

# **UNIVERSITY OF MUMBAI**



**Syllabus for the S.Y.B.Sc.**

**Program: B.Sc.**

**Course: Life Science**

(Credit Based Semester and Grading System with  
effect from the academic year 2012–2013)

NEW SYLLABUS OF S.Y.B.Sc. IN LIFE SCIENCES  
(SEMESTER BASED CREDIT AND GRADING SYSTEM)  
TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2012-2013

**T H E O R Y**

**SEMESTER I**

**USLSC 301**

**Comparative Physiology (Total Lectures: 45)**

(The number of periods for each topic is given in brackets)

**PREAMBLE:**

Comparative approach to Physiology should indicate and remind students that in isolated, narrow subdisciplines there is also a wealth of information that can be obtained from unrelated and distant organisms. Thus comparing and contrasting diverse mechanisms provides a cohesive understanding of physiology. Further understanding normal physiology also helps in treatment of diseases which leads to its alteration.

**Control and Coordination**

**Unit I**

**Homeostatic mechanisms and cellular communication**

Control systems in homeostasis and components of homeostatic control (1)

An overview of cell signalling and biochemical basis of cell signalling - Release and transport of chemical messengers, communication of signal to target cell (5)

Cell signalling in the nervous system and endocrine system [eg. Peptide hormones, steroid hormones and amines (catecholamine and thyroid hormones)] -- Regulation of receptors (up and down regulation) --- Regulation of cell signalling: 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order feedback mechanisms. (3)

**An overview of endocrine glands and their hormones (3)**

Pineal, Hypothalamus, Anterior pituitary, Thyroid, Parathyroid, Pancreas, Adrenal cortex, Testis and Ovary. Arthropod steroid hormone: ecdysone.

**Plant hormones and their role in Homeostasis (3)**

Ethylene, Cytokinin, Abscisic acid, Giberillic acid, Auxins (structure and functions)

**Unit II**

**Control and Coordination in plants and animals**

**Animals:**

The Nervous System – CNS and PNS overview (2)

Nature of the Nerve Impulse – Resting potential, Action Potential, Transmission of Nerve impulses and synapses (5)

Phylogenetic development of the Nervous System – nerve net, nerve plexus and ganglionated nervous system in hydra, starfish and earthworm. (1)

Behaviour and behavioural adaptations – Innate and learned behaviour (habituation) (2)

**Plants:**

- Plant movements – Tropisms, Taxes, Nasties and Kinesis – discuss with reference to a hormone eg. auxins (3)  
Circadian rhythm in plants using suitable example. (2)

**Unit III**

**Reproduction and Development**

- Endocrine regulation of reproduction in human: (7)  
General principles of gametogenesis in human reproductive system  
Sex determination : Role of SRY gene and Aromatase  
Sex determination in plants Eg. Maize  
Sex reversal and role of environmental factors in sex determination.  
Sex differentiation of gonads, internal and external genitalia.  
Ovarian and testicular functions, puberty and regulation of uterine changes in menstrual cycle, menopause, pregnancy, parturition, lactation.  
Artificial regulation of reproduction: Use of contraceptive methods

**An overview of sexual and asexual reproduction :** (3)

- Asexual reproduction: Parthenogenesis in insects eg. Wasp/Honey bee/Ants  
Fig wasp / Gall wasp : An interesting plant-animal interaction for reproduction

**Alternation of generations in plants (sporophyte and gametophyte stage in fern) :** (2)

- Fruiting body formation in slime mold (*Dictyostelium discoideum*)

**Gametogenesis and early development in Plants and animals:** (3)

- Microsporogenesis and megasporogenesis.  
Types of ovules and fertilization.  
Development of embryo in monocot and dicot plants

Type of egg in frog: Cleavage and development of embryo in frog.

**USLSC 302**

**Life processes at the tissue, organ and organism levels**  
**A Biochemical Approach**

**(Total Lectures: 45)**

**PREAMBLE:**

To understand the detailed functioning of a cell it is necessary to study it at the molecular level. Basic biochemical processes in cells and tissues and their regulation and integration are the mainstay of a normal functional cell.

**UNIT I Enzymes and their environment (Total 15)**

- A. **Water, pH, Buffers** – a review, stressing on the significance (3)  
B. **Enzymes** (12)

1. Extraction, purification and Specific activity  
(Mention Techniques : Dialysis, Gel-filtration, Ion-exchange, Affinity chromatography and Spectrophotometry)
2. Classification
3. Effect of pH and Temperature
4. Co-enzymes and co-factors
5. Kinetics
6. Enzyme Inhibitors, Activators and feed-back
7. Allosteric enzymes and their significance in metabolic regulation

**UNIT II Metabolism - Energy from Carbohydrates : (Total 15)**

**A. Carbohydrates - Catabolism (9)**

1. Glycolysis – process and metabolic regulation
2. Citric Acid Cycle –
  - a) Process and regulation.
  - b) Importance as a central amphibolic pathway unifying all primary biological processes.
  - c) Anaplerosis

**B. Bioenergetics :**

1. Electron Transport System (2)
  - i. Localisation and
  - ii Sequence of electron transporters
2. Oxidative Phosphorylation (4)
  - i. Mitchell's Chemiosmotic Hypothesis
  - ii. ATP synthesis
  - iii. Control of respiration, uncoupling and metabolic poisons

**UNIT III Metabolism - Energy from Lipids and Proteins : (Total 15)**

**A. Lipids - Catabolism : (7)**

1. Lipolysis
2. Role of Carnitine in mitochondrial permeability
3. Beta– Oxidation of fatty acids and integration into  
Kreb's cycle
4. Ketone bodies and their significance

**B. Amino Acids - Catabolism : (8)**

1. Protein Degradation liberating amino-acids'
2. Deamination & ammonia disposal by Urea cycle.
2. Decarboxylation & integration into Kreb's cycle

**USLSC 303**

**Population approach : population and communities as regulaory unit**

**PREAMBLE:**

As T. Dobzansky said "Nothing in biology makes sense unless seen in light of evolution". The first two units are an introduction to basics in evolution and its modern syntheses with focus of integrating genetics and population.

Quantitation is an important aspect of modern biology. A clear understanding of how to handle measurements and biological variation in a variety of experimental setups is obligatory. Unit 3 and 4 include fundamentals of biostatistics. Further elementary bioinformatics has been added to introduce students to 'in silico' laboratories available.

Population dynamics of human population are not only dependent on biological forces but also social forces. The diseases prevalent in an area often are a reflection of both. Units 5 & 6 introduces students to these concepts and discusses some epidemiologically important diseases.

**UNIT I: Concepts in Evolution and Population Genetics (15)**

1. Darwinism: Conceptual arguments for evolution by Natural Selection given by Charles Darwin and Alfred Wallace.
2. Evidences for evolution: Comparative anatomy and embryology, Fossil records and living fossils, Artificial selection.
3. Populations and allelic frequencies, Hardy Wienberg Equilibrium, change in gene frequencies due to selection, mutation, migration and genetic drift (founders effect).
4. Origin of variability, polymorphism, kinds of selection – directional, stabilising and disruptive, ecological aspects of population growth- density dependent and density independent influences, r and k selection, selectionist vs neutralist.
5. Evolutionary significance of biodiversity-food chains and food webs with examples

**UNIT II : BIOSTATISTICS (15)**

1. Introduction, uses of statistics, sources of data, diagrammatic presentation : bar diagram, Multiple bar diagram, pie diagram. Preparing frequency tables.
2. Central tendency and its measures :- mean, median, mode.
3. Dispersion and its measures : range, coefficient of range, variance and standard deviation coefficient of variation

**UNIT III : BIOSTATISTICS AND BIOINFORMATICS (15)**

**Biostatistics (cont'd)**

4. Bivariate data, scatter diagram and its uses, Karl Pearson's correlation coefficient, Regression equations and their uses
- 5.

**Bioinformatics**

Introduction to bioinformatics : Concept of information network: internet , IP address, TCP/IP,FTP,HTTP,HTML and URLs, Virtual libraries (concept of databases and their use in Biology) The European Molecular Biology Network,- EMBnet, The National Center for Biotechnological Information – NCBI, Pub Med

**S.Y.B.Sc. (LIFE SCIENCES)**

**PRACTICALS**

**USLSCP3**

(Based on paper1)

1. Good Laboratory Practices. (1 practical)
2. Demonstration of reproductive system and location of endocrine glands in Albino Mouse Male and Female. (1 Practical)

3. Microtomy and preparation of Endocrine gland slides from above dissected specimen or any suitable plant specimen ( 4 practicals)
4. Study of Histological features of Endocrine glands. (1 practical)
5. A complete study of Frog Embryology( Egg to Tadpole to Adult). (1 practical)
6. Study of Floral parts from the given flower.study of microscopic structure of anthers , ovules, and seed structure.
7. Study of pollen germination Using Vinca flower (in vitro) (1 practical)
8. Study of in vivo pollen germination in Hibiscus (in Vivo) (1 practical)
9. Detection of activity of plant hormones. (1 practical)

**USLSCP3**

(Based on paper 2)

**This practical involves the following points relevant to Biochemistry :**

**A. Instrumentation / Technique ( I / T )**

- pH metry
- Colorimetry
- Titration

**B- Process / Concept and immediate Relevance ( C and R )**

- Extraction, Purification
- Analysis / Estimation
- GLP(Good Laboratory practices) incorporated into every practical

**Acid, bases and buffers :**

1. pH meter – (i) principle & instrumentation and (ii) determination of pH (titration of Acids/Bases/Buffers/ 'chameleon balls'). **I, C, T** (*in FY the student was introduced to the concept of pH measurement of familiar liquids-here tech & details are given- practically understanding buffering using Glycine/titration curve*)
2. Protein precipitation by pH manipulation ( Casein from Milk/ Curds) **C, R** (*From previous experiment and pH manipulation, proteins can be precipitated*)

**Enzymology & localization :**

3. Study of Enzyme activity and Kinetics : Determination of  $K_M$  of an enzyme – Urease (from Jack beans)/Lipase/Protease(from detergents) **I, C, T**  
(*Enzyme activity can be detected and estimated - using colorimetry*)
4. Histochemical localization of Enzymes (Acid Phosphatase) **C, T**  
(*Enzyme activity can be localized*)

**Estimation / Quantitation :**

5. Colorimetric Protein Estimation by Biuret Method (Enzyme extract / Casein from previous expts.). **I, C, T**  
(*Proteins, such as the isolate from experiment 2 can be estimated by colour reaction*)
6. Colorimetric Cholesterol Estimation / total Lipid Estimation from egg. **C, T, R**  
(*lipid metabolism is an important component of our systems, content can be estimated by colour reaction*)
7. Colorimetric estimation of Inorganic Phosphates by Stannous chloride method. **C, T,R**  
(*Estimation of biologically relevant inorganic ions by colorimetric method*)
8. Titrimetric estimation of Ascorbic acid (Vit C). **C, T, R**

*(Estimation of biological materials by non-colorimetric method)*

**USLSCP3**

(Based on paper 3)

- |   |              |
|---|--------------|
| 1. Measures of Central Tendency   | 1 Practical  |
| 2. Measures of dispersion,  | 1 practical  |
| 3. Correlation and Regression   | 1 Practical  |
| 4. Bioinformatics-  | 3 practicals |
| a. Database searching   |              |
| b. Introduction to ORF- 6 reading frames and sequence annotation  |              |
| c. Blast Search   |              |
| 5. Population Genetics- Calculation of Gene Frequencies by-   | 2 practicals |
| a. ABO Blood Group testing  |              |
| b. Phenotypic characters  |              |
| c. PTC testing for gene penetrance and expressivity   |              |
| 6. Project/Field work : Based on Population studies- Submission of project proposal - to be continued in Sem II |              |

**SEMESTER II**

**USLSC 401**

**Comparative Physiology**

**(Total Lectures: 45)**

**Altered Homeostasis due to stress and infections:**

**Unit I**

**Homeostasis to stress:**

**Thermal physiology:**

(5)

Thermal strategies in poikilotherms and homeotherms, ecto and endotherms.

Temperature regulating reflexes, acclimatization

Fever, Hyperthermia, heat exhaustion and heat stroke.

Antifreeze proteins.

Thermogenesis: shivering and nonshivering thermogenesis, Hyperthermia induced by pyrogens

Plant adaptation in extreme cold condition

(5)

**Fuel Homeostasis during exercise and Stress :**

(5)

Diabetes mellitus, hypoglycemia, increased plasma cholesterol

Regulation of energy stores: control of food intake

Role of Leptin and Kisspeptin

Overweight and obesity

Eating disorders: Anorexia and Bulimia Nervosa

## Unit II

### Homeostasis during infections

#### Defence mechanisms in plants (2)

biomolecules such as secondary metabolites, surface protectants and enzymes

#### Defence mechanisms in animals

Innate and Adaptive Immunity (1)

Mechanisms of Innate Immunity – In invertebrates (hemocytes) and in Vertebrates (physical and physiological barriers, phagocytosis and inflammation) (3)

Mechanisms of Adaptive Immunity – T and B cells (antigens and antibodies) (3)

#### Host Parasite Relationship (2)

Virulence factors and toxins: virulence factors, exotoxins, enterotoxins, endotoxins

Host factors in infection: host risk factors, innate resistance (2)

Parasite escape mechanisms (2)

## Unit III

**Infectious Diseases** (to be discussed with respect to epidemiology, aetiology, pathology (of target tissue only), diagnosis, therapy, preventive measures and vaccines)

**Vector borne Diseases** – Malaria, (2)

**Viral Disease** – Hepatitis, AIDS (3)

**Bacterial Diseases** - Tuberculosis, Leprosy, Typhoid, Cholera (4)

**Fungal Diseases** – Ringworm, Candidiasis (2)

**Helminthic Diseases** – Filariasis (1)

**Infections in Plants** - Tobacco mosaic virus, (3)

- Crown gall bacterial infection

- Puccinia fungal infection

## USLSC402

### Life processes at the tissue, organ and organism levels

#### A Biochemical Approach

#### Semester II

(Total Lectures: 45)

UNIT I Metabolism - Anabolism of biomolecules: (Total 15)

A. **Carbohydrate Anabolism :** (4)

1. Gluconeogenesis

2. Pentose phosphate pathway

3. Short account of polysaccharide synthesis



**B. Lipids Anabolism :**

1. Fatty acid biosynthesis (3)
2. Cholesterol and prostaglandin biosynthesis

**C. Amino-acid Anabolism :**

1. Transamination and its significance (2)
2. Glutamate synthesis

**D. Photosynthesis**

1. Photophosphorylation, Hill reaction (6)
2. C3 and C4 cycles
3. Photorespiration

**UNIT II Nucleic acids :**

**(Total 15)**

1. Chemistry of nucleic acids – Existence of two pathways for purine & pyrimidine synthesis and Significance of the 'salvage pathway' .
2. Absorption spectra and melting curves.
3. DNA replication system in prokaryotes – process and enzymes
3. Transcription (a) in prokaryotes - binding, initiation, elongation & termination and (b) In Eukaryotes - only in terms of different RNA polymerase along with promoters RNA processing – of rRNA, tRNA and mRNA (5'cap, polyA tail and intron splicing).
5. Reverse transcription.

**UNIT III Regulation of gene expression and Integration of metabolism (Total 15)**

**A. Protein biosynthesis :**

(12)

1. Translation : Genetic code; Translation system, post translational Modification
2. Regulation of gene expression – (a) Operon model ( Lac, Trp).  
(b) Gene splicing in immunoglobulin diversity.  
(c) Alternate splicing  
(d) RNAi

**B. Overview of metabolism :**

(3)

Integration of carbohydrate, protein, lipid and nucleic acid metabolism .

**USLSC403**

**Population approach : population and communities as regulatory unit**

**Semester II**

**UNIT I :**

**Evolution and its consequences**

(15)

1. Origin of Species: Biological species concept, morphological species, Allopatric and sympatric speciation, Isolating mechanism preventing gene exchange in populations. Rates of speciation- punctuated or gradual. Life history of a species, extinctions.
2. Genes and Phylogenetic relationships: Proteins based (eg. Haemoglobin), Gene duplications and divergence (eg. Globin genes), concept of paralogous and orthologous genes, Nucleic acid based phylogenies, restriction fragment Length

polymorphism, nucleotide sequence comparisons and homologies, mitochondrial DNA and tracing human phylogeny, Parsimony principle and limitations of molecular phylogenetic trees.

3. Human evolution: Factors in Human Origin: Bipedalism, improvement in food acquisition, improved predator avoidance and reproductive success, Hunter gatherer societies and evolution of communication –speech and language. Tool making. Altruism and kin selection.

4. Evolution and Society : Cultural vs biological evolution, social Darwinism, eugenics, reproductive technologies and genetic engineering- impact on human culture, gene machine vs intelligent design arguments.

#### **UNIT II: BIOSTATISTICS**

(15)

1. Probability definition, addition law, random variable, probability mass function, Binomial and Poisson probability mass functions.
2. Normal distribution and its properties, calculation of normal probabilities by using standard normal tables.
3. Hypothesis and its types, errors in testing and its types, level of significance, test for equality of two means.

#### **UNIT III:**

#### **BIOSTATISTICS AND BIOINFORMATICS.**

(15)

4. Applications of t- distribution : Paired and unpaired t tests, Chi Square test for independence 2x2 table, Analysis of variance one way classification

#### **Bioinformatics**

1. DNA sequence Data analysis- annotation of putative genes, translation of codes to amino acids letter code
2. Phylogenetic Trees

### **SEMESTER II**

#### **PRACTICAL**

#### **USLSCP4**

(Based on paper 1)

1. Observation and Study of locally collected Leaf Gall and any other one plant disease. (1 practical)
2. To demonstrate the effect of rooting powder on plants/seedling. (1 practical)
3. Extraction and detection of Plant alkaloids, saponines, tannins and volatile oils from suitable plant source.
4. Principle and working of home pregnancy test slide. (1 practical)
5. Widal Test- Qualitative. (1 practical)
6. Streak plating to isolate microorganisms from a mixed culture using differential media.

- |   |                |
|---|----------------|
|   | ( 1 practical) |
| 7. Antibiotic sensitivity of microorganisms.                              | ( 2practicals) |
| 8.Observation of Fish,chick , Goat brain ( external Morphology )          | (1Practical)   |
| 9. A Complete study of Frog embryology (Egg to Tadpole, Adult)            | (1 practical)  |
| 10. Study of effect of temperature and caffeine on heart beat of Daphnia. | (1practical)   |

#### USLSC4

(Based on paper2)

#### This practical involves the following points relevant to Biochemistry :

##### **A. Instrumentation / Technique ( I / T )**

##### **PAGE (Demonstration)**

- **Chromatography – Paper, Thin layer, Column**
- B- Process / Concept and immediate Relevance ( C and R )
  - **Extraction, Purification**
  - **Analysis / Estimation**
  - **GLP(Good Laboratory practices) incorporated into every practical**

#### Separation / Extraction techniques :

- |   |                |
|---|----------------|
| 1. Extraction and Detection of RNA/Ribose Sugars.<br><i>(Extraction of nucleic acid and detection by colour reaction)</i>   | <b>C, T</b>    |
| 2. Chromatography of Sugars – Circular/Ascending Paper<br><i>(Separation of carbohydrates and detection by colour reaction)</i>   | <b>C, T</b>    |
| 3. Thin Layer Chromatography for separation of Plant Pigments.(Slide-technique)<br><i>(Separation techniques for charged, uncharged materials based on solvent partition)</i> | <b>C, T,R</b>  |
| 4. Solvent Extraction of Lipids.<br><i>(Extraction of lipid and proportional estimation by weight)</i>  | <b>C, T, R</b> |
| 5. Column Chromatography of Proteins / Pigments.<br><i>(Separation technique for proteins/ other materials based on charge/size)</i>  | <b>I, C, T</b> |
| 6. Protein separation by PAGE (Demonstration)<br><i>(Separation techniques for charged materials based on electrophoretic mobility)</i>                                       | <b>I, C</b>    |

#### USLSC4

(Based on paper3)

- |   |             |
|---|-------------|
| 1. Comparative Anatomy of Brain (Invertebrate to vertebrate)-                                 | 1 Practical |
| 2. DNA extraction and it's quantification-  | 1 Practical |
| 3. Karyotyping- Plant /Animal genome-   | 1 practical |
| 4. <i>Chironomous</i> Larva- Study of Giant Chromosome from Salivary Glands                   | 1 practical |
| 5. Bioinformatics- Phylogenetic analysis using Globin gene-                                   | 1 Practical |
| 6. Application of normal distribution and hypothesis testing                                  | 1 Practical |
| 7. Applications of t distribution and Chi square distribution                                 | 1 Practical |
| 8. Analysis of variance one way classification -  | 1Practical  |
| 9. Project/Field work : Based on Population studies- preparation of power point presentation. |             |

## References

### USLSC 301 and 401

1. Plant physiology  
Taiz and Zeiger ( 5<sup>th</sup> edition ) (2010)  
Pub : Sinauer Associates.
2. Essential Developmental Biology  
J.M. W. Slack (2<sup>nd</sup> edition ) (2006)  
Pub: Blackwell Publishers
3. Developmental Biology  
Scott Gilbert (9<sup>th</sup> edition ) (2010)  
Sinauer Associates.
4. Fundamentals of physiology - A Human perspective  
L Sherwood 5<sup>th</sup> edition (2006)  
Pub : Thomson Brooks
5. Embryology of Angiosperms  
Bhojwani and Bhatnagar 4<sup>th</sup> edition (1999)  
New Delhi Vikas Pub
6. Vander's Human Physiology  
Widmaier, Raff, Strand (10<sup>th</sup> edition,) (2006)  
Mc Graw Hill Int. Edition.
7. Principles of Animal Physiology  
C Moyes and Schulte 2<sup>nd</sup> edition (2007)  
Peason Education.
8. Medical Microbiology: A guide to microbial infections .  
Greenwood, Slack, Peutherer and Barer 17<sup>th</sup> Ed (2007)  
Churchill Livingstone
9. Microbiology  
Davis, Dulbecco and Ginsberg. (1990)  
Lippincott Company, Philadelphia
10. Textbook of Microbiology.  
Ananthanarayanan and Panniker 5<sup>th</sup> Edition (1996).  
Orient Longman

### USLSC 302 and 402

1. Lehninger's Principles of Biochemistry  
Eds : D.L Nelson and M.M. Cox,  
Pub : W. H Freeman Publishers, New York. 4<sup>th</sup> edition (2005)
2. Biochemistry  
Eds : J.M. Berg, J L Tymencko and L. Stryer  
Pub : W H Freeman and co., New York. 5<sup>th</sup> edition (2002)
3. Fundamentals of Biochemistry by

Eds : D.Voet , J. G. Voet

Pub : John Wiley &Co., New York Pratt 1<sup>st</sup> ed (2004)

4. Principles of Biochemistry

Ed: Lehninger.A

Pub: CBS Publishers and Distributors, 2<sup>nd</sup> Edition (1993)

5. Principles of Biochemistry

Eds: Zubay G.L, Parson W.W. and Vance D.E.

Pub: W. C. Brown, First Edition (1995)

6. An Introduction to Genetic Analysis

Ed: Griffiths A.J. et al

Pub: W. H. Freeman (London) Seventh Edition (2000)

**USLSC 303 and 403**

1. Strickberger's Evolution – B. Hall and B. Hallgrimsson 4<sup>th</sup> Edition (2008) Jones and Bartlett Publishers

2. Remarkable Creatures: Epic Adventures in Search of the Origin of Species

Sean B. Carroll, (2009).

Mariner Books,

3. Population Genetics,

M.B.Hamilton, (2009).

Wiley-Blackwell,

4. Population Genetics : A Concise Guide

J.H.Gillespie, (2004)

Johns Hopkins University Press.

5. Methods in Biostatistics of Medical students and Research Workers

B.K.Mahajan, 8<sup>th</sup> Edition, (2010)

Jaypee.

6. Fundamental concepts of Bioinformatics

Krane and Raymer (2003)

Benjamin Cummings Publication.

7. Exploring Bioinformatics – A Project-based Approach

St. Clair and Visick (2010)

Jones and Bartlett Publishers

8. Bioinformatics for Dummies

Jean-Michel Claverie, Cedric Notredame, 2003,

John Wiley & Sons