St. Xavier's College – Autonomous
Mumbai

Syllabus
For 4th Semester Courses in
LIFE SCIENCE
(June 2013 onwards)

Contents:

LIFE SCIENCE

S.Y.B.Sc **Course Code: S.LSC.4.01**

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

Practicals S.LSC.4.01 PR:

1. To study the sections of kidney, liver, testes, ovary, thyroid, adrenal, stomach, thymus, bone marrow and cartilage.
2. Observation of permanent slides of developmental stages of frog till gastrula
3. Pollen tube germination in different plants
4. Effect of minerals/heavy metals on pollen tube germination
5. Comparative study of nervous system of invertebrates with the help of slides/photographs
6. To demonstrate the effect of the growth hormone (GA) on seed germination with respect to amylase activity

Group Projects:

1. Effect of toxins/ growth factors/hormones on seed germination
2. Effect of different conditions like temperature, pH etc on the activity of acetylcholine esterase enzyme
3. Grow Zebra fish in Lithium/heavy metal and see toxicity in developing embryo.
4. Any other suitable project

References:

1. Human Anatomy and Physiology –Tortora and Grabowski
2. Medical Physiology – Guyton
3. Physiology by Withers
4. Human Physiology by Ross and Taylor
5. Biology – Solomon and Berg, 8th Edition
6. Biology – Campbell & Reece, 8th Edition.

LIFE SCIENCE

S.Y.B.Sc. **Course No. S.LSC.4.02**

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 a gene (1)
3. Classes of RNA molecules (1)
4. Transcription (7)
   a. In prokaryotes
   b. In eukaryotes
      i. Types of RNA polymerases
      ii. RNA polymerase II transcription in brief (concept of promoters, upstream activation sites, enhancers, silencers)
      iii. pre mRNA processing: RNA splicing, capping, polyA tail
5. Reverse transcriptase
6. Inhibitors of transcription e.g.: rifampicin

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 e.g.: streptomycin, puromycin
2. Gene regulation (8)
   a. Prokaryotes (5)
      i. Levels of regulation
      ii. Operon model: lactose, tryptophan,
      iii. Problems on lac operon
   b. Lambda phage: choice between lytic and lysogenic cycles (3)

UNIT III: DNA mutation and repair (15 lectures)

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 versus induced; point versus chromosomal (giving examples of *Drosophila* mutants)
3. Point mutations:
   a. Base substitutions: transitions, transversions
   b. Frame-shift: addition, deletion, suppressor mutations
4. Chromosomal mutations:
   a. Structural: deficiency, duplication, inversion, translocation
   b. Numerical: aneuploidy, euploidy, concept of non-dysjunction
5. Human genetic disorders: Sickle cell anemia, Philadelphia chromosome, Down's syndrome, Turner's syndrome, Fragile X chromosome
6. DNA repair mechanisms – photo-reactivation repair, excision repair

Practicals S.LSC.4.02 PR

1. Extraction of genomic DNA and estimation of purity and yield by UV absorbance
2. Estimation of ribose by orcinol method
3. Problems on lac operon
4. Study of DNA repair mechanism in *E. coli*: UV induces damage and light repair
5. Study of central dogma of molecular biology: using problems
6. Study of polytene chromosome from *Chironomous* larvae
7. Replica plate technique for isolation of auxotrophs
8. Projects:
   a. Isolation and study of plasmids from naturally occurring antibiotic resistant strains
   b. Extraction of genomic DNA and estimation of purity and yield by UV absorbance using different protocols from the same source
   c. Extraction of genomic DNA from phage, bacterial, plant and animal sources

References

1. Molecular Biology of the Gene (4th edition) – Watson et al
2. Lehninger's Principles of Biochemistry (5th Edition) – Nelson & Cox
3. Biochemistry (6th Edition) – Lubert Stryer
4. i-Genetics (2nd Edition) – Peter J. Russell
5. "Genome" by Mark Ridley
6. Double Helix by JD Watson

LIFE SCIENCE

S.Y.B.Sc **Course Code: S.LSC.4.03**

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. χ^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)

Practicals S.LSC.4.03 PR:

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 χ^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
11. List of sample projects:

a. Biostatistical analysis of effect of different concentrations of heavy metals on seed germination & length of shoot.
b. Statistical analysis of change in heart rate of Daphnia under different conditions of stress.
c. To make a questionare/survey – one group in the class makes the questionare and the other group conducts it (should be double blind).
d. Statistical analysis of phenotypic data

Reference books for Biostatistics:

1. Sokal R R and Rahlf H A (1995) Biometry: the principles and practice of Statistics for Biology. research. 3rd edi W H Freeman and Co.
2. Zar J H (1998) Biostatistical analysis 4th ed. Prentice Hall
3. Satistics Alive
4. Statistics for Behavioural Science Gravetter

Reference books for Population Genetics:

1. Biology by Brooker, Widmaer, Graham, stiding, Mc Graw Hill Intl Edn. 2008
2. Concepts of Genetics: Klug, Cummings, Spencer 8th Edn, 2006
3. Genetics – Peter Russel latest edition
4. Genetics – Strickberger latest edition
5. "The beak of the Finch" by Weiner

Template of Theory Question paper

SYBSC LIFE SCIENCE (2013-14)

Courses 4.01, 4.02, 4.03

CIA I – 20 marks, 45 mins.

Unit I: Objectives/numerical problems, not more than 5 marks each

CIA II – Mid Semester exam – 20 marks, 45 mins.

Unit II: Objectives/numerical problems, not more than 5 marks each

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

CIA & End Semester Practical Examination

4.01, 4.02, 4.03

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 reportviva	10 marks