



St. Xavier's College (Autonomous) Mumbai

Syllabus For 3rd Semester Courses in **LIFE SCIENCE** (June 2018 onwards)

Contents:

Syllabus (theory and practicals) for Courses:

SLSC0301	Comparative Physiology I
SLSC0302	Enzymes and Metabolic Pathways
SLSC0303	Microbes and Human Health
SLSC03PR	Practicals

Template for theory and practical question paper
Evaluation and Assessment Grid

Percent revision:

2015-16: No revision
2016-17: No revision
2017-18: No revision
2018-19: 40-50% revision to practicals
2019-20: No revision
2020-21: No revision

LIFE SCIENCE

S.Y.B.Sc.

Course No.: SLSC0301

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.
3. 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. malpighian 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, H₂O ; 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* (2006) 8th Edition, Sadava, D., Heller, H.C., Onaris, G.H., Purves, W.L. and Hillis, D.M., W.H. Freeman and Co.
2. *Animal Physiology- Adaptation and Environment* (1995) 5th Edition, Knut Schmidt-Nielson, Cambridge University Press
3. *Biology* (2008) 8th Edition, Campbell, N.A., Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V. and Jackson, R.B. Pearson Benjamin Cummings
4. *Plant Physiology* (2006) 4th Edition, Taiz, L., Zeiger, E. Sinauer Associated, Inc.
5. *Principles of Anatomy and Physiology* (2008) 12th Edition, Tortora, G.J. and Derrickson, B.H. Wiley
6. *Anatomy and Physiology* (2002) 6th Edition, Seeley, R.R., Stephens, T.D. and Tate, P. Tata McGraw-Hill

LIFE SCIENCE

S.Y.B.Sc.

Course No.: SLSC0302

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. Mitochondrial 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* (2008), 5th Edition, Nelson, D.L., and Cox, M.M., W.H. Freeman and Co.
2. *Biochemistry* (2006) 6th Edition, Berg, J.M., Tymoczko, J.L. and Stryer, L. W.H. Freeman and Co.
3. *Fundamentals of Biochemistry* (2001) 9th Revised Edition, Deb, A.C. New Central Book Agency (p) Ltd.

LIFE SCIENCE

S.Y.B.Sc.

Course No.: SLSC0303

Title: Microbes and Human Health

Learning Objectives:

This course will:

1. Explain the role of microorganisms and their interactions within their natural ecosystem.
2. Enable students to appreciate the biological interactions between microbes and humans.
3. Introduce the concepts of microbial parasites, 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. Immunodiagnosics: 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: SLSC03PR

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

SLSC0301, 0302 & 0303

CIA I – 20 marks, 45 mins.

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

CIA II – 20 marks

Unit II: Test (*45 mins.*) /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: SLSC03PR

End Semester Practical Examination

Total marks: 150

Experiments

75 - 105 marks

Identification

30 - 60 marks

Journal

15 marks

DEPARTMENT OF LIFE SCIENCES AND BIOCHEMISTRY

S.Y.B.Sc. Life Science Exam Grid Semester 3

S.Y.B.Sc. Life Science Exam Grid Semester 3						
Course	Exam	Knowledge and Information	Understanding	Application	Analysis	Total
0301	CIA I	10	7	-	3	20
	CIA II	10	7	-	3	20
	End semester	20	20	10	10	60
Course	Exam	Knowledge and Information	Understanding	Application/Analysis		Total
0302	CIA I	10	7	3		20
	CIA II	10	7	3		20
	End semester	30	20	10		60
Course	Exam	Knowledge and Information	Understanding	Application	Analysis	Total
0303	CIA I	7	7	-	6	20
	CIA II	7	7	-	6	20
	End semester	30	10	10	10	60