St. Xavier's College (Autonomous),

Mumbai


# Syllabus of the courses offered by the Department of Life Science and Biochemistry (2019-20)


# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 1st Semester Courses in
# LIFE SCIENCE
(June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:


| | |
|---|---|
| SLSC101 | Fundamentals of Biochemistry and Analytical Techniques |
| SLSC102 | Genetics and Evolution |


Template for theory and practical question paper

# LIFE SCIENCE

**F.Y.B.Sc.** **Course No.: SLSC101**

**Title: Fundamentals of Biochemistry and Analytical Techniques**

**Learning Objectives:**

The course aims to:

- Introduce the students to fundamental chemical processes and interactions that prevail in living systems
- Familiarize the students with biological molecules that are crucial for the maintenance of structure/function in an organism
- Introduce the students to the tools that may be used in the study of biomolecules and cells

**Number of lectures: 45**

**UNIT I** **(15 lectures)**

1. Types of Bonds: Covalent And Non-Covalent **(1)**
2. Physiological Role of Water: **(4)**
   a. Structure of water
   b. Dissociation and Ionic Product
   c. Ionic interaction with water
   d. Concept of pH and Buffers
   e. Buffering Systems in a living cell
3. Carbohydrates: **(5)**
   a. Classification & structure of Carbohydrates.
   b. Monosaccharides: i. Aldose & Ketose (one example each)
      ii. C3 to C6 (one example each)
   c. Disacharides: Maltose, Cellobiose, Lactose & Sucrose
   d. Polysaccharides: Starch, Glycogen & Cellulose
   e. Properties & Reactions of Glucose & Fructose:
      i. Isomerism
      ii. Oxidation & Reduction
      iii. Esterification
      iv. Glycoside formation.
4. Lipids: **(5)**
   a. Bloor‟s classification of lipids
   b. Simple lipids (one example each).
   c. Complex lipids (one example each)
   d. Derived lipids (one example each)
   e. Fatty acids: Types, nomenclature & properties (upto C18)

**UNIT II** **(15 lectures)**

1. Amino acids and Proteins: **(7)**
   a. Classification and Structure of Amino acids, and concept of iso-electric pH
   b. Chemical reaction with acid/alkali, Ninhydrin, Sanger‟s reaction
   c. Classification of Proteins based on function & shape
   d. Protein Structure: Primary structure and the concept of 'N' and 'C' terminal, peptide bond formation, characteristics of peptide bond, secondary structures: α helix & β sheets, tertiary & quaternary structure

2. Nucleic Acids: **(8)**
   a. Structure of nucleosides and nucleotides
   b. Structure of a poly nucleotide
   c. Forms of DNA: 'A', 'B' and 'Z'
   d. Types of RNA: mRNA, tRNA, rRNA, snRNAs
   e. Differences between DNA and RNA

**UNIT III** **(15 lectures)**

1. Separation of organelles: **(2)**
   a. Differential centrifugation
   b. Density gradient centrifugation
2. Separation of Macromolecules: **(6)**
   a. Salting in and Salting out
   b. Paper chromatography
   c. Thin layer chromatography
   d. Electrophoresis
3. Colorimetry: **(2)**
   a. Beer Lambert‟s law & principle of a colorimeter
4. Microscopy: **(5)**
   a. Principle of Light Microscopy
   b. Introduction to Electron microscopy: SEM, TEM, Fluorescence microscopy and Confocal Microscopy

**References:**

1. Biochemistry (2006), U. Satyanarayan, Allied Publishers
2. Textbook of Biochemistry, 3rd Ed.( 1961), E.S. West and W. Todd, Mcmillan, NY
3. Harper‟s Physiological Chemistry 22nd Ed.(2) ,
4. Biochemistry, A.C. Deb, Books and Allied Publ.
5. Outlines of Biochemistry 5th Ed., E.E. Conn, P.K. Stumpf, Wiley Publishers

## LIFE SCIENCE

**F.Y.B.Sc.:** **Course No.: SLSC102**

**Title: Genetics and Evolution**

**Learning Objectives:**

On successful completion of this module it is expected that students will be able to:

1. Articulate Mendel‟s "laws" and explain the evidence for it.
2. Define, differentiate, and utilize terminology associated with Mendelian genetics.
3. Utilize Punnett square, forked line, and probabilistic methods of calculating expected ratios of offspring.
4. Construct and analyze pedigrees to determine patterns of inheritance, genotypes, and probabilities.
5. Understand that not all genetic traits are inherited in Mendelian fashion.
6. Explain how life might have originated on this planet
7. Describe Darwin's theories and how the principles of natural selection can lead to speciation.

**Number of lectures: 45**

**UNIT I** **(15 Lectures)**

1. Gene as a unit of heredity: Organisation of genes on chromosomes: **(6)**
   a. Structure of a Prokaryotic genome: eg; *E.coli*
   b. Structure of a Eucaryotic genome: packaging of DNA to chromosome
   c. Evidence of DNA as genetic material: Griffith‟s experiment, Avery & Mcleod‟s experiment
2. Mendelian Inheritance: **(8)**

a. Concept of alleles, dominance & recessivity, homozygous, heterozygous, phenotype, genotype

b. Mendel‟s laws: Law of segregation of alleles, Law of Independent Assortment

c. Monohybrid, dihybrid and trihybrid ratios: test cross and self cross, Punnet square and branch diagram for determining ratios of genotypes and phenotypes, chi square analysis for mono-hybrid and di-hybrid ratios

3. Concept of cytoplasmic inheritance **(1)**

**UNIT II** **(15 Lectures)**

1. Extensions of Mendel‟s laws: Incomplete dominance; co-dominance **(10)** multiple genes; Multiple alleles; Lethal alleles; Gene interactions: Epistasis- dominant and recessive; Penetrance and expressivity; Extrinsic factors- temperature, nutrition; Intrinsic factors- Sex (sex limited; sex influenced), age; Pleiotropy
2. Study of human pedigrees: Modes of inheritance: sex-linked dominant & recessive autosomal dominant & recessive **(4)**
3. Concept of Karyotype: The Human Karyotype **(1)**

**Unit III** **(15 Lectures)**

1. Origin of life
   a. Theories of origin of life: Overview of Creation myths/ Divine creation; Spontaneous generation; Cosmozoic hypothesis; Steady state; Biochemical origin. **(2)**

b. Biochemical theories: Origin of macromolecules; Miller‟s experiment; RNA world **(2)**
c. Origin of cells: Protocells; Coacervates; Microspheres; Prokaryotes, Eukaryotes **(3)**

2. Evolution
   a. Pre Darwanian ideas; Darwin‟s theory of natural selection, evidences and objections **(2)**
   b. Evidences for evolution **(2)**
   c. Speciation: Concept of species: Physiological species, Biological species, evolutionary species; Significance of speciation **(2)**
   d. Speciation and macroevolution: Allopatric, sympatric, and parapatric; **(2)**

**References:**


1. "Genetics – A conceptual approach"- Benjamin Pierce 3rd Edition (2008)
2. "Genetics- A molecular approach" Peter Russell 2nd edition, Pearson International(2006)
3. "Principles of Genetics"- Snustad and Simmons, 3rd edition (2003)
4. "Genes VI"- Benjamin Lewin (1997).
5. "Cell Biology, molecular biology, evolution and genetics" Varma and Aggarwal
6. "Concepts of Genetics"- W.S. Klug, M.R. Cummings, C.A.Spencer. 8th edition, Pearson Education International (2006)
7. "Introduction to Genetic Analysis"- A.J. Griffiths, S. R. Wessler, R.C. Lewontin, S.B. Caroll. 9th edition, Freeman and Company (2008)
8. "Molecular Biology of the gene"- J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M.Levine. 5th edition, Pearson Education (2004)
9. "Genetics": The Continuity of Life"- D.J. Fairbanks, W.R. Andersen, Brooks/Cole Publishers (1999)
10. "Strickbergers evolution: the integration of genes, organisms and population, Brian K. Hall, B. Halleirmsson, 4th edition, Jones and Barlett Publishers. (2008)
11. "The World of Biology", Solomon E.P., L.R. Berg, 8th edition, Sanders College publishing(2008)
12. Essential Biology , N. A. Campbell , J.B. Reece, L.A.Umy, M.A. Cain et al, 8th ed, Pearson Benjamin Cummings (2008).

**Practical: SLSC1PR**

1. GLP Lab safety and introduction to common laboratory glassware and instruments
   a. Use of balance
   b. Validation of a glass pipette
2. Concentration and strengths of solutions
   a. Concepts of w/v. v/v, percentage, ppm, ppb, moles/L, molarity, normality, molality
   b. Preparation and verification of solutions of desired strengths
3. Determination of pH of different food samples using pH paper and universal indicator
4. Colorimetric determinations
   a. Verification of Beer's Law using $CoCl_2$
   b. Estimation of proteins using Biuret method
   c. Determination of $\lambda_{max}$ of a colored solution and preparing a calibration curve for it (Perform in triplicate on a table and collate results)
5. Qualitative analysis
   a. Sugars (mono & disaccharides, ketose & aldose, reducing & non-reducing)
   b. Proteins
6. Extraction of genomic DNA from onion and confirmation with diphenylamine (DPA) reaction
7. Karyotype analysis

**Template of Theory Question paper**
**Courses 101 & 102**

**CIA I – 20 marks, 45 mins.**
**Unit I:** Objectives/Short questions, not more than 5 marks each

**CIA II – 20 marks, 45 mins.**
**Unit II:** Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam – 60 marks, 2 hours**
**Question 1**: Unit I: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
**Question 2**: Unit II: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
**Question 3:** Unit III: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks

**Mark-distribution pattern for Practical**
**Course: SLSC1PR**

| **End semester Practical Examination** | **Total marks: 100** |
|---|---|
| Experiments | 70 marks |
| Identification | 20 marks |
| Journal | 10 marks |

# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 2nd Semester Courses in
# LIFE SCIENCE

(June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:

| | |
|---|---|
| SLSC201 | Cell Biology |
| SLSC202 | Fundamentals of Microbiology |

Template for theory and practical question paper

## LIFE SCIENCE

**F.Y.B.Sc.** **Course No. SLSC201**

**Title: Cell Biology**

**Learning Objectives:**

On completion of the course, the student must be able to:

1. Differentiate between prokaryotes and eukaryotes.
2. Students will understand the structures and basic components eukaryotic cells, with respect to membranes and organelles.
3. Describe the function and the composition of the plasma membrane.
4. Understand how the endoplasmic reticulum and Golgi apparatus interact with one another and know with which other organelles they are associated.
5. Understand the structure and function of the mitochondria and chloroplast.
6. Understand the basis and significance of mitosis and meiosis

**Number of lectures: 45**

**UNIT I** **(15 lectures)**

1. Cell as a unit of life**:** Prokaryotes, Eukaryotes (plant, yeast, animal cell) **(1)**
2. Cell membrane**:** **(4)**
    a. Membrane Structure and Function
    b. Chemical composition of membranes
    c. Membrane lipids; Membrane proteins
    d. Functions of membranes: Transport, Cell-cell interactions, Receptors (eg; insulin receptor with link to diabetes)
    e. Membrane Model: Fluid Mosaic Model (Freeze fracture technique)
3. Membrane transport: **(5)**
    a. Active Transport:
        i. Uniport, Symport, Antiport
        ii. Primary, Secondary
    b. Passive Transport:
        i. Simple diffusion
        ii. Facilitated diffusion (Carrier proteins, Channels)
        iii. Osmosis (one example of each type of transport)
    c. Membrane transport associated disease : cystic fibrosis
    d. Bulk transport: endocytosis and exocytosis
4. Membrane junctions **(4)**
    a. Classification of junctions:
        i. Occluding: Tight
        ii. Anchoring: Desmosomes
        iii. Channel- forming: Gap, Plasmodesmata
        iv. Signal- Relaying: Chemical synapse
5. Cell wall: **(1)**
    a. Structure and function of Plant Cell Wall: Primary and secondary wall.

**UNIT II** **(15 lectures)**

1. Ribosomes: **(2)**
    a. Structure and function of Prokaryotic and Eukaryotic ribosomes

2. Endoplasmic Reticulum: **(4)**
    a. RER: structure and role in protein synthesis and glycosylation of proteins Eg. Glycophoprin
    b. SER: structure and function
3. Golgi: **(3)**
    a. Structure, Origin and Relationship with the ER
    b. Role in storage and secretion of glycoproteins
4. Lysosomes And Peroxisomes: **(2)**
    a. Lysosomes : Lysosome cycle, Functions , Tay Sachs disease
    b. Peroxisomes : Structure and Function, Zellweger syndrome
5. Mitochondria: **(2)**
    a. Structure and function
    b. Mitochondria associated disease: LHON and MELAS
6. Plastids: **(2)**
    a. Types of plastids
    b. Structure and function of chloroplast

**UNIT III** **(15 lectures)**

1. Cytoskeletal Elements: **(6)**
    a. Microfilaments:
        i. Structure and function in plant & animal cells (sarcomere structure)
        ii. Microfilament associated disease: DMD
        iii. Microtubules: Structure and role in mitotic spindle & cilia/flagella
        iv. Intermediate filaments: Structure and function
2. Cell cycle and cell division
    a. Cell cycle (G0, G1, G2, M phases) **(2)**
    b. Mitosis and Meiosis and their significance **(3)**
3. Nucleus: **(4)**
    a. Structure of an interphase nucleus: nuclear membrane, nucleolus, nucleosome.
    b. Heterochromatin & Euchromatin
    c. Specialized chromosomes: polytene and lampbrush chromosomes

**References**

1. Molecular Biology of the Cell,5th Ed.(2008) , B.A.Alberts, A. Johnson ., J. Lewis, M. R. K. Roberts, P.Walters, Garland Science Publication
2. Cell and Molecular Biology-concepts and experiments-4th Ed. G.Karp, (2005), John Wiley and Sons Inc.
3. The World of Cell, 5th Ed.(2003), W.M. Becker, L.J. Kleinsmith, J. Hardin, Pearson Education (Singapore)
4. The Cell-A molecular approach, $th Ed.(2007), G.M.Cooper, R.E. Hausman, ASM Press Washington, D.C.
5. Molecular Cell Biology – 6th Ed. (2008) H.Lodish, A. Berk, C.A. Kaiser, M. Krieger, M.P.Scott, A. Bretscher, H. Ploegh, P. Mortsudira, W.H. Freeman and Company, N.Y.
6. Cell Biology (1992) Smith and Wood, Chapman and Hall

## LIFE SCIENCE

**F.Y.B.Sc.** **Course No. SLSC202**

**Title: Fundamentals of Microbiology**

**Learning Objectives:**

On completion of the course, the student must be able to:

1. This course provides a working knowledge of microbes and its special techniques. Students will learn the structure and function of prokaryotic and eukaryotic micoorganisms, as well as viruses.
2. Describe both the nutritional and environmental conditions required for growth by microorganisms
3. Construct bacterial growth curves and explain the specfic phases that occur during bacterial growth.
4. Discuss the physical and chemical mechanisms for controlling microbial populations both in vivo and in vitro.

**Number of lectures: 45**

**UNIT I** **(15 lectures)**

1. Introduction to Microbiology **(3)**
   a. History of microbiology: early Microscope, Spontaneous Generation & Germ Theory
   b. Impact of Microorganisms in industry, agriculture, biotechnology and health.
2. Microbial diversity and Molecular Taxonomy: **(3)**
   a. Prokaryotes, eukaryotes and archaeabacteria
   b. Bacterial phylogeny (based on ribosomal DNA)
3. Prokaryotic cell: Cell shape, size and arrangement **(6)**
   a. bacterial cell wall: Gram positive and gram negative,
   b. capsule, flagella, endospores, nucleoid, plasmid
4. Archaebacteria: Classification, Structure of cell wall and cell membrane, one example of each of: Psychrophiles, Halophiles, Thermophiles and Sulfur bacteria. **(3)**

**UNIT II** **(15 lectures)**

1. Viruses, Viroids and Prions **(6)**
   a. Virus structure: capsid morphology, genetic material ( DNA and RNA viruses),viral envelope, classification of viruses: general features, bacterial (T4), plant (TMV) and animal viruses (Retrovirus)
   b. Life cycle: T4 and lambda phage.
   c. Viroids
   d. Prions e.g., scrapie
2. Fungi **(4)**
   a. Classification
   b. Growth and reproduction: sexual & asexual eg; yeast & neurospora.
3. Algae **(2)**
   a. Classification
   b. Structural Organization
   c. Life cycle of *Chlamydomonas*
   d. Role of Algae in nature

4. Protozoa **(3)**
   a. Classification
   b. Morphological Diversity
   **c.** Life cycle: Parasitic eg; *Entamoeba*, Non-parasitic eg; *Paramoecium*

**UNIT III** **(15 lectures)**

1. Microbial Nutrition: **(6)**
   a. Common nutrient requirements: C, H, $O_2$, N, P, S
   b. Nutritional types
   c. Culture media: simple, complex, differential media, selective media (One eg each)
   d. Anaerobic growth media and methods: thioglycollate medium
   e. Laboratory culture of microorganisms: Concept of pure culture and 'consortium'
   f. Preservation of cultures
2. Microbial growth: **(5)**
   a. Cell growth and Binary fission
   b. Exponential growth: The growth curve, Generation time
   c. Batch and Continuous culture
   d. Factors influencing microbial growth: oxygen, temp., pH, salt
   e. Measurements of Growth
3. Control of Microbial Growth **(4)**
   a. Physical agents: heat sterilization, radiation sterilization, filter sterilization
   b. Chemical agents
   **c.** Antimicrobial agents: Antibiotics (penicillin)

**References**

1. Brock Biology of Microorganisms (12th Edition); Madigan, Martinko, Dunlap & Clark
2. Alcamo's Fundamentals of Microbiology (8th Edition); Jeffrey C. Pommerville
3. Microbiology-an introduction (6th Edition); Tortora, Gerard J.
4. Microbiology (7th Edition) – Prescott, Harley and Klein
5. Principles of Microbiology (2nd edition) – Ronald Atlas
6. Microbiology (7th edition) – Prescot, Harley, Kline

**Practical: SLSC2PR**

1. Microscopy
   a. Know your microscope and wet mount of Hydrilla
   b. Iodine mount of onion cells
   c. Methylene blue staining and observation of cheek epithelial cells
   d. Cytoplasmic streaming in Hydrilla
   e. Observation of different stages of mitosis in onion root tip
   f. Observation of fungi and algae
2. General microbiology lab instructions, biosafety and sterilization techniques
3. Monochrome staining (curd/mouth swab/ skin swab/ soil)
4. Gram staining
5. Cell wall staining
6. Preparation of microbial media
   a. Nutrient broth
   b. Nutrient agar plates
   c. Nutrient agar slants and butts
7. Aseptic techniques
8. Isolation of microorganisms by streak plate technique
9. Determination of MIC of NaCl for microbial cultures

**Template of Theory Question paper**
**Courses SLSC201 & 202**

**CIA I – 20 marks, 45 mins.**
**Unit I:** Objectives/Short questions, not more than 2-3 marks each

**CIA II – 20 marks, 45 mins.**
**Unit II:** Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam – 60 marks, 2 hours**
**Question 1**: Unit I: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
**Question 2**: Unit II: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
**Question 3:** Unit III: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks

**Mark-distribution pattern for Practical**
**Course: SLSC2PR**

| **End semester Practical Examination** | **Total marks: 100** |
|---|---|
| Experiments | 70 marks |
| Identification | 20 marks |
| Journal | 10 marks |

# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 3rd Semester Courses in
# LIFE SCIENCE

(June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:


| | |
|---|---|
| SLSC301 | Comparative Physiology I |
| SLSC302 | Enzymes and Metabolic Pathways |
| SLSC303 | Microbes and Human Health |


Template for theory and practical question paper

# LIFE SCIENCE

**S.Y.B.Sc.** **Course No.: SLSC301**

## Title: Comparative Physiology I

**Learning Objectives:**
The course aims to:

1. Introduce a student to comparative animal physiology
2. Help the learner understand changes in the anatomical design of systems across phyla and the physiological principles that various life forms adopt for survival. The processes under consideration are digestion, excretion, circulation and respiration.

**Number of lectures: 45**

**UNIT I: Nutrition and Digestion** **(15 lectures)**

1. Nutrition and digestion **(7)**
   a. Acquisition of Water, Minerals and Nitrogen from soil by Plants.
   b. Animal nutrition: Macro and micro nutrients, Protein quality measures, (BV, NPU) nitrogen balance, proximate principles, vitamins
   c. Feeding and Digestion:
      i. Evolution of digestive systems
      ii. Modes of feeding
      iii. Digestion - Intra, Extracellular and Symbiotic; digestion of Protein- trypsin, Carbohydrate- amylase and cellulase, Lipids - lipase
      iv. Coprophagy

2. Digestion in humans **(8)**
   a. Overview of the digestive system and accessory glands - salivary, gastric, liver, pancreas
   b. Chemical digestion of carbohydrates, lipids, proteins
   c. Hormonal control of digestion
   d. Mechanical digestion
   e. Absorption of nutrients:
      i. Structure of villus
      ii. Absorption of glucose, amino acids, lipids - formation of chylomicron

3. Assignment: Diseases

**UNIT II: Excretion and Transport** **(15 lectures)**

1. Excretion and Osmoregulation **(4)**
   a. Water and Salt regulation under normal and stressed conditions in plants.
   b. Forms of nitrogenous waste in animals
   c. Types of excretory systems in animals: protonephridia, metanephridia,
   d. malphigian tubules; kidneys – evolution in vertebrates freshwater and marine
   e. fish, amphibians, reptiles, birds, mammals.
   f. Specialized excretory organs – gills, rectal glands, salt glands, liver, intestine
   g. Excretion in humans **(6)**
      i. An overview of the Urinary system [parts and functions]
      ii. Nephron [structure, filtration membrane]

iii. Renal physiology: Glomerular filtration rate, Glomerular filtration pressure and its regulation, tubular re-absorption of $Na^+$, glucose, $H_2O$ ; tubular secretion of $K^+$

2. Transport / Circulation: **(5)**
   a. Transport of: water in xylem – cohesion tension theory; solutes in phloem – Munch hypothesis
   b. Uptake of water by roots – apoplast, symplast, transmembrane pathway; Root Pressure theory
   c. Circulatory system in animals:
      i. Functions and general principles of circulation
      ii. Open and Closed circulatory systems, single and double circulation, neurogenic and myogenic hearts
   d. Comparison of circulatory routes: Systemic, Pulmonary, Portal

3. Assignment: Diseases

**UNIT III: Respiration and Cardiovascular Systems (15 lectures)**

1. Respiration: **(5)**
   a. Physical principles of gas exchange
   b. Respiration in: protozoans, insect, fish, amphibian, bird, mammals; Pneumatophores
   c. Respiratory pigments - Hemocyanin, Hemerythrin, Chlorocruorin, Hemoglobin
   d. Respiratory System in Humans **(5)**
      i. Overview of the respiratory system
      ii. Physiology of Respiration:
         - Pulmonary ventilation
         - Gaseous exchange - external and internal respiration
         - Spirogram of lung volumes and capacities
         - Transport of gases
         - Chloride shift

2. Cardiovascular Systems **(5)**
   a. Functions and components of Blood, Anatomy of the heart, Blood flow and Conduction system
   b. Cardiac muscle contraction, ECG, Cardiac cycle & cardiac output
   c. Dynamics of capillary exchange: Starling's law

3. Assignment: Diseases

**References:**

1. The Science of Biology, 8th Ed: C. Sadava, Heller, Onaris , Purves, Millis
2. Biology – Updated Version: 3rd Ed: Raven P.H.
3. Animal Physiology – Adaptation and Environment; 5th Ed: Knut Schmidt Neilsen
4. Biology; 8th Ed: Campbell and Reece
5. Plant Physiology, 4th Ed: Taiz and Zeiger
6. Principles of Anatomy and Physiology; 12th Ed: Tortora & Derrickson
7. Anatomy and Physiology, 6th Ed: Seeley, Stephens, Tate

# LIFE SCIENCE

**S.Y.B.Sc.** **Course No.: SLSC302**

**Title: Enzymes and Metabolic Pathways**

**Learning Objectives:**
On completion of the course, the student must be able to describe / discuss:

1. advantages of using an aqueous system in biocatalysis
2. role of enzymes as biocatalysts, with introductory knowledge on enzyme kinetics.
3. thermodynamics of biological reactions
4. basic cellular energy metabolism utilizing glucose and fatty acids
5. elementary amino acid metabolism viz. transamination, deamination & urea cycle
6. composition & role of oxidative phosphorylation and photophosphorylation systems in cellular ATP synthesis.

**Number of lectures: 45**

**UNIT I** **(15 Lectures)**

1. Water, pH and buffers (with problems) **(4)**
2. Enzymes **(7)**
   a. Types of enzymes: proteins and RNA
   b. Classes of enzymes
   c. Concept of: active site, activation energy, binding energy, allostery, enzyme activity and specific activity
   d. Kinetics: Orders of reaction (upto second order)
      i. Derivation of Michaelis-Menten equation
      ii. Michaelis-Menten plot
      iii. Lineweaver Burke plot
      iv. Inhibition: competitive and non competitive
   e. Factors affecting enzyme activity: pH, temperature, and substrate concentration
3. Enzyme Purification Techniques **(4)**
   a. Basic principles of extraction: salt precipitation, dialysis, and gel filtration.

**UNIT II** **(15 Lectures)**

1. Basic thermodynamics: concept of free energy **(1)**
2. Carbohydrate metabolism: **(8)**
   a. Glycolysis: process and regulation
   b. Krebs cycle: process, regulation and importance as an amphibolic pathway, glyoxylate pathway
   c. Gluconeogenesis
   d. Pentose phosphate pathway
3. Lipids **(4)**
   a. Concept of Lipolysis and lipogenesis
   b. Catabolism of Fatty acids (palmitate)
4. Purine and pyrimidine Metabolism: Salvage Pathway **(2)**
   (Exercise on connecting biomolecules into metabolic pathways)

**UNIT III** **(15 Lectures)**

1. Amino acid metabolism **(4)**
   a. Transamination: GPT, GOT

   b. Deamination of glutamine and glutamate
   c. Urea cycle
   d. Decarboxylation eg. histidine
2. Bioenergetics **(5)**
   a. Microbial Electron transport: sequence of electron carriers and their localization and role of cyanide as inhibitor of ETC
   b. Oxidative phosphorylation: Mitchell's chemiosmotic hypothesis, structure of ATP synthase complex, role of DNP as inhibitor
3. Photosynthesis **(5)**
   a. Photophosphorylation
   b. Calvin cycle
   c. Concept of Photorespiration
4. Integration of Carbohydrate, Lipids and Amino acid Metabolism **(1)**

(An exercise in connecting biomolecules into metabolic pathways)

**References**

1. Lehninger's Principles of Biochemistry (5th Edition) – Nelson & Cox
2. Biochemistry (6th Edition) – Lubert Stryer
3. Biochemistry –A.C. Deb

# LIFE SCIENCE

**S.Y.B.Sc.** **Course No.: SLSC303**

**Title: Microbes and Human Health**

Learning Objectives:
The course must enable the student to:

1. Studying microorganisms in their natural habitat
2. Understanding their role in the ecosystem
3. Studying the various microbial interactions in the ecosystem
4. Studying interaction of various microbial parasites of man and the diseases they bring about
5. Understanding concept of epidemiology and public health

**Unit I: Microbial Ecology** **(15 Lectures)**

1. Ecological Concepts: Microbiome, ecosystem, community, guild, niche, biofilm, consortium **(2)**
2. Microorganisms in their natural habitat: Soil, Water (marine & fresh) and air microenvironments and their microbial composition **(3)**
3. Role of microorganisms in biogeochemical cycling: Carbon, Nitrogen, Phosphorus, Sulfur and Iron **(5)**
4. Microbial Interactions: **(4)**
   a. Symbiotic associations: Commensalism, Mutualism, Parasitism
   b. Non-symbiotic associations: Synergism, Antagonism
5. Quorum sensing in microbial populations **(1)**

**Unit II: Host – Microbe Interactions** **(15 Lectures)**

1. Human body as a microbial host **(4)**
   a. Normal Microbiota: distribution and significance
   b. Physical Barriers to microbe entry: Skin, mucous membranes, GIT, UT, eye
   c. Chemical Mediators in host resistance: Cationic peptides, bacteriocins, Complement, INFs, Endogenous pyrogens, Antibodies
   d. Host risk factors: Age, Nutritional Status, Stress
2. Microbe as a pathogen to humans **(2)**
   a. Pathogenicity and virulence: virulence factors, endotoxins, enterotoxins, exotoxins, cytopathic effects
   b. Portals of entry, adherence and penetration or evasion of host defenses
3. Microbial diseases in humans **(7)**
   a. Bacterial: Typhoid
   b. Viral: Influenza
   c. Protozoal: Malaria
   d. Fungal: Candidiasis
4. Immunodiagnostics: Enzyme-linked immunosorbent assay (ELISA), Radioimmunoassay (RIA) **(2)**

**Unit III: Epidemiology and Public Health** **(15 Lectures)**

A. Principles of Epidemiology **(5)**

1. Classification of diseases
   a. Occurrence: endemic, epidemic, pandemic and sporadic
   b. Communicable and non-communicable diseases

2. Measurement of disease: morbidity, mortality, life expectancy, DALY (disability-adjusted life years)
3. Disease reservoirs: biotic and abiotic
4. Transmission of disease: direct and indirect modes; Emerging diseases: Enterohaemorrhagic *E.coli* (EHEC) infections, Melioidosis
5. Re-emerging diseases: MDR-TB / MRSA / Malaria

B. Concepts in Public Health

1. Health – definition and changing perceptions [mortality to Human Development Index (HDI)] (**1**)
2. Factors influencing health outcomes (**2**)
   a. Distal factors: Income, Education, Technology
   b. Proximal Factors: Nutrition, Physical activity, Occupational risks, Environmental risks, sexual and reproductive health, substance & alcohol abuse
3. Combating challenges in public health (to be done using case studies) (**4**)
   a. Infectious disease – Tuberculosis / Polio
   b. Environmental risk – Allergic asthma (pollution) / Cholera (sanitation)
   c. Substance abuse – Tobacco
   d. Nutrition – Obesity
   e. Lifestyle – Diabetes Mellitus / Cardiovascular disease
4. Public Health Programs in India (**3**)
   a. National Cancer Control Program
   b. National Program for Control of Blindness
   c. National Mental Health Program

**References**:


1. *Prescott, Harley, Klein's Microbiology* (2008), 7th Edition, Willey J.M., Sherwood L.M., Woolverton C.J.; Tata McGrawHill Education (Asia)
2. *Principles of Microbiology* (2007), 2nd Edition, Ronald Atlas;
3. *Microbiology – A Systems Approach* (2006), Cowan M.K., Talaro K.P.; McGrawHill Co.
4. *Microbiology* (1986), 5th Edition, Pelczar C.J., Chan E.C.S., Kreig N.R.; McGraw Hill Book Company
5. *Microbiology – An Introduction* (2007), 9th Edition, Tortora G.J., Funke B.R., Case C.L.; Pearson Education Inc.
6. *Brock's Biology of Microorganisms* (2009), 12th Edition, Madigan, Martinko, Dunlap, Clark; Pearson Education Inc.
7. *Sherris Medical Microbiology – An Introduction to Infectious Diseases* (1994), 4th Edition, Ryan K.J., Ray C.G.; McGrawHill Medical Publishing Division
8. *Medical Microbiology* (2009), 6th Edition, Murray P.R., Rosenthal K.S., Pfaller M.A.; Mosby Inc. (Elsevier)
9. *Medical Microbiology* (2008), 16th Edition, Greenwood D., Slack J., Peutherer; Churchill Livingstone Publishing Co.
10. *Park's Textbook of Preventive and Social Medicine* (2007), 19th Edition, Park K.; Bharot Publishers Co.
11. *The Microbial Challenge* (2010), 2nd Edition, Krausner R.I.; Jones & Bartlett Publishers, Inc.
12. *India Health Report* (2003), Misra R., Chatterjee R., Rao S.; Oxford University Press (New Delhi)

13. *Improving Global Health: Forecasting the next 50 years* (2011), Huges B.B. et al.; Oxford University Press (New Delhi)
14. *Public Health and Sanitation* (1999), Kopardekar H.D., Khanolkar K.R.; All India for Local Self Government

**Practical: SLSC3PR**

***Comparative Physiology I***

1. Dissection and display of the digestive system of cockroach
2. Dissection and display of the nervous system of cockroach
3. Temporary mount of cornea, spiracles and muscle fibre of cockroach
4. Study of polytene chromosomes of Chironomous larva
5. Study of mineral crystals in plants
6. Comparison of stomatal index of different plants
7. Study of the effect of minerals/ heavy metals (using ocular)
    a. Pollen tube germination
    b. Pollen tube length

***Enzymes and Metabolic Pathways***

1. Isolation of casein from milk
2. Estimation of Vitamin C by Iodometry
3. Estimation of ribose by Orcinol method
4. Cell fractionation
5. Separation of amino acids by ascending paper chromatography
6. pH and buffers:
    a. Preparation of phosphate buffer
    b. Determination of $pK_a$
1. Determination of $K_M$ value of amylase
2. Project:
    a. Lipid extraction
    b. Separation and visualization by thin layer chromatography

***Microbes and Human Health***

1. Gram staining of *E. coli*, *Bacillus* and other bacterial cultures
2. Maintenance of cultures using NA slants
3. Capsule staining of *Klebsiella* or *Bacillus* bacterial cultures
4. Identification of organisms by biochemical tests – IMVIC
5. Study of differential media, e.g., McConkey's agar
6. Determination of viable count of the given culture using the spread plate technique
7. Determination of microbial sensitivity to antibiotics – disc method
8. Innate immunity: saliva, lysozyme from tears, psoriasin from skin

**Template of Theory Question paper**
**SLSC301, 302 & 303**

**CIA I – 20 marks, 45 mins.**
**Unit I: Objectives/numerical problems**, not more than 5 marks each

**CIA II – 20 marks, 45 mins.**
**Unit II:** Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam – 60 marks, 2 hours**
**Question 1**: Unit I: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
**Question 2**: Unit II: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
**Question 3:** Unit III: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks

**Mark-distribution pattern for Practical Courses: SLSC3PR**

| **End Semester Practical Examination** | **Total marks: 150** |
|---|---|
| Experiments | 75 - 105 marks |
| Identification | 30 - 60 marks |
| Journal | 15 marks |

# St. Xavier's College – Autonomous
# Mumbai

# Syllabus
# For 4th Semester Courses in
# LIFE SCIENCE

(June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:

| | |
|---|---|
| SLSC401 | Comparative Physiology II |
| SLSC402 | Molecular Biology |
| SLSC403 | Biostatistics and Population Genetics |

Template for theory and practical question paper

## LIFE SCIENCE

**S.Y.B.Sc.** **Course No.: SLSC401**

**Title: Comparative Physiology- II**

**Learning Objectives**

The course aims to:

1. Introduce a student to the various endocrine hormones and their role in the maintenance of homeostasis.
2. Help the learner understand the organization of the nervous system and the physiological principles underlying nervous function.
3. Provide an insight into the various mechanisms for regulation of body temperature.
4. Elucidate the processes of gametogenesis, reproduction and embryo development in various life forms

**Self Study**: Levels of organization – cells, tissues, organs, organ systems; epithelial and connective tissue

**Number of lectures: 45**

**UNIT I: Endocrine system** **(15 lectures)**

Endocrine system (**7**)

1. Endocrine glands and Hormones: Insect and Amphibian
2. Positive and negative feedback and Concept of Neuroendocrine coordination (**1**)
3. Plant hormones: Auxins, Gibberillins, Cytokinins, Abscissic acid and Ethylene
4. Endocrine System in humans (**7**)
   a. Endocrine glands; Hormones – types; Hierarchical organization of the endocrine system
   b. Mechanism of Hormone action – hormone receptors and their up and down regulation; mode of action via membrane receptors eg. epinephrine- upto secondary messenger; intracellular receptor eg: steroid hormone
   c. Role of hormones in the maintenance of homeostasis: Thyroid - T3, T4, Pancreas-
      i. insulin, glucagon
      ii. Adrenal gland - cortex – glucocorticoids & mineralocorticoids medulla – epinephrine
      iii. Pituitary – Anti-Diuretic Hormone (ADH)

**UNIT II: Temperature regulation and Nervous System** **(15 lectures)**

1. Nervous system (**3**)
   a. Evolution of the nervous system: Invertebrate to Vertebrate Brain
2. Nervous system in humans (**6**)
   a. Central Nervous System: Brain – membranes and parts; Spinal cord – sensory and motor tracts; Peripheral Nervous System: Somatic and Autonomic
   b. Cells of nervous tissue – Neurons, Neuroglia and Synapses
   c. Ion channels, Resting membrane potential and Action Potential
3. Temperature Regulation (**6**)
   a. Poikilothermy and Homeothermy

b. Regulation of Body temperature at temperature extremes.

**UNIT III: Reproductive systems and Development (15 lectures)**

1. Reproduction (**4**)
   a. Asexual: Budding, Parthenogenesis, Spore formation, Vegetative propagation
   b. Sexual reproduction:
      i. Gametogenesis- angiosperm
      ii. Types of eggs
      iii. Fertilization – Internal and External, Hermaphroditism
   c. Reproductive System of humans (**4**)
      i. Overview of the male and female reproductive system; Oogenesis & Spermatogenesis; Structure of sperm and eggs
      ii. Reproductive Hormones; Female reproductive cycle
      iii. Birth-control measures
2. Development (**7**)
   a. Embryogenesis in plants
   b. Patterns of Cleavage, Blastulation and Gastrulation in Amphibians
   c. Embryonic Development: Fertilization, Formation of Morula, Blastocyst, Implantation; Role of Hormones
   d. Assisted Reproductive Technology

**References:**

1. Tortora G and Grabowski S (2002) Principle of Anatomy and Physiology *Wiley*.
2. Guyton A and Hall J (2006) 'Textbook of Medical Physiology' *Elsevier Saunders*.
3. Withers P (1992) 'Comparative Animal Physiology' *Saunders College Publication*.
4. Solomon E, Berg L and Martin D (2007) 'Biology' *Thomson Brooks/Cole*.
5. Campbell N and Reece J (2005) 'Biology' *Pearson, Benjamin Cummings*.

## LIFE SCIENCE

**S.Y.B.Sc** **Course No.: SLSC402**

**Title: Molecular Biology**

**Learning Objectives:**
This course aims to provide molecular understanding of the information processing pathways in the cell that lead to the expression of the genetic information in DNA.

1. To understand the molecular processes in DNA replication, DNA repair, transcription and translation.
2. To understand the molecular basis of mutations and how it leads to human genetic disorders.
3. To comprehend the principles of gene expression and its regulation in prokaryotes and eukaryotes.

**Number of lectures: 45**

**Unit I:** **(15 lectures)**

1. DNA replication **(6)**
   a. Basic structure of double-stranded DNA,
   b. Messelson and Stahl Experiment
   c. DNA replication in *E.coli*
   d. Replication of Eukaryotic Chromosomes: multiple origins, end-replication problem.
2. Molecular Concept of a gene **(1)**
3. a. Transcription in *E. coli* **(7)**
   b. Transcription in Eukaryotes **(3)**
      i. Types of RNA polymerases
      ii. RNA polymerase II transcription in brief
      iii. Pre-mRNA processing
   c. Reverse transciptase **(1)**

**Unit II:** **(15 lectures)**

1. Translation **(7)**
   a. The Genetic Code
   b. Structure of ribosomes and Transfer-RNA
   c. Protein synthesis in *E.coli*
   d. Protein synthesis inhibitors eg: streptomycin, puromycin

**2.** Gene regulation in *E. coli* **(8)**
   a. Lambda phage: Choice between lytic and lysogenic cycles (self study)
   b. Lac operon
   c. Tryptophan operon
   d. Problems on Lac operon

**Unit III:** **(15 lectures)**

DNA damage

1. Mutagenic agents and their mode of action: physical – X –rays and UV rays and chemical – any four.
2. Classification of mutations: germ line versus somatic; spontaneous v/s induced; point v/s chromosomal (giving examples of *Drosophila* mutants).
3. Point Mutations: Base substitution: transitions, transversions; Frame-shift: addition, deletion, suppressor mutations.
4. Chromosomal mutations: Structural: deficiency, duplication, inversion, translocation. Numerical: aneuploidy, euploidy, concept of non-dysjunction
5. Human genetic disorders: Sickle cell anemia, Philadelphia chromosome, Down's syndrome, Turner's syndrome, Fragile X syndrome
6. DNA repair mechanisms – Photo - reactivation repair

**References:**

1. Watson J, Baker T, Bell S, Gann A, Levine M, Losick R (2006) 'Molecular Biology of the Gene' *Pearson Education, Inc*.
2. Nelson D, Lehninger A, Cox M (2008) 'Lehninger's Principles of Biochemistry' *W. H. Freeman*.
3. Stryer L (1999) 'Biochemistry' *W. H. Freeman*.
4. Russel P (2009) 'iGenetics – A molecular approach' *Benjamin Cummings Publication*.
5. Ridley M (2006) 'Genome: the Autobiography of a Species in 23 Chapters' *Harper Perennial Publication*.
6. Watson S (1968) 'Double Helix' *Simon and Schuster Publication (USA)*.

## LIFE SCIENCE

**S.Y.B.Sc** **Course Code: SLSC403**

**Title: Biostatistics and Population Genetics**

**Learning Objectives:**

1. To equip students with basic statistical concepts and methods.
2. To introduce students to the display and communication of statistical data. This will include graphical and exploratory data analysis.
3. To help students understand estimation, testing and interpretation for single group summaries such as mean, median, variance, correlation and regression.
4. To promote an understanding of the basics of hypothesis testing, confidence intervals and the interpretation and application of commonly used statistical tests – Z, t, Chi square.
5. To aid in the understanding of the basic concepts of ANOVA.
6. To explain the Hardy-Weinberg law of equilibrium and to solve a simple Hardy-Weinberg equation to calculate genotype frequencies.
7. To understand the various factors that afftect Hardy-Weinberg equilibrium.

**Number of lectures: 45**

**UNIT I: Biostatistics (15 lectures)**

1. Introduction to Biostatics: Terms used in Biostatistics, Types of Data, **(1)**
2. Presentation of Data: qualitative and quantitative **(1)**
3. Measures of Central tendency: Mean, Median, Mode; Normal and skewed distributions, kurtosis **(5)**
4. Measures of Variation: range, variance, standard deviation, coefficient of variation **(4)**
5. Measures of location: Percentiles, 'z' score, probability calculations **(3)**
6. Concept of sampling: random sample, sample size determination, precision **(1)**

**UNIT II: Biostatistics (15 lectures)**

1. Analysis of data
    a. Quantitative data:
        i. Normal Distribution, concept of sampling error and standard error **(2)**
        ii. Hypothesis testing: unpaired and paired't' test, Type I and Type II errors **(6)**
        iii. ANOVA (single factor), Tukey's post hoc test **(4)**
    b. Qualitative data:
        i. $\chi^2$ test as a test of association **(2)**
        ii. Standard error of proportion
2. Concept of correlation between two variables and regression line **(1)**

**UNIT III: Population Genetics (15 lectures)**

1. Introduction to Population Genetics: Concept of gene pool; genetic diversity in populations: polymorphism and heterogeneity **(3)**
2. Allelic and genotypic frequencies in populations: Hardy Weinberg Law relating allelic and genotypic frequencies in an ideal population: for two alleles, multiple alleles and X linked alleles; testing populations for Hardy Weinberg equilibrium **(3)**

3. Evolutionary factors responsible for altering allelic frequencies in natural populations and their effects: (**7**)
    a. Mutations
    b. Migration
    c. Random genetic drift
    d. Non random mating
    e. Natural selection: Concept of fitness and its contribution to allelic frequencies.
4. Numerical problems on all of the above (**2**)

**Reference books for Biostatistics**:

1. Sokal R and Rahlf H (1995) 'Biometry: the principles and practice of Statistics for Biology research' *W H Freeman*.
2. Zar J (1998) 'Biostatistical analysis' *Prentice Hall*.
3. Rosner B (1995) 'Fundamentals of Biostatistics' *Duxbury Press*.
4. Daniel W (2005) ' Biostatistics: A Foundation for Analysis in Health Sciences' *Wiley*.

**Reference books for Population Genetics**:

1. Russel P (2009) 'iGenetics – A molecular approach' *Benjamin Cummings Publication*.
2. Klug W and Cummings M (2006) 'Concepts of Genetics' *Prentice Hall*
3. Brooker R, Widmaier E, Graham L, Stiling P (2008) 'Principles of Biology' *McGraw Hill Education*.
4. Strickberger M (1985) 'Genetics' *Prentice Hall*.

**Practicals: SLSC4PR**
**Comparative Physiology 2:**

1. Histological study of kidney, liver, testis, thyroid, adrenal, stomach, thymus, bone marrow and cartilage
2. Determination of cell viability by dye exclusion method
3. Total RBC count
4. Total WBC count
5. Differential WBC count
6. Study of the effect of minerals/ heavy metals on heart rate of Daphnia
7. Study of the effect of exercise/ environment on physiological parameters – heart rate, blood pressure and oxygen saturation

**Molecular Biology:**

1. UV survival curve of *E. coli*
2. Replica plating of auxotrophic/ antibiotic resistant bacteria
3. Screening of antibiotic resistant mutants
4. UV light repair
5. UV dark repair
6. Isolation of lysozyme from egg white and its effect on Gram-positive and Gram-negative bacteria

**Biostatistics and Population Genetics**:

1. Presentation of data: qualitative and quantitative, continuous and discrete using excel sheet.
2. Measures of Central Tendency: mean (with assumed mean), median, mode
3. Measures of Location: Percentiles & probability, 'Z' score
4. Measures of variation: range, standard deviation
5. Concept of sampling: methods of sampling, importance of sample size, precision
6. Paired and unpaired 't' test
7. Standard error of proportion and $\chi^2$
8. Correlation and Regression using experimental data
9. Study of Genetic Variation in human populations and application of Hardy Weinberg Law (preferably from data collected by students)
10. Study of effects of different evolutionary forces on allelic frequencies: problems

Use of MS Excel and SPSS for solving problems.

**Template of Theory Question paper**
**SYBSC LIFE SCIENCE**
**Courses 401, 402, 403**

**CIA I** – 20 marks, 45 mins.
Objectives/numerical problems, not more than 5 marks each

**CIA II** – 20 marks, 45 mins.
Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam** – 60 marks, 2 hours

Question 1: Unit I: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
Question 2: Unit II: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks
Question 3: Unit III: maximum marks per sub-question - 6 marks
20 marks to be answered out of 28-30 marks

**Mark-distribution pattern for Practical**
**Courses: SLSC3PR**

| **End Semester Practical Examination** | **Total marks: 150** |
|---|---|
| Experiments | 75 - 105 marks |
| Identification | 30 - 60 marks |
| Journal | 15 marks |


# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 5th Semester Courses in
# LIFE SCIENCE
(June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:


| | |
|---|---|
| SLSC501 | Genetics |
| SLSC502 | Developmental Biology |
| SLSC503 | Industrial Biotechnology and Nanotechnology |
| SLSC504 | Ecology and Biodiversity |


Template for theory and practical question paper

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC501**

**Title: Genetics**

**Learning Objectives:**

The course must enable the student to:

1. Understand the concepts of linkage, recombination and gene mapping in phage, bacteria and eukaryotes.
2. Understand gene recombination and DNA transposition.
3. Understand cellular and molecular changes caused in cancer.
4. Describe the basic principles of gene manipulation and its application.

**Number of lectures: 60**

**UNIT I: Principles of bacterial and phage genetics (15 lectures)**

**1. Overview of a prokaryotic genome (1)**

**2. Gene mapping of bacteria**

**I. Conjugation (4)**

a. Discovery of conjugation
b. F plasmid & Hfr strains
c. F' plasmids
d. Mapping of bacterial genomes – Jacob & Wollman's Interrupted Mating Experiment
e. Numerical problems

**II. Transformation (3)**

a. Discovery
b. Genome mapping using transformation
c. Numerical problems

**III. Transduction (3)**

a. Generalized transduction
b. Specialized transduction: production of λdgal
c. Mapping phage genomes using co-transduction frequency
d. Numerical problems

**3. Mapping of bacteriophage genomes (4)**

a. Benzer's fine structure mapping of phage genomes
b. Recombination mapping
c. Concept of "genes within genes", "alternate splicing" and "terminal redundancy" in phage genomes
d. Numerical problems

**UNIT II: Principles of Eukaryotic genetics (15 lectures)**

**1. Overview of eukaryotic genome (3)**

a. Structural organisation
b. Sequence complexity
   i. Unique sequences, repetitive sequences and satellite DNA
   ii. Denaturation kinetics

**2. Genetic recombination in yeast** **(4)**

a. Life cycle of yeast
b. Constructing a linkage map using tetrad analysis
c. Numerical problems

**3. Genetic mapping in eukaryotes** **(8)**

a. Life cycle of *Drosophila*
b. Linkage analysis – sex-linked and autosomal genes
c. Recombination mapping with two-point and three-point crosses
d. Interference and coefficient of co-incidence
e. Mapping of human genes
   i. Somatic cell hybridization, radiation hybrids
   ii. Mapping with molecular markers
f. Numerical problems

**UNIT III** **(15 lectures)**

**1. DNA recombination and repair** **(10)**

a. Forms of recombination: Homologous, site-specific and illegitimate
b. Model for homologous recombination: Holliday Model
c. Gene conversion
d. Recombination repair systems in *E.coli*- REC- BCD pathway
e. Exision repair systems in *E.coli*: Base excision and Error - Prone repair
f. Non -homologus end joining repair

2**. Mobile genetic elements** **(5)**

a. Overview
b. Transposable elements in bacteria: IS element
c. Transposable elements in eukaryotes: Ac element in maize
d. Transposable elements in humans: LINES, SINES
e. Evolutionary significance of transposable elements

**UNIT IV: Genetic Engineering** **(15 lectures)**

**1. Molecular techniques for cloning genes** **(9)**

a. Restriction endonucleases Type II
b. Cloning vectors: plasmids, cosmids
c. Construction of recombinant DNA molecules: Insulin gene cloning
d. Selection of recombinant clones: antibiotic and lacZ selection
e. Construction of DNA libraries: genomic and cDNA libraries
f. Screening DNA libraries: nucleic acid hybridization, immunochemical
g. Amplification of DNA by PCR

**2. Molecular analysis of cloned sequences** **(4)**

a. Analysis of DNA: Southern blot
b. Analysis of RNA: Northern blot
c. Analysis of protein: Western blot
d. DNA sequencing: Sanger's method
e. Restriction mapping

**3. Application of recombinant DNA technology** **(2)**

a. Human genome project
b. Human gene therapy

**References:**


1. Snustad P, Simmons M, Gardner J (2005) 'Principles of Genetics' *Wiley*.
2. Griffiths A, Wessler S, Carroll S, Doebley J (2015) 'Introduction to Genetic Analysis' *W. H. Freeman*.
3. Rusell P (2009) 'iGenetics – A molecular approach' *Benjamin Cummings Publication*.
4. Pierce B (2017) 'Genetics: A Conceptual approach, Benjamin Pierce' *McMillan Publishers*.
5. Goodenough U (1984) 'Genetics' *W.B. Sanders Co. Ltd*.
6. Krebs J, Goldstein E, Kilpatrick S (2108) 'Lewin Genes XII' *Jones and Bartlett Learning*.

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC502**

**Title: Developmental Biology**

**Learning Objectives:**

The course must enable the student to describe/ discuss:

1. Model systems commonly used in the study of embryonic development.
2. Embryonic development in avian (chick), amphibian (*Xenopus*) and plant (*Arabidopsis*) systems.
3. Cellular and molecular mechanisms controlling development in *Drosophila*.
4. The process of morphogenesis, regeneration and ageing.
5. The role of environmental agents in teratogenesis.
6. Advances in stem cell biology and its applications.

**Number of Lectures: 60**

**Unit I:** **(15 lectures)**

1. History and basic concepts in Development **(2)**
2. Model organisms in Developmental Biology and their significance: C.elegans, Drosophila, Zebrafish, Xenopus, Mouse **(3)**
3. Fertilization **(2)**
4. Avian Embryology: **(8)**
   a. Cleavage
   b. Gastrulation
   c. Axis Specification and the Avian 'Organizer'
   d. Neurulation:
   e. Somite formation
   f. Organogenesis

**Unit II:** **(15 lectures)**

1. Totipotency, Pluripotency, Determination and Differentiation **(2)**
2. Differentiation as a change in gene expression. **(3)**
3. Cell cell communication in development **(3)**
4. Cell cycle and its regulation **(3)**
5. Programmed cell death: apoptosis **(2)**
6. Stem cell biology - basic concepts, stem cell niche, Induced Pluripotency, Transdifferentiation **(2)**

**Unit III:** **(15 lectures)**

1. Drosophila Development **(12)**
   a. Early development
   b. Generation of body plan
   c. Genes that pattern the body plan: anterior-posterior polarity, dorsal-ventral patterning
      i. maternal genes
      ii. segmentation genes
      iii. Homeotic genes
      iv. Realiasator genes
2. Patterning of Flower development in Arabidopsis **(3)**

**Unit IV:** **(15 lectures)**

1. Metamorphosis and regeneration **(4)**
2. Ageing and Senescence: cellular and molecular changes **(2)**
3. Abnormal Developmental Programs: **(5)**
   a. Teratogenesis: Alcohol, Retinoic acid, Endocrine disruptors
   b. Cancer as a disease of development
4. Sex Determination and dosage compensation **(2)**
5. Evolutionary Developmental Biology **(2)**

**References:**

1. Gilbert S. (2010) 'Developmental Biology' *Sinauer Associates*.
2. Wolpert L (2011) 'Principles of Development' *Oxford Univ Press*.
3. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P (2008) 'Molecular Biology of the Cell' *Garland Science*.
4. Lodish H and Baltimore (2007) 'Cell Biology' *W.H. Freeman*.
5. Muller W (1997) 'Principles of Developmental Biology' *Springer International*.

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC503**

**Title: Industrial Biotechnology and Nanotechnology**

**Learning Objectives:**

The course must enable the student to:

1. Understand the basics of industrial fermentation processes – strain improvement, media formation, design of bioreactors and downstream processing of products.
2. Describe bioprocess technology involved in industrial production of fermented beverages, antibiotics, recombinant insulin and enzymes.
3. Explain the steps involved in discovery and development of a lead molecule.
4. Understand the concept of business development and bioentrepreneurship.
5. Understand the concept and applications of nanotechnology.

**Number of lectures: 60**

**Unit I: Fundamentals of Industrial Biotechnology (15 lectures)**

1. History and overview of fermentation process
2. Source of Industrial Biocatalysts – microbial cells, animal & plant tissues
3. Batch and Continuous process
4. Primary & Secondary Screening of Microorganisms, Strain improvement of Industrial Microorganisms (selection of auxotrophic and analogue resistant mutants)
5. Media requirements & optimization, Criteria for good fermentation medium.
6. Types and design of Bioreactors
    a. Types of fermentation process: suspended and solid substrate.
    b. Basic bioreactor design, overview of bioreactor types-stirred tank bioreactor, bubble column bioreactor, air-lift reactor,
    c. Schematic overview of a bioreactor with control systems

**Unit II: Downstream processing in industry (15 lectures)**

1. Role and importance of downstream processing in biotechnological processes.
2. Separation and Recovery of products:
    a. Methods in cell harvesting – filtration and centrifugation
    b. Cell disruption methods for intracellular products – mechanical & non-mechanical methods
    c. Separation of Insoluble Products - flocculation and sedimentation, centrifugation and filtration
    d. Separation of Soluble Products - Precipitation & liquid-liquid extraction
    e. Membrane-based separations - micro- & ultra-filtration, dialysis.
    f. Chromatography techniques – ion-exchange, adsorption, HPLC, Affinity, Gel filtration

**Unit III: Bioprocess Technology - Industrial Production (15 lectures)**

1. Food – Wine and Vinegar
2. Antibiotics – Penicillin
3. Recombinant human insulin
4. Enzyme - Amylases
5. Concept of immobilization – Biosensors (Principle, types, advantages and uses)
6. Plant Tissue Culture – Micropropagation (Clonal propagation), Plant secondary metabolites (anticancer drugs)
7. Animal Tissue Culture : Vaccines - Polio, HBV

**Unit IV: Discovery & Development of Industrial Product and Bio-nanotechnology (15 lectures)**

1. Discovery and Development of Industrial Product **(7)**
   a. High content screening to identify lead molecules and High throughput screening
   b. *In vitro* and *In vivo* toxicity studies
   c. Clinical trials – Phase I , Phase II Phase III
   d. GMP and GLP – Regulatory issues in Industrial Bioprocess
   e. Business Development and Bio-entrepreneurship

2. Bio-nanotechnology **(8)**
   a. Introduction and the scope of Bionanotechnology
   b. Nanomaterials used in medicine
   c. Fields of Application
      i. Nanoparticles for delivery of Drugs, DNA, RNA
      ii. Cancer Therapy
      iii. Biomolecular motors.

**References**:


1. Shuler M and Kargi F (2008) 'Bioprocess Engineering: Basic Concepts' *Prentice-Hall*.
2. Stanbury P, Whitaker A, Hall S (2007) 'Principles of Fermentation Technology' *Elsevier*.
3. Freshney R.(2011) 'Culture of Animal Cells' *Wiley*.
4. Prescott S and Dunn C (1982) 'Industrial Microbiology' *AVI Publication Company*.
5. Casida L (1968) 'Industrial Microbiology' *Wiley*.
6. Hammond J, McGarvey P, Yusibov V. (1999) 'Plant biotechnology' *Springer*.
7. Hornyak G, Dutta J, Tibbalsnil H, Rao K. (2008) 'Introduction to Nanosciene' *CRC Press*.
8. Clark D and Pazdernik N (2009) 'Biotechnology – Applying the genetic revolution' *Academic Press*.
9. Walsh G (2003) 'Biopharmaceuticals- Biochemistry and Biotechnology' *Wiley*.
10. Hodgson E (2010) 'A textbook of modern toxicology' *Wiley*.

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC504**

**Title: Ecology and Biodiversity**

**Learning Objectives:**
The course must enable the student to:
1. Discuss the concepts of ecology and inter-relations of abiotic and biotic factors
2. Elucidate the fundamental laws of energy transfer and efficiency in ecosystems
3. Elaborate on various intra-species and inter-species interactions
4. Understand biodiversity – qualitatively and quantitatively
5. Identify and weigh out the threats that damage ecosystems and endanger biodiversity

**Number of Lectures: 60**

**UNIT I: Ecology and Ecosystems** **(15 lectures)**
1. History and scope of ecology.
2. Physiological Ecology:
a. Ecological niche, tolerance range, optima, acclimation
b. Limiting factors: temperature, water, light, soil, fire, nutrients.
3. Biogeochemical cycling of Carbon, Nitrogen and Phosphorus.
4. Population Ecology: -
a. Concept of an ecosystem
b. Carrying capacity
c. Population Dynamics: Growth, Density, Age distribution, Mortality, Natality
d. Intrinsic rate of natural increase
e. Population Fluctuations and cyclic oscillation, Population regulation;
f. Density dependent and independent mechanisms, r- and k Selection.
5. Behavioral Ecology
a. Development of behavior
b. Behavioral adaptations for Survival, Foraging and feeding behavior
c. Parental care and Mate location.

**UNIT II: Community and Ecosystem Ecology.** **(15 lectures)**
1. Community Ecology - Species interaction with communities and ecosystems:
a. Relationships- Predation, Competition, Mutualism,
b. Antagonism.
2. Community Change
a. Succession: Primary and Secondary
b. Models of Succession.
c. Climax community and types of climax.
3. Concept of ecosystem:
a. Classification of ecosystem.
b. Trophic structure of ecosystem.

4. Energy Transfer in an Ecosystem

a. Fundamental concepts of energy.

b. Laws of thermodynamics.

c. Concept of production.

d. Primary production, limits and Efficiency of Primary production.

e. Secondary production, limits and Efficiency of secondary production.

f. Energy flow in the ecosystem.

5. Trophic structure

a. Food chains: - components and types.

b. Food Web

c. Ecological pyramids.

**UNIT III: Biodiversity and Cladistics** **(15 lectures)**

1. Biodiversity: - Distribution of flora and fauna and factors affecting this distribution.
2. Levels of biodiversity.
3. Status and importance of biodiversity.
4. Measurement of biodiversity: - a) classical methods and b)using genetic tools.
5. Assessment of global and local biodiversity, making an inventory.
6. Evolution of biodiversity (with one example).
7. Loss of biodiversity.
8. Basic principles and methods of cladistic analysis.
9. Introduction to Cladograms.
10. Construction of a simple cladogram.

**UNIT IV: Impact of human activities on ecosystems** **(15 lectures)**

1. Impact on Biological diversity: **(8)**

a. Deforestation: Land use for mining, housing projects, dams.

b. Threats associated with Intensive agricultural practices.

c. Mono culturing of plant species and loss of diversity.

d. Impact of exotic species on local biodiversity.

e. Exploitation of aquatic plant and animal species.

f. Emergence of new and resistant species, bacteria and pests.

2. Toxicology: **(7)**

a. Basic principles of toxicology

b. Concepts of LD50, LC50 and dose-response relationship.

c. Classification of Pesticides and their mode of action.

d. Pesticides / xenobiotics and public health programs eg diclofenac.

e. Toxicokinetics: - Absorption, Distribution, Metabolism and Excretion of Xenobiotics.

f. Bio accumulation and bio magnification of pesticides and industrial chemicals (Dioxins, heavy metals and halogenated compounds).

**References**:

1. Pushpam K and Muradian (2008) 'Payment for Ecosystem Services' *UNDP*
2. Prasanthrajan P and Mahendran P (2008) 'A Text Book on Ecology and Environmental Science' *Agrotech.*
3. National Book Trust of India (1995). Trees – An Ecology Book. Asian/Pacific Cultural Centre for UNESCO, Tokyo. National Book Trust, India
4. Smith G. A., Williams D. R. (1999). *Ecological Education in Action - On Weaving Education, Cultural and the Environment*. State University of New York. Press, USA.
5. Raffaelli D and Frid C (2012) 'Ecosystem Ecology: A New Synthesis' *Cambridge Univ. Press*.
6. National Book Trust of India (1995). Trees – An Ecology Book. Asian/Pacific Cultural Centre for UNESCO, Tokyo. National Book Trust, India

**Practical: SLSC5PR**

***Genetics***

1. Isolation of a pure culture from natural habitat:
   a. Identification up-to species level (Gram nature, basic biochemical tests, Bergey's manual)
   b. Culture maintenance
2. Viable count of overnight culture from the isolate
3. T4 plaque assay
4. Growth curve of *E. coli*
5. Genomic DNA extraction from chicken liver and quantification
6. Molecular biology
   a. Plasmid isolation and visualization on agarose gel after electrophoresis
   b. Competent cell preparation and transformation of *E. coli* DH5 with plasmid DNA

***Developmental Biology***

1. Study of a developing chick embryo using permanent slides
2. Study of different developmental stages of a developing chick embryo by preparing temporary mounts
3. Study of differential development at regions within a chick embryo using a mitochondrial marker enzyme (cytochrome c oxidase)
4. Study of different developmental stages of zebra fish by preparing temporary mounts
5. Whole mount staining of zebrafish embryo - Alcian blue staining to study fin development
6. Study of the morphology and life cycle of *C. elegans*
7. Behavioural assay using *C. elegans* as a model system
8. Project

***Industrial Biotechnology and Nanotechnology***

1. TLC of lipids
2. Estimation of alcohol
3. Purification of Amylase by ammonium sulphate precipitaion
4. Electrophoresis-
   a. Activity staining of Amylase in agarose gels
   b. Separation of bioprocess products by PAGE
5. Immobilization of Amylase/yeast cells using sodium alginate
6. Bioassay of ampicillin
7. Projects (any one/ two)
   a. Wine production
   b. Mushroom cultivation

***Ecology and Biodiversity***

1. Quadrat and Transect Analysis
2. Estimation of hardness in a given water sample
3. Estimation of chlorinity and salinity in a given water sample
4. Isolation of *Rhizobium* from fenugreek
5. Cladistics – construction of a simple cladogram using principle of parsimony
6. Project

## Template of Theory Question paper
## T.Y.B.Sc. LIFE SCIENCE
## Courses 501, 502, 503, 504

**CIA I – 20 marks, 45 mins.**
**Unit I:** Objectives/Short questions

**CIA II – 20 marks, 45 mins.**
**Unit II:** Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam – 60 marks, 2 hours**
**Question 1**: Unit I: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-30 marks
**Question 2**: Unit II: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-30 marks
**Question 3:** Unit III: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-30 marks
**Question 4:** Unit III: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-30 marks

## Mark-distribution pattern for Practical
## Course: SLSC5PR

| **CIA & End Semester Practical Examination** | **Total marks: 200** |
|---|---|
| **CIA per course** | |
| Q1. Any one / two practicals | 15 marks |
| Q2.Journal | 05 marks |
| | |
| **End semester Practical Examination** | |
| Q1. Any two / three practicals | 20 marks |
| Q2. Identification/project report/viva | 05 marks |
| Q3.Viva / Identification | 05 marks |


# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 6th Semester Courses in
# LIFE SCIENCE
(June 2018 onwards)

Contents:
Syllabus (theory and practicals) for Course:

| | |
|---|---|
| SLSC601 | Immunology |
| SLSC602 | Neurobiology |
| SLSC603 | Recombinant DNA Technology and Bioinformatics |
| SLSC604 | Sustainable Development and Carbon Management |

Template for theory and practical question paper

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC601**

**Title: Immunology**

**Learning Objectives:**

The course must enable to student to:

1. Understand the concept and role of innate and adaptive immunity and the factors that contribute towards immunity
2. Be able to describe the organization and the role of the various cells and organs of the immune system
3. Understand the structure-function relationship of immunoglobulins
4. Know the structure and role of antigen receptors in immunity
5. Describe the role of the MHC molecules in adaptive immunity
6. Study the various disorders related to the immune systems

**Number of lectures: 60**

**UNIT I** **(15 lectures)**

**A. Overview of the immune system** **(1)**

**B. Cells and organs of the immune system** **(5)**

1. Cells:
   - i. Hematopoiesis of leukocytes
   - ii. Myeloid cells – structure and function
   - iii. Lymphoid cells
   - iv. NK cells
2. Primary and secondary lymphoid organs
   - i. Bone marrow and Bursa of Fabricus
   - ii. Thymus
   - iii. Spleen
   - iv. Lymph node
   - v. MALT

**C. Principles of innate immunity** **(7)**

1. External barriers
   - i. Skin and mucous membranes
   - ii. Chemical secretions
   - iii. Normal microflora
2. Inflammation
3. Complement
   - i. Classical pathway
   - ii. Alternative pathway
   - iii. Lectin pathway
   - iv. Functions
4. Pattern recognition in innate immune system
   - i. PAMP's
   - ii. PRR's
   - iii. TLR's

**D. Ontogeny and phylogeny of immune cells:** **(2)**
Immune response in the neonate
Evolution of the immune system

**UNIT II** **(15 lectures)**

**A. Structure of a typical antibody molecule** **(5)**
1. Five classes of immunoglobulins
2. Structure and function of Ig classes

**B. Genetics of antibody diversity** **(5)**
1. Heavy chain gene rearrangement
2. Light chain gene rearrangement
3. Somatic hypermutation

**C. Humoral immune response** **(5)**
1. B-cell receptors
2. B-cell ontogeny
3. Role of APC's and T-cells in B-cell response

**UNIT III** **(15 lectures)**

**A. Cell mediated immunity** **(5)**
1. T-cell receptors
2. T-cell ontogeny
3. Role of TH1, TH2 and Treg cells
4. Cell mediated cytotoxicity of T cells

**B. MHC complex and development of immunity** **(4)**
1. MHC-I and MHC-II molecules – structure and function
2. MHC polymorphism
3. MHC restriction
4. Antigen processing and presentation in endogenous pathways
5. Antigen processing and presentation in exogenous pathways

**C. Transplantation** **(2)**

**D. Hypersensitivity** **(4)**
1. Anaphylactic hypersensitivity (type I)
2. Antibody dependent cytotoxic hypersensitivity (type II)
3. Immune complex mediated hypersensitivity (type III)
4. Cell-mediated (delayed-type) hypersensitivity (type IV)

**UNIT IV** **(15 lectures)**

**A. Immune tolerance** **(3)**
1. Mechanism of T and B cell tolerance
2. Immunology of pregnancy
3. Role of T-regulatory cells

**B. Autoimmunity** **(4)**
1. Mechanism of induction

2. Types of autoimmune diseases
   i. Systemic: systemic lupus erythromatosus, multiple sclerosis
   ii. Organ-specific: Grave's, Myasthenia Gravis

**C. Immunodeficiency diseases** **(3)**

1. Primary: X-linked aggamaglobulinemia, SCID, CGD
2. Secondary: AIDS

**D. Vaccines** **(5)**

1. Passively acquired immunity
2. Killed organisms as vaccines
3. Live attenuated organisms as vaccines
4. Subunit vaccines
5. DNA vaccines
6. Monoclonal antibody as vaccines

**References**


1. Kuby Immunology by Kindt, Goldsby, Osborne; 6th edition, W. H. Freeman, 2007
2. Immunology by Roitt, Brostoff, Male; 6th edition, Blackwell Publishing, 2001
3. Immunobiology by Janeway and Travers, et al, 7th edition , Garland Sc. 2005
4. Immunology by Ian Tizzard , 4th ed., SaundersCollege Publishing, 1995.
5. Roitt's Essential Immunology – P.Delves, S. Mastin et al, Blackwell Pub., 11th ed., 2006.
6. Immunology by Kalus Elgert, 2nd ed., Wiley Blackwell, 2010
7. The Immune response to infection by S.Kaufmann et al, ASM Press,2011
8. Cellular and Molecular Immunology by A.K. Abbas et al, 5th ed, Saunders, 2003.

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC602**

**Title: Neurobiology**

**Learning Objectives:**

On completion of the course, the student must be able to:

1. Know the structural and functional organization of the nervous system.
2. Understand the cellular and molecular mechanisms that underlie neuronal signaling.
3. Comprehend the structure-function relationships in the sensory components of the nervous system.
4. Elucidate the cellular and molecular processes that contribute to the development, maintenance and modification of neural circuitry.

**Number of lectures: 60**

**UNIT I: Organization and physiology of the nervous system (15 lectures)**

1. Evolution of the nervous system **(1)**
2. Cellular organization of the nervous system **(2)**
   a. A typical nerve cell
   b. Cellular diversity of the nervous system
3. Vertebrate nervous system **(4)**
   a. Organization of the nervous system
   b. Central nervous system: brain and spinal cord, lobes of the brain and their functional role, motor areas, somatosensory areas
   c. Peripheral nervous system: cranial and spinal nerves, autonomic nervous system, structural organization and functional role
4. Ionic basis for nerve potentials **(8)**
   a. Resting membrane potential –ionic basis: Donnan's equilibrium experiments, Nerst' potential, Goldman's equation
   b. Action potential and its propagation –Hodgin and Huxley's voltage clamp experiment, propagation of an action potential along a myelinated and non-myelinated axon, ion channels and sodium-potassium pump

**UNIT II: Communication in the nervous system (15 lectures)**

1. Types of synapse: structural organization of chemical and electrical synapses, n-m junction, types of channels **(3)**
2. Neurotransmitters: metabolism receptors, second messenger systems, physiological role and pharmacological significance: **(8)**
   a. Acetylcholine (nicotinic and muscarinic receptors)
   b. Norepinephrine, dopamine (D1 and D2 receptors)
   c. GABA
   d. Glutamate
3. Synaptic potentials: chemical synapses –excitatory post synaptic potential (EPSP), inhibitory post synaptic potential (IPSP), neuro-muscular junctions –miniature end plate potentials (MEPPs) **(3)**
4. Receptor potentials (phasic and tonic receptors), generator potentials **(1)**

**UNIT III: Signal transduction and processing in the sensory nervous system**

**(15 lectures)**

1. Mechanotransduction: skin, muscle stretch receptors, hair cells in the auditory and vestibular systems **(6)**
   a. Auditory system: structure of the ear, cochlea and organ of Corti, receptors and mechanism of transduction, auditory pathway (diagrammatic representation only)
   b. Vestibular system: structure of the vestibular labyrinth, maculae and cristae, receptors, mechanisms of transduction
2. Temperature and pain transduction **(1)**
3. Phototransduction –visual system: structure of the eye, retina, photoreceptors (rods and cones), mechanism of phototransduction, binocular vision, visual pathway (retina –Lateral Geniculate Nucleus –visual cortex; diagrammatic representation only) Light and dark adaptation **(5)**
4. Chemotransduction: olfactory and gustatory systems, receptors –structure, mechanism of transduction **(3)**

**UNIT IV: Cognitive functions of the brain and neurological disorders (15 lectures)**

1. Embryological development of the vertebrate nervous system: (comparison with invertebrate, *Drosophila*, whenever possible) **(6)**
   a. Pattern formation –axes of symmetry
   b. Nerulation: formation of neuroectoderm, neural tube and neural crest cells and their derivatives, induction as the basis of neurulation
   c. Formation of the major sub-divisions of the brain: fore brain, mid brain and hind brain
   d. Differentiation: into neuronal and glial cell types, neuronal migration, synapse formation, synapse competition, maturation and cell death
   e. Circuit formation: critical periods in development, effect of neuronal activity in development of neural circuits
2. Emotions **(4)**
   a. The limbic system: amygdala, physiological changes associated with emotions (e.g., fear, pleasure), addiction-role of neurotransmitters, serotonin as a mood enhancer.
3. Memory **(5)**
   a. Qualitative and temporal categories of memory, molecular mechanisms of short and long term memory, e.g.: behaviour test in Aplysia.
4. Neurological diseases and disorders (assignments for continuous internal assessment-II)

**References**

1. Neuroscience: Exploring the brain, M.F.Baer, B.W.Connors & M.A.Paradiso, William & Wilkins, Baltimore, 2007
2. Neurobiology 3rd edition G.M. Shepherd Oxford University Press.
3. Principles of Neural Science. E.R.Kandel, J.H.Schwartz and T.M. Jessel. Prentice Hall International.
4. Instant Notes –Neurosciences, A.Longstaff Viva Books Pvt Ltd., New Delhi, 2002
5. Text Book of Medical Physiology A.C.Guyton and J.E.Hall Saunders College Publishers.

6. Elements of Molecular Neurobiology C.U.M. Smith J Wiley and Sons Publishers, N.Y.
7. An Introduction to Molecular Neurobiology Z.W. Hall Sinauer Associates Inc. Publishers.
8. Ion Channels –Molecules in Action D. J. Aidley and P.R. Stanfield Cembridge University Press.
9. Fundamentals of Neuroscience, Larry Squire et al 2006
10. From Neuron to Brain, John Nicholls, Fifth edition, 2010
11. Neuroscience, Dale Purves et al, Fourth edition, 2008
12. Physiology of a nerve cell, Katz
13. Comparative Neurobiology, J.P. Mill

**Life Science**

**T.Y.B.Sc.** **Course No.: SLSC603**

**Title: Recombinant DNA Technology and Bioinformatics**

**Learning Objectives**:

The objective of the course is to:

1. To describe the use of restriction endonucleases in gene cloning.
2. To describe the different vectors(prokaryotic and eukaryotic) that can be used in gene cloning experiments, including the advantages and disadvantages of each.
3. Describe the essential steps involved in gene cloning with relavant examples.
4. To describe the various strategies of cloning, screening and selction methods.
5. To understand the various metods used in DNA sequencing.
6. To explain the general principles of generating transgenic plants, animals.
7. To describe the applications of recombinant DNA technologies is medicine, agriculture and industry.
8. To introduce the use of bioinformatics in biology.

**Number of lectures**: 60

**UNIT I** **(15 lectures)**

A. Introduction to Genetic Engineering **(1)**

B. Restriction Endonucleases **(4)**

1. Restriction Endonuclease: Type I, Type II, Type III
2. Restriction mapping

C. DNA Joining Strategies **(2)**

1. DNA ligase
2. Homopolymer tailing
3. Adaptors

D. Cloning Vectors: **(8)**

1. Basic properties of plasmids
2. pBR322 as vector
3. pUC as vector
4. Transcription vectors (pGEM3Z)
5. Expression vectors (GST fusion)
6. Cosmid vectors
7. P element as a vector
8. Mammalian vectors

**UNIT II** **(15 lectures)**

A. Cloning strategies: **(5)**

1. Shotgun Cloning: Genomic DNA libraries
2. cDNA cloning
3. Positional cloning
4. PCR cloning
5. Cloning eukaryotic genes (insulin / somatostatin)

B. Screening and selection strategies: **(4)**

1. Direct Selection eg antibiotic resistance, GFP, LacZ
2. Immunochemical screening
3. Nucleic acid hybridization method
4. Subtraction cDNA cloning

C. Sequencing Genes and Genomes: **(6)**

1. Chain termination method of DNA sequencing
2. Next generation sequencing
3. Shotgun approach to genome sequencing
4. Clone contig approach

**UNIT III** **(15 lectures)**

A. Cloning in Yeast: **(2)**

1. Vectors for use in Yeast
2. Cloning large DNA molecules in YAC

B. Transgenic Plants **(6)**

3. *Agrobacterium* mediated transformation
4. Ti plamid
5. Transgenic tobacco expressing luciferase gene
6. Bt Cotton
7. Herbicide-resistant plants
8. Plant viruses as vectors (eg CaMV virus)

C. Transgenic Animals **(7)**

1. Selectable markers for animal cells eg HAT, methotrexate
2. Reporter genes for promoter analysis (Lac Z, GFP)
3. Viruses as gene-transfer vectors (Baculoviruses)
4. Methods for production of transgenic mice (Pronuclear microinjection, retroviruses, Embryonic stem cells)
5. Transgenic mouse / Super mouse – (MT promoter fused to human growth hormone)
6. Transgenic Goats (isolation of cloned proteins from goat milk)
7. Whole animal cloning eg Dolly

**Unit IV** **(15 lectures)**

A. Advanced Transgenic Technology: **(4)**

1. Knock-out, knock-down, knock-in technology
2. Site-specific recombination using Cre-recombinase LOX system
3. Gene therapy eg SCID

B. Gene cloning and DNA analysis in : (one example each) **(2)**

1. Medicine and Agriculture,
2. Forensics and Archaeology

C. Ethics of Cloning : GM foods, Animal Cloning **(1)**

D. Bioinformatics: **(8)**

1. Databases
2. Analyses programs (FASTA, BLAST, CDD, CLUSTALW, RASMOL, SWISSPROT, PDB, SignalP)
3. Sequence annotation

4. Molecular phylogeny and evolution
5. Gene expression Omnibus, OMI: (how a gene is altered in different diseases)

**References:**


1. Principles of gene manipulation by S.B. Primrose and Twyman, 7th Ed, Blackwell Sc., 2006
2. Principles of gene manipulation by R.W. Old and S.B. Primrose, 6th edition, Blackwell Sc., 2004
3. Recombinant DNA by Watson, 3rd ed. ASM Press, 2001.
4. Gene cloning and DNA analysis by T.A. Brown, 2nd ed. 2009
5. Bioinformatics-Methods and Applications by S.C. Rastogi et al 2nd edition, 2006
6. Integrated Genomics by A. Caldwell et al, Wiley Publishers, 2006
7. Molecular Biotechnology- Principles and application of recombinant DNA, 4th ed., B. Glick et al, ASM Press, 2010.
8. Biotechnology- Applying the genetics to revolution, D. Clark, N. Pazdernik, Academic Press, 2009.

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC604**

**Title: Sustainable Development and Carbon Management**

**Learning Objectives:**

The course aims to sensitize the students towards the current issues related to environment management. At the end of the course the students are expected to:

1. Understand conservation of biodiversity and legal frameworks available for its implementation.
2. Identify the consequences of Global warming and Climate change and be informed of the various National and International Policies governing these issues.
3. Familiarize themselves with the basic tenets of sustainability.
4. Understand the concept of carbon currency in International Trade.

**Number of lectures: 60**

**UNIT I: Conservation of Biodiveristy (15 lectures)**

1. Valuation of biodiversity / living resources for active conservation.
2. National Parks and Sanctuaries (establishment, designing and management).
3. The importance of Sunderbans and wetlands in India.
4. Provisions for inventorying and monitoring the conservation process.
5. Ex-situ conservation: (Zoos, aquariums, botanical gardens, herbariums and arboretums).
6. Eco tourism.
7. Earth Summits
8. Man and Biosphere program.
9. Overview of Indian Legislation - Wild life Protection Act, Environment Protection Act, CITES and CBD.
10. Intellectual property and status of India.

**UNIT II: Global warming and Climate change (15 lectures)**

1. Greenhouse Gases, Global Warming Potential (GWP), Greenhouse Gas Effect and Global Warming
2. Causes of Climate Change
3. Impact of Climate Change on Ecology and Biodiversity
4. Effects of Climate Change – on agriculture, human health and economy.
5. Adaptations to Climate Change - Indicators
6. International Protocols and National policies: Montreal, Kyoto, COP, CDP, GHG, GRI, NAPCC, PAT and REC
7. Concept of Carbon Footprint

**UNIT III: Concept of Sustainable Development (15 lectures)**

1. Introduction to sustainability- theory and principles.
2. Practices for sustainable agriculture.
3. Importance of local and indigenous varieties.
4. Remote sensing technologies for monitoring.

5. Sustainability in Urban Development and Planning – LEEDS & GRIHA rating of buildings.
6. Principles of market demand and supply- green products.
7. Principles of enterprise- greening supply chains.
8. Economic Evaluation of eco-system goods and services

**UNIT IV: Carbon Management** **(15 lectures)**

1. Carbon markets and international climate change mitigation mechanisms.
2. Carbon foot printing and Greenhouse gas auditing (GHG protocols under Scope 1, Scope 2 and Scope3).
3. National Action Plan on Climate Change: a) National Solar Mission, b) National Mission for enhanced Energy Efficiency, c) National Water Mission, d) National Mission on Sustainable Habitat, e) National Mission for Sustainable Agriculture, f) National Mission for Sustaining the Himalayan Ecosystems, g) National Mission for Green India, h) National Mission on Strategic Knowledge of Climate Change.
4. EIA case studies- National and International.
5. Carbon Footprint Reduction Strategies & the Abatement Curve

**References:**

1. Gadgil M. (2002). *Diversity the cornerstone of life.* Edited by Bittu Sahgal . NCSTC-HORNBILL. Natural History Series
2. Sathasivam K. & WWF-India (2004). *Marine Mammals of India*. Universities Press (India) Private Limited, India.
3. Menon S. (2000). *Trees of India*. Timeless Books (New Delhi), India
4. Biodiversity in India, Volume 4, T. Pullaiah, Daya Books, 2006
5. Biodiversity in India: issues and concerns, Sadasivam Kannaiyan, A. Gopalam, Associated Pub. Co., 2007
6. Biodiversity and ecological economics: participation, values, and resource management, Luca Tacconi, Earthscan, 2000

**Practicals - SLSC6PR:**
**Immunology:**

1. Study of Antigen Antibody Interaction:
   a. Agglutination reactions:
      i. Blood typing: Direct and reverse.
      ii. Determination of Isohemagglutinin titre in blood.
      iii. Quantitative Widal test.
   b. Precipitation reaction:
      i. Determination of shared epitopes between antigens: Ouchterlony test (Double diffusion).
      ii. Quantitative determination of antigen: Mancini test (Single Radial immunodiffusion)
2. Separation of mononuclear cells (lymphocytes) from blood using density gradient and the determination of viable count of the same
3. Electrophoresis of serum proteins
4. ELISA as a diagnostic tool (demonstration)
5. Advanced techniques in immunology (principle, technique and research applications): Fluorescence Activated Cell Sorter (FACS)

**Neurobiology**:

1. Study of nervous system using permanent slides - Spinal Cord, Retina, Brain
2. Temporary mount of cornea and statocyst of Prawn
3. Dissection and display of vertebrate brain - Bony fish
4. Dissection and display of vertebrate brain - Hen brain
5. Anatomical study of mammalian brain - Goat brain
6. Organization of grey and white matter in vertebrate brain using Mulligan's stain
7. Cognitive tests
   a. Blind spot test
   b. Stroop test
   c. Cognitive test using COGLAB

**Recombinant DNA Technology and Bioinformatics:**

1. Cloning and expression of an eukaryotic gene in *E.coli*
   a. Genomic DNA extraction
   b. Plasmid DNA extraction
   c. Restriction enzyme digest of plasmid and genomic DNA
   d. Ligation
   e. Competent cells preparation and transformation of *E.coli* hosts
   f. Antibiotic / lac Z Selection
   g. Expression of a gene (pGlo)
2. Bioinformatics problems
3. PCR of genomic DNA using specific primers
4. Problems on DNA fingerprinting
5. Problems on restriction mapping
6. Use of NEB catalogue: comparison of different restriction enzymes and vectors

**Sustainable Development and Carbon Management**:

1. Estimation of Dissolved Oxygen content of a given water sample
2. Estimation of BOD of a given water sample
3. Estimation of COD of a given water sample
4. Estimation of phosphorus in a given water sample
5. Estimation of chromium in a given water sample
6. Estimation of lead in a given water sample
7. Effect of pesticides on the heart rate of *Daphnia*
8. Quadrat and Transect Analysis
9. Calculating Carbon footprint of the College or Department or Malhar or any other suitable place/ service using available Carbon tools
10. Calculating a Carbon Footprint or Emissions from a particular source - Life Cycle Analysis (LCA) of Products
11. Creating and Marketing a Green Product or Service

**Template of Theory Question paper**
**T.Y.B.Sc. LIFE SCIENCE**
**Courses 601, 602, 603, 604**

**CIA I – 20 marks, 45 mins.**
**Unit I:** Objectives/Short questions

**CIA II – 20 marks, 45 mins.**
**Unit II:** Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam – 60 marks, 2 hours**
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15 marks to be answered out of 22-30 marks
**Question 4:** Unit III: maximum marks per sub-question - 12 marks
15 marks to be answered out of 22-30 marks

**Mark-distribution pattern for Practical**
**Course: SLSC6PR**

| **CIA & End Semester Practical Examination** | **Total marks: 200** |
|---|---|
| **CIA per course** | |
| Q1. Any one / two practicals | 15 marks |
| Q2.Journal | 05 marks |
| | |
| **End semester Practical Examination** | |
| Q1. Any two / three practicals | 20 marks |
| Q2. Identification/project report/viva | 05 marks |
| Q3.Viva / Identification | 05 marks |


# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 5th Semester Courses in
# ENVIRONMENTAL SCIENCE

(June 2018 onwards)

Contents:
Syllabus (theory and practicals) for Courses:

SLSC5AC Environment and Environmental Pollution

Template for theory and practical question paper

# ENVIRONMENTAL SCIENCE

**T.Y.B.Sc** **Course No.: SLSC5AC**

**Course title: Environment and Environmental Pollution**

**Learning objectives:**
The course must enable the student to:

1. Describe the various life support systems that exist on earth
2. Understand the importance of these life sustaining resources to man
3. Recognize the implications of overuse or misuse of these resources

**Number of lectures: 60 Lectures**

**UNIT I Life's Support Systems** **15 lectures**

1. Atmosphere – Origin, composition, structure; variables – temperature, pressure,
2. humidity; atmospheric observations using radar systems and satellite imagery (**3**)
3. Hydrosphere – Characteristics; Hydrological cycle; Ocean, snow & ice, fresh water systems; El Niño, La Niña (**3**)
4. Lithosphere – Formation, Zonal structure, Soil studies – origin, profile, texture,
5. physic-chemical properties, classification, soil as a habitat (**3**)
6. Biogeochemical cycles – C, N, O, P, S, Ca, Mg (**3**)
7. Abiotic Factors – Temperature, Light (**3**)

**UNIT II Environment as an Over-Exploited Resource** **15 lectures**

1. Fossil fuels – Coal, Petroleum & Natural Gas (prospecting, mining, refining and utilization of each) (**3**)
2. Mineral resources – Environmental impact of mineral mining (Case Study – Kudremukh, Vedanta, Mining in Goa) (**2**)
3. Forest resources: Use and over exploitation, deforestation, case studies, timber extraction (**2**)
4. Ocean resources: (**2**)
5. Implications of uncontrolled exploitation of marine resources: fishing, continental shelf & deep sea mining
6. Water resources: (**3**)
   a. Use and over utilisation of surface and ground water (Case Study – Coca Cola)
   b. Conflicts over water
   c. Dams – benefits and problems (Case Study - Narmada, Yangetze)
7. Land resources: Land as a resource, man-induced land-slides, soil degradation soil erosion and desertification, land use change. (**1**)
8. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture (eg. GM crops), fertilizer - pesticide problems, water logging, salinity, case studies (**2**)

**Unit III : Environmental Pollution** **15 lectures**

A. Water Pollution

1. Sources and classification of water pollutants **(2)**
2. Water pollution parameters and their biological significance **(7)**
    a) Physical parameters: colour, odour, temperature, turbidity, and density
    b) Chemical parameters: suspended solids, total and dissolved solids, hardness of water, acidity, alkalinity, pH, dissolved oxygen, Ions- iron, copper, manganese, nickel, potassium, calcium, nitrate, phosphate, fluorides, chlorides
3. Detergents
4. Biological pollutants- Coliforms, faecal streptococci, BOD, COD and their significance as pollution indicators
5. Thermal pollution: Waste heat and its uses, cooling ponds and towers, effect of thermal pollution on life and atmosphere **(2)**
6. Ground Water pollution (case studies: Love Canal) **(1)**

B Noise Pollution **(3)**

1. Sources and types of noise
2. Sonic boom, measurement of noise
3. Effects of noise and control of pollution.

**Unit IV** **15**

A. Air pollution **(10)**

1. Types & Classification of air pollutants
2. Gaseous inorganic air pollutants: NOx, SOx, CO, $CO_2$, $H_2S$, $NH_3$, $O_3$.
3. Organic air pollutants- aliphatic and aromatic compounds
4. Particulate matter-types, properties and effects
5. Acid rain, Photochemical smog
6. Depletion of ozone layer,
7. Green house effect
8. Economic impact of air pollutant

B. Chemical Toxicology **(5)**

Sources and biochemical effects of Arsenic, Mercury Cadmium, Lead, Cyanide, perioxyacetyl nitrate (PAN), pesticides, carcinogens, radioactive pollutants, Dioxins

**References**


1. G.T. Miller Jr. *Living in the Environment (15th Edition)*; Thompson Brooks/ Cole
2. D.B.Botkin and E.A.Keller *Environmental Science (4th Edition)*; John Wiley & Sons Inc.
3. M.L.Cain, W.D. Bowman and S.D. Hacker *Ecology*; Sinauer Associates Inc.
4. R.M. Harrison (Ed.) *Understanding Our Environment;* Royal Society of Chemistry Press
5. E. Agaudo and J.E. Burt *Understanding Weather and Climate (2nd Edition)*
6. Alan Strahler and Arthur Strahler *Introductory Physical Geography and Science of Human Environment (3rd Edition)*; Transparency Acetates
7. NASA Earth System Study Guide (free-online guide)
8. K.Omasa, H.Saji, S. Youssefícin *Air Pollution and Plant Biotechnology (2007)*; Springer International Edition
9. S.P. Mahajan *Pollution Control in Process Industries (1985);* Tata MsGrawHill Company
10. G.S. Sodhi *Fundamental Concepts of Environmental Chemistry (2005)*
11. A.K. Bhagi and G.R. Chatwal *Environmental Chemistry (2003)*; Himalaya Publishing House
12. A. Sharma and Kaur *Environmental Chemistry*

**Practicals: SLSC5ACPR**

1. Determination of pH – pH paper and pH meter
2. Determination of Hardness
3. Determination of Acidity
4. Determination of Alkalinity
5. Determination of Chlorinity
6. Sulphate Estimation
7. Nitrite Estimation
8. Phosphate Estimation
9. Determination of Conductivity
10. Dissolved Oxygen (DO)
11. Most Probable Number (M.P.N.)
12. Copper Estimation

**Template of Theory Question paper**
**SLSC5AC**

**CIA I**– 20 marks, 45 mins.
Short/Essay questions, not more than 10 marks each

**CIA II** - 20 marks, 45 mins
Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam** – 60 marks, 2 hours.
Question 1: Unit I: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks
Question 2: Unit II: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks
Question 3: Unit III: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks
Question4: Unit IV: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks

**Mark-distribution pattern for Practical**
**Course: 5ACPR**

| **End Semester Practical Examination** | **Total marks: 50** |
|---|---|
| Experiments | 35 marks |
| Identification | 10 marks |
| Journal | 05 marks |

# St. Xavier's College – Autonomous Mumbai

# Syllabus
# For 6th Semester Courses in
# ENVIRONMENTAL SCIENCE

(June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Course:
SLSC6AC Environment Sustainability and Legislation

Template for theory and practical question paper

## LIFE SCIENCE

**T.Y.B.Sc.** **Course No.: SLSC6AC**

**Title: Environment Sustainability and Legislation**

**Learning Objectives:**

On completion of this course, a student must:

1. Know how waste is managed
2. Understand the need for and measures available for sustainable development & carbon management
3. Be aware of the various primary and renewable sources of energy
4. Be familiar with basic environmental legislations

**Number of lectures: 60**

**UNIT I** **(15 lectures)**

1. Waste-water treatment: Water treatment systems: Primary, Secondary and Tertiary treatment of waste water, advanced techniques of water treatment, sewage treatment, water reuse and recycling in industries and agriculture. **(8)**
2. Solid and Hazardous waste management: **(6)**
   a. Sources of solid waste – municipal, industrial, agricultural, biomedical, e-waste, radioactive wastes
   b. Integrated waste management of solid waste
   c. Case studies
3. Management of Spillage of petroleum products (Case Study – Bharat Petroleum) **(1)**

**UNIT II** **(15 lectures)**

1. Treatment of polluted soils: Bioremediation, rejuvenation **(2)**
2. Clean Technologies- **(5)**
   Concept of clean technology, green technology, green chemistry
   Case studies of various industries with respect to Good Manufacturing practices, Hazard Analysis Critical Control Points (HACCP), ISO certification, Cradle to cradle vs. Cradle to grave – manufacturing.
3. Sustainability & Business – cradle to cradle, greening supply chains, triple bottom line approach and Corporate Social responsibility (CSR).
4. Disaster Management **(8)**
   Natural: Example- forest fires, Tsunami, floods, hurricanes, tornadoes, cyclones etc.
   Anthropogenic- nuclear reactors (Chernobyl/ 3- Mile Island), Bhopal Gas Tragedy, Oil Well fires

**UNIT III** **(15 lectures)**

Renewable energy technologies:

1. Need for renewable resources
2. Solar energy-based technology – space & water heating devices, Solar collectors, PV (solar) cells, Solar ponds,
3. Wind Turbine technology – Principle & working of a wind turbine – Energy Laws in India – Case Study of Wind Farm Projects in India
4. Hydrogravitational energy – hydroelectric power plant, tidal energy towers

5. Fuel cell technology
6. Geothermal energy
7. Biomass – briquetting, gasification
8. Nuclear power – Fission reaction, design of a nuclear power plant, fissile uranium and transuranic waste, decommissioning of nuclear power plants; environmental impact of nuclear power plant (case studies: Japan, Kalpakam)

**UNIT IV** **(15 lectures)**

1. Environmental legislations: **(10)**
   a. National Action Plan on Climate Change (2008) – 8 Core Missions of (i) National Solar Mission, (ii) National Mission for Enhanced Energy Efficiency, (iii) National Water Mission, (iv) National Mission on Sustainable Habitat, (v) National Mission for Sustainable Agriculture, (vi) National Mission for Sustaining the Himalayan Ecosystems, (vii) National Mission for Green India and (viii) National Mission on Strategic Knowledge of Climate Change.
   b. Air - Prevention and control of pollution Act
   c. Water - Prevention and control of pollution Act
   d. Wildlife Protection Act
   e. Forest Conservation Act
   f. Environmental Protection Act
   g. International Legislation: Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species (CITES)
   (All of the above with cases studies)

2. Concept of Carbon Management **(5)**
   a. Climate Change & Carbon Management
      i. Causes & Effects of Climate Change
      ii. Implications on the environment, society and economy
   b. Kyoto and Montreal protocols
   c. Concept of Carbon Credits with case studies in India
   d. Concept of Carbon Footprinting & Carbon Disclosure Project (CDP)

**References:**

General

1. Hillary E. (1984). *Ecology 2000- The changing face of Earth*. Michael Joseph, London, UK.
2. Down to the Wire, Confronting Climate Collapse, Oxford University Press, 2009, David Orr.
3. C.P.R. Environmental Education Centre – *Plants And People*
4. Friedman Y. and Schaur E. (2003) *Environment and Self-Reliance.* Vigyan Prasar, New Delhi, India.
5. Friedman Y. (2003) *Energy and Self-Reliance.* Vigyan Prasar, New Delhi, India.
6. Chris Summerville (2006) *Looking Back, Moving Forward* – An Environmental Course for the Next Generation, Reading And Discussion – Macmillan Languagehouse
7. Kamla Chowdhry (1989) *Industrialisation Survival and Environment* – A Dialogue on Development The INTACH Environmental Series

8. Molly O'Mera Sheehan, Project Director (2007) – *State of the World –Our Urban Future* – A World watch Institute Report on Progress Toward a Sustainable Society. W. W. Norton & Company New York London
9. Relevant Publications from Center for Science & Environment (CSE).

Water

10. A Water Harvesting Manual for Urban Areas (Case Studies From Delhi and Mumbai). Centre for Science And Environment, New Delhi, India.
11. Shyam R Asolekar (Professor). (2007), *Wastewater Treatment For Pollution Control and Reuse* – Third Edtion - Tata McGraw-Hill Publishing Company Limited New Delhi
12. Agarwal A., Narain S. and Khurana S. (eds) (2001*). Making Water Everybody's Business - Practice and Policy of Water Harvesting*. Centre for Science and Environment, New Delhi, India.

Waste Management

13. Indian Centre for Plastics in the Environment (2003*) Plastics for Environment & Sustainable Development*, Thomson Press (India) Limited, New Delhi, India
14. Palnitkar S. (Dr, Mrs) *Solid Waste Management.* All India Institute of Local Self-Government, Mumbai, India
15. Palnitkar S. (Dr, Mrs) (2004). *The Wealth of Waste : Waste Recyclers For Solid Waste Management - A Study of Mumbai*. All India Institute of Local Self- Government, Mumbai, India

Environmental Legislations

16. Divan S. and Rosencranz A. (2001). *Environmental Law And Policy In India.* Oxford India Paperbacks, India
17. Environmental Legislation in India By K.R. Gupta

Renewable Energy Technology

18. Handbook of Renewable Energy Technology By Ahmed F. Zobaa, Ramesh Bansal
19. Renewable energy: technology, economics, and environment, Martin Kaltschmitt, Wolfgang Streicher (Ao. Univ.-Prof. Dipl.-Ing. Dr. techn.), Andreas Wiese, Andreas Wiese (Dr.-Ing.), Springer, 2007

**Practicals: SLSC6AC PR**

1. SOIL ANALYSIS
   a. Determination of pH
   b. $CaCO_3$ estimation
   c. Organic Matter
   d. Moisture Content
   e. Isolation and Gram Staining of *Azotobacter*

2. SEWAGE ANALYSIS
   a. Determination of pH
   b. TS, TDS and TSS in Effluents
   c. Specific gravity
   d. Biological Oxygen Demand (BOD)
   e. Chemical Oxygen Demand (COD)

3. LIGHT
   a. Measurement of light intensity using Luxmeter

4. MODEL-MAKING (preparation of a working model on any one of the following topics)
   a. Renewable energy systems (solar cell/ solar collectors/ wind turbine etc)
   b. Sewage Treatment Plant
   c. Carbon Management in Industry
   d. Energy efficient heating devices for housing complex / buildings
   e. Water Harvesting System
   f. Organic Farm
   g. Vermiculture

5. Site visit ex: Visit to Suzlon Campus (Pune)
6. Case study ex: Study of ECO-LINK at Daman- recycled polyal- Vapi
7. Screening of Short Films

## Template of Theory Question paper
## SLSC6AC

**CIA I**– 20 marks, 45 mins.
Short/Essay questions, not more than 10 marks each

**CIA II** - 20 marks, 45 mins
Test /Survey /Assignment /Presentation /Poster /Essay /Review

**End Semester exam** – 60 marks, 2 hours.
Question 1: Unit I: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks
Question 2: Unit II: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks
Question 3: Unit III: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks
Question4: Unit IV: maximum marks per sub-question - 6 marks
15 marks to be answered out of 22-23 marks

## Mark-distribution pattern for Practical
## Course: 6ACPR

| | |
|---|---|
| **CIA & End Semester Examination** | **Total marks: 50** |
| **CIA** | **Total marks: 20** |
| Q1. Model making | 15 marks |
| Q2. Journal | 05 marks |
| **End Semester Practical Examination** | **Total marks: 30** |
| Q1. Major experiment | 20 marks |
| Q2. Minor experiment/ Case Study Report/ Field Visit Report | 10 marks |