> edition 1993, CBS Publications

### **Sem I Paper II voc-biotech 212**

#### **rDNA technology (Theory)- 48L**

- 1) Introduction to rDNA technology ,NIH guidelines ,tools in rDNA technology(5)
- 2) Restriction enzymes & DNA modifying enzymes (3)
- 3) Vectors in gene cloning – plasmids , cosmids , phage vectors , shuttle vectors, BAC , YAC (6)
- 4) Transformation & transfection methods for introduction of rDNA into host cells- (5 )
- 5) Screening & selection of transformants – Gene library, southern, northern, western hybridisation radioactive & non radioactive detection procedures (10)
- 6) Site – directed mutagenesis (2)
- 7) PCR (3)
- 8) DNA sequencing methods (4)
- 9) Applications of rDNA technology (4)
- 10) Introduction to Genomics & proteomics(6)

#### **Reference books suggested:**

- 1) Gene cloning and analysis: T.A.Brown
- 2) Principles of gene analysis: Old and primrose
- 3) Genetic engineering-Sandhya Mitra
- 4) Biotechnology-U.Satyanarayana
- 5) Recombinant DNA-Watson
- 6) Biotechnology-Dubey

### **Sem II Paper I voc-biotech 221**

#### **Plant & animal tissue culture (Theory)- 48L**

#### **PTC:**

- 1) Introduction to plant tissue culture :- History, Lab designing, Instruments, Aseptic techniques, advantages of Plant tissue culture. – (4)
- 2) Culture media, Role of growth hormones (2 )
- 3) Stages of Micropropagation (I-VI) – (10)
  - i) Selection of plant
  - ii) Ex-plant preparation
  - iii) Surface sterilization
  - iv) Inoculation and incubation
  - v) Subculturing
  - vi) Hardening

- 4) Callus, cell and protoplast culture (4)
- 5) Application of PTC (2)

**ATC:**

1. Introduction to ATC (1)
2. Culture medium (2)
3. Introduction to stem cells (2)
4. Types of cultures & their applications (9)
5. Cell lines & characterization (7)
6. Separation of cell types (4)
7. Organ culture (3)
8. Organ transplants (2)
9. Cell banks (2)

**Reference books suggested:**

- 1) Plant tissue culture M.K.Razdan
- 2) Plant tissue culture –H.D.Kumar
- 3) Animal tissue culture –Ian Freshney
- 4) Biotechnology by U.Satyanarayan
- 4) Animal tissue culture- John Paul.

**Sem II Paper II voc-biotech 222**

**Immunology and Medical Microbiology (Theory)- 48L**

**Immunology**

- 1) Introduction (1)
- 2) Cell and Organs of immune system, Antigen presentation (4)
- 3) Innate & acquired immunity (2)
- 4) Structure & function of antibody & antigen (6)
- 5) Humoral & cellular immunity (6)
- 6) Hypersensitivity (4)
- 7) Primary & secondary immune response (2)
- 8) Vaccines (2)
- 9) Techniques in immunology , Applications (Widal test , complement fixation test, VDRL test, Weil-Felix test ) (7)
- 10) Autoimmune disease (3)

**Reference books suggested:**

- 1) Immunology by Janus Kuby
- 2) Essentials of Immunology Roit
- 3) Immunology by pathak and Palan
- 4) Text book of Microbiology by Anant narayan

**Medical Microbiology (11)**

1. Study of etiological agents with respect to characterization, morphology, preventive measures and control:
  - A) Intestinal diseases (Typhoid and Polio)
  - B) Respiratory Diseases (TB, Sore throat)

- C) CNS (Meningitis,)
- D) Skin diseases ( wound infection by *Staphylococcus aureus* and *Pseudomonas*), Dermatomycosis
- E) Urinogenital diseases ( syphilis, urinary tract infection)
- f) Viral diseases ( HIV, SARS, H1N1)

**Reference books suggested:**

1. Tortora, G.J., Funke B.R., Case C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub.Co.NY.
2. Text book of Microbiology by Anant narayan fifth edition
3. Microbiology- Dulbecco Davis
4. Medical Microbiology-Dey& Dey

**Annual Practical Paper voc-biotech 203**

**Practical s (31Practicals)**

**Cell, molecular biology and rDNA technology**

- 1) Introduction to microscopy and various staining techniques to stain the various cell parts (4x3H)
- 2) Fractionation of sub cellular organelles (4x3 H)
  - i) Nuclei
  - ii) Chloroplast
  - iii) Mitochondria
  - iv) lysosomes
- 3) Isolation and estimation of chromosomal and plasmid DNA (2x3 H)
- 4) Isolation and estimation of RNA (2x3 H)
- 5) Making host cells as competent cells (2x 3 H)
- 6) Transformation of cells and selection of transformants (2x3 H)
- 7) Restriction digestion of chromosomal and plasmid DNAs (2x3 H)
- 8) Ligation of DNA with ligase enzyme(2x3 H)
- 9) Amplification of DNA with PCR (1x3 H)

**Plant tissue culture**

- 1) Methods of dry and wet sterilization of apparatus and glasswares for plant tissue culture(1X3H)
- 2) Working and principles of different instruments like autoclave, laminar air flow, pH meter, water distillation unit(1X3H)
- 3) Preparation of nutrient media for plant tissue culture with emphasis on composition and calculation of concentration of ingredients(1X3 H)
- 4) Initiation of callus culture(2X3 H)

**Immunology**

- 1) Raising of polyclonal antibodies (2x3 H)
- 2) Determination of blood group (1x3 H)
- 2) Radial immunodiffusion (1x3 H)
- 3) ELISA technique (2x3 H)