St. Xavier's College – Autonomous Mumbai

Syllabus
For 4th Semester Courses in
LIFE SCIENCE

Contents:

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*.

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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. 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)**

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 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

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