



SOPHIA COLLEGE

(AUTONOMOUS)

Affiliated to the University of Mumbai

Syllabus for Semesters III to IV

Program : B.Sc.

Course: Life Sciences

(Choice Based Credit System with effect from the year 2018-19)

Sophia College (Autonomous)
S.Y.BSc. Life Sciences Syllabus

Choice based Credit and Grading System
Academic year 2018-2019

SEMESTER III

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	LECTURES
Paper I	Comparative physiology			45
SBSLSC301	1	Homeostasis	6	15
	2	Neuro Endocrine glands and their hormones		15
	3	Developmental biology		15
SBSLSCP301	Practical		2	
Paper II	Life processes at the tissue, organ and organism levels: A Biochemical Approach			45
SBSLSC302	1	Enzymes and their environment	6	15
	2	Metabolism - Energy from Carbohydrates		15
	3	Metabolism - Energy from Lipids and Proteins		15
SBSLSCP302	Practical		2	15
Paper III	Population approach: population and communities as regulatory unit			45
SBSLSC303	1	Concepts in Evolution and Population Genetics	6	15
	2	Biostatistics		15
	3	Bioinformatics		15
SBSLSCP303	Practical		2	

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SEMESTER IV

COURSE CODE	UNIT	TOPIC HEADINGS	CREDITS	LECTURES
Paper I	Comparative physiology			45
SBSLSC401	1	Homeostasis to stress	6	15
	2	Homeostasis during infections		15
	3	Infectious Diseases		15
SBSLSCP401		Practical	2	
Paper II	Life processes at the tissue, organ and organism levels: A Biochemical Approach			45
SBSLSC402	1	Metabolism: Anabolism of biomolecules	6	15
	2	Nucleic acids		15
	3	Regulation of gene expression and Integration of metabolism		15
SBSLSCP402		Practical	2	15
Paper III	Population approach: population and communities as regulatory unit			45
SBSLSC403	1	Evolution and its consequences	6	15
	2	Biostatistics		15
	3	Bioinformatics		15
SBSLSCP403		Practical	2	

SEMESTER III

SBSLSC301

PAPER I COMPARATIVE PHYSIOLOGY

THEORY

(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 sub disciplines 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.

THEORY

Control and Coordination

Unit I. Homeostasis (15)

A. Homeostatic mechanisms and cellular communication

1. Control systems in homeostasis and components of homeostatic control (1)
2. An overview of cell signalling and biochemical basis of cell signalling - Release and transport of chemical messengers, communication of signal to target cell (3)
3. Cell signalling in the nervous system and endocrine system [eg. Amines (catecholamine and thyroid hormones)] -- Regulation of receptors (up and down regulation) --- Regulation of cell signalling: 1st, 2nd and 3rd order feedback mechanisms. (3)

B. Neuro Endocrine glands and their hormones (5)

1. Pineal, Hypothalamus, Pituitary Thyroid, Parathyroid, Pancreas, Adrenal cortex, Testis and Ovary.
2. Steroid hormone: Ecdysone.

C. Structure and functions of Plant Growth Regulators (3) Auxins, Gibberillic acid, Cytokinin, Abscisic acid, Ethylene

Unit II: Control and Coordination in plants and animals (15)

A. Animals:

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

2. Human Nervous System – CNS and PNS overview (2)
3. Nature of the Nerve Impulse – Resting potential, Action Potential (2)
4. Transmission of Nerve impulses and synapses (3)
- 5.a. **Behaviour and behavioural adaptations (Neuronal)– Innate and learned behaviour (Habituation) with an example of Aplysia** (2)
5. b. **Behavioral Strategies in Bird Migration (Physiological aspect-Accumulation of body fat and thermoregulation)** (2)

B. Plants:

1. Plant movements – Tropisms, Taxes, Nasties and Kinesis – discuss with suitable examples with reference to physiology (3)

Unit III: Developmental Biology (15)

A. Reproduction and Development

1. Basis of Sex Determination (4)

(a) Plants: Maize

(b) Animals: Role of SRY gene and Aromatase

(c) Role of environmental factors – Temperature and Parthenogenesis in insects
Eg. Wasp/Honey bee/Ants

(d) Plant-animal interaction for reproduction Fig wasp / Gall wasp

(e) Sex reversal

3. Sex differentiation of gonads, internal and external genitalia. (1)

4. Ovarian and testicular functions, puberty and regulation of uterine changes in menstrual cycle, menopause, pregnancy, parturition, lactation. (2)

5. Artificial regulation of reproduction: Use of contraceptive methods (1)

B. Gametogenesis and early development:

(a) Plants (4)

1. Microsporogenesis and megasporogenesis.

2. Types of ovules and fertilization.

3. Development of embryo in monocot and dicot plants

(b) Animals: Cleavage and development of embryo in frog. (2)

PRACTICALS

SBSLSCP301

(Based on paper I)

1. Good Laboratory Practices.
 2. Demonstration of reproductive system and location of endocrine glands in Albino Mouse Male and Female (Virtual Lab).
 3. Microtome and preparation of Endocrine gland slides from above dissected specimen or any suitable plant specimen
 4. Study of Histological features of Endocrine glands.
 5. A complete study of Frog Embryology (Egg to Tadpole to Adult).
 6. Study of Floral parts from the given flower (*Hibiscus* and *Pancretium*)
study of microscopic structure of anthers , ovules. Seed structure
(Maize and Okra).
 7. Study of pollen germination Using *Vinca* flower (*in vitro*)
 8. a. Study of pollen germination in *Vinca* (*in Vivo*)
b. Tracing the path of the pollen tube along the stylar canal using
Aniline blue stain
 9. Detection of activity of plant hormones (Dose dependent response).
 10. Observation and Study of locally collected Leaf Gall and any other one
plant disease.
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SBSLSC302

PAPER III 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 (15)

A. Enzymes (15)

1. Extraction, purification and Specific activity
Enzyme example (Plant: RUBISCO, Animal: LDH)
(Mention Techniques: Dialysis, Gel-filtration, Ion-exchange, Affinity chromatography and Spectrophotometry)
2. Classification (With an example of each)
3. Effect of pH and Temperature
4. Co-enzymes and co-factors: NAD, FAD, Mn, Mg, Zn and Cu
(one reaction each)
5. Kinetics (MM, LB)
6. Enzyme Inhibitors, Activators and feed-back
7. Allosteric enzymes (Kinases in Glycolysis) and their significance in metabolic regulation

UNIT II Metabolism – Energy from Carbohydrates: (15)

A. Carbohydrates – Catabolism) (9)

Glycolysis – Brief Historical background

process and metabolic regulation

Citric Acid Cycle – Brief Historical background

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: (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

A. Amino Acids –Catabolism: (8)

1. Protein Degradation liberating amino-acids'

2. Deamination, Transamination & ammonia disposal by Urea cycle.

3. Decarboxylation & integration into Krebs cycle

PRACTICALS

SBSLSC302

(Based on paper II)

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, R)

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

1. pH meter - (I, C, T)

- (i) principle & instrumentation and
- (ii) determination of pH (titration of Acids/Bases/Buffers/ 'chameleon balls').
(in FY the student were 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)
(From previous experiment and pH manipulation, proteins can be precipitated)(C, R)

3. Enzymology & localization:

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

4. Estimation / Quantitation:

- i. 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) C,T,R
- ii. Colorimetric Cholesterol Estimation / total Lipid Estimation from egg. *(lipid metabolism is an important component of our systems, content can be estimated)*

by colour reaction)

iii. Colorimetric estimation of Inorganic Phosphates by Stannous chloride method. **C, T, R**

(Estimation of biologically relevant inorganic ions by colorimetric method)

iv. Titrimetric estimation of Ascorbic acid (Vit C). **C, T, R**

(Estimation of biological materials by non-colorimetric method)

SBSLSC303

PAPER III POPULATION APPROACH: POPULATION AND COMMUNITIES AS REGULATORY UNIT

THEORY

(Total Lectures: 45)

PREAMBLE:

Population dynamics of human population are not only dependent on biological forces but also social forces. Unit I focuses on Evolutionary concepts and Population studies. Quantification 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 II and III include fundamentals of biostatistics and bioinformatics. Further elementary bioinformatics has been added to introduce students to ‘*in silico*’ laboratories available.

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. (1)
2. Evidences for evolution: Comparative anatomy and embryology, Fossil records and living fossils, Artificial selection. (2)
3. Study of Evolution in context of human genetic diseases (BRCA –I / Huntington’s/ Thalassemia) (3)
4. Populations and allelic frequencies, Hardy Weinberg Equilibrium, change in gene frequencies due to selection, mutation, migration and genetic drift (founders effect) (5)
5. Origin of variability, polymorphism, kinds of selection – directional, stabilizing and disruptive, selectionist vs neutralist (4)

UNIT II : BIOSTATISTICS (15)

1. Probability definition, addition law, random variable, probability mass function (3)
2. Binomial, Poisson and Normal distribution (5)
3. Bivariate data, scatter diagram and its uses, Karl Pearson’s correlation coefficient, Spearman’s Rank correlation coefficient (4)
4. Regression equations and their uses (3)

Unit III: Bioinformatics (15)

1. Introduction to bioinformatics: Concept of information net work:
internet, IP address, TCP/IP, FTP, HTTP, HTML and URLs (2)

2. Virtual libraries - The European Molecular Biology Network (EMBnet),
The National Center for Biotechnological Information (NCBI), Pub Med
and its applications. (4)

3. Concept of databases and their use in Biology (2)
Primary, Secondary and composite databases

4. Types of Databases (7)

(a) Nucleotide Database (Prokaryotic and Eukaryotic Gene to be discussed)

(b) Protein Database (PDB/ExPaSy)

(c) Species Database (Yeast, Arabidopsis and Human)

PRACTICALS

SBSLSCP303

(Based on paper III)

1. Correlation (Using serial dilution and OD, Data from Paper II and Using MS EXCEL / Population genetics data)
 2. Regression Analysis (Using serial dilution and OD, Data from Paper II and Using MS EXCEL / Population genetics data)
 3. Probability testing using suitable example
 - 4 Normal Distribution using suitable example
 5. Database searching: Nucleotide, Protein, Species
 6. Introduction to ORF- 6 reading frames and sequence annotation- 6 frame translation using suitable software (ex. Bioline)
 7. Testing of Hardy-Weinberg law using suitable examples of gene and allelic frequencies -Sex linked (One each)
 8. Project proposal based on Bioinformatics/Biostatistics/ Population Genetics / Evolution
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SEMESTER IV

SBSLSC401

PAPER I COMPARATIVEPHYSIOLOGY

THEORY

(Total Lectures: 45)

Altered Homeostasis due to stress and infections:

Unit I Homeostasis to stress: (15)

A. Thermal physiology: (10)

1. Plant adaptation in extreme thermal conditions
2. Thermal strategies in poikilotherms and homeotherms, ecto and endotherms.
3. Temperature regulating reflexes, acclimatization
4. Fever, Hyperthermia, heat exhaustion and heat stroke.
5. Thermogenesis: shivering and non-shivering thermogenesis, Hyperthermia induced by pyrogens
6. Antifreeze proteins.

B. Fuel Homeostasis during exercise and Stress: (5)

1. Regulation of energy stores: control of food intake
2. Role of Leptin, Ghrelin and Kisspeptin
3. Eating disorders: Anorexia and Bulimia Nervosa
4. Overweight and obesity
5. Type I and Type II Diabetes

Unit II. Homeostasis during infections (15)

A. Host Parasite Relationship

1. Virulence factors and toxins: virulence factors, exotoxins, enterotoxins, endotoxins (2)
2. Host factors in infection: host risk factors, innate resistance (2)
3. Parasite escape mechanisms (2)

B. Defence mechanisms in plants

Biomolecules such as secondary metabolites, surface protectants and enzymes (2)

C. Defence mechanisms in animals

1. Innate and Adaptive Immunity (1)
2. Introduction to primary and secondary lymphoid organs and Lymphatic systems (1)
3. Mechanisms of Innate Immunity – In invertebrates (hemocytes) and in Vertebrates

(physical and physiological barriers, phagocytosis and inflammation) (3)

4. Mechanisms of Adaptive Immunity – T and B cells
(Mode of Recognition of Antigen) (2)

Unit III. Infectious Diseases (15)

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

A. Vector borne Diseases – Malaria (2)

B. Viral Disease - AIDS, Herpes (3)

C. Bacterial Diseases - Tuberculosis, Leprosy, Typhoid (4)

D. Fungal Diseases – Ringworm, Candidiasis (2)

E. Helminthic Diseases – Filariasis (1)

F. Infections in Plants (3)

- Tobacco mosaic virus,
- Crown gall bacterial infection
- Puccinia fungal infection

PRACTICALS

SBSLSCP401

1. Extraction and detection of Plant alkaloids, saponins, tannins and volatile oils from suitable plant source.
 2. Alkaloid separation by TLC
 3. ABO blood typing
 4. Principle and working of home pregnancy test slide.
 5. Widal Test- Qualitative.
 6. Streak plating (T, Pentagon and Quadrant –Any 2) to isolate microorganisms from a mixed culture using differential media.
 7. Antibiotic sensitivity of microorganisms (Plant extract, Tetracycline/ Gentamycin)
 8. Study of effect of temperature and caffeine on heart beat of Daphnia.
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SBSLSC402

**PAPER III LIFE PROCESSES AT THE TISSUE, ORGAN AND ORGANISM
LEVELS A BIOCHEMICAL APPROACH**

(Total Lectures: 45)

- UNIT I Metabolism - Anabolism of biomolecules: (15)**
- A. Carbohydrate Anabolism: (4)**
1. Gluconeogenesis
 2. Pentose phosphate pathway
 3. Short account of polysaccharide (Glycogen) synthesis
- B. Lipids Anabolism:**
- (3) 1. Fatty acid biosynthesis
 2. Cholesterol (4 Stages –Condensation, Conversion, Polymerization and Cyclization) and prostaglandin biosynthesis
- C. Amino-acid Anabolism: (2)**
1. Transamination and its significance
 2. Glutamine synthesis
- D. Photosynthesis (6)**
1. Photophosphorylation, Hill reaction
 2. C3 and C4 cycles
 3. Photorespiration
- UNIT II Nucleic acids: (15)**
- Chemistry of nucleic acids – (8)
1. Existence of two pathways for purine & pyrimidine synthesis and Significance of the ‘salvage pathway’.
 2. DNA replication system in prokaryotes – process and enzymes (with domains of DNA polymerase)
 3. Transcription (7)
 - (a) Prokaryotes - binding, initiation, elongation & termination
 - (b) 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 (snRNPs only).
 4. Concept of Reverse transcription.

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

1. Translation: Genetic code; Translation system, post translational Modification (Phosphorylation, methylation and Acetylation) (7)

2. Regulation of gene expression and its significance (8)

(a) Operon model (Lac, Trp).

(b) Alternate splicing

(c) Concept of RNAi

PRACTICALS

SBSLSCP402

(Based on paper II)

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. **C, T**
(Extraction of nucleic acid and detection by color reaction)
 2. Chromatography of Sugars – Circular Paper **C, T**
(Separation of carbohydrates and detection by color reaction)
 3. Thin Layer Chromatography for separation of Plant Pigments
(Slide technique) **C, T, R**
(Separation techniques for charged, uncharged materials based on solvent partition)
 4. Solvent Extraction of Lipids. **C, T, R**
(Extraction of lipid and proportional estimation by weight)
 5. Column Chromatography of Proteins / Pigments. **I, C, T**
(Separation technique for proteins/ other materials based on charge/size)
 6. Protein separation by PAGE (Demonstration) **I, C**
(Separation techniques for charged materials based on electrophoretic mobility)
 - 7&8. Plant enzyme (Qualitative / Quantitative) **I, C, T**
 9. Interpretation of pathological reports based on the biochemical analysis.
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**PAPER III POPULATION APPROACH: POPULATION AND COMMUNITIES AS
REGULATORY UNIT**

THEORY

(Total Lectures: 45)

UNIT I: Evolution and its consequences (15)

1. Origin of Species: Biological species concept, morphological species, Allopatric and sympatric speciation, isolating mechanism preventing exchange in populations. Rates of speciation- punctuated or gradual. Life history of a species, Mitochondrial DNA and tracing human phylogeny and extinctions (5)
2. 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. (6)
3. 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. (4)

UNIT II: Biostatistics (15)

1. Hypothesis and its types, errors in testing and its types, level of significance (3)
2. Analysis of variance one way classification, F-test (3)
3. Test for equality of two means, Paired and unpaired t-tests. (3)
4. Comparison between Parametric and Non parametric test (3)
5. Chi Square test for independence 2x2 table (3)

Unit III: Bioinformatics (15)

1. DNA sequence Data analysis- (5)
 - (a) Annotation of putative genes – ORF finding
 - (b) Genetic code and Frame translation to amino acids, concept of six frame translation
2. Phylogenetic Analysis (10)
 - (a) Concept of paralogous and orthologous genes
 - (b) Nucleic acid based phylogenies
 - (c) Nucleotide sequence comparisons and homologies
 - (d) Phylogenetic Trees
 - (e) Parsimony principle and limitations of molecular phylogenetic trees

SEMESTER IV

PRACTICALS

SBSLSCP403

(Based on paper III)

1. a. Comparative Anatomy of Brain (Invertebrate to vertebrate)
b. Study of Fossils (Any two)
 2. Human Karyotyping- Normal and Abnormal (Numerical and Structural)
 3. *Chironomous* Larva- Study of Giant Chromosome from Salivary Glands
 4. Blast search
 5. Bioinformatics- Phylogenetic analysis using Globin gene and Mitochondrial DNA

 6. Applications of t distribution
 7. Analysis of variance one way classification
 8. Chi square distribution
- (In all statistical analysis use of Excel should be introduced)
9. Project report based on Bioinformatics/Biostatistics/ Population Genetics / Evolution
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References

SBSLSC 301 and 401

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8. Bioinformatics for Dummies

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