



St. Xavier's College – Autonomous Mumbai

Syllabus For 3rd Semester Courses in **LIFE SCIENCE** (June 2013 onwards)

Contents:

Syllabus (theory and practical) for Courses:

S.LSC.3.01: Comparative Physiology I

S.LSC.3.02: Enzymes and Metabolic Pathways

S.LSC.3.03: Microbes and Public Health

Template of Theory Question Paper

Examination grid

LIFE SCIENCE

S.Y.B.Sc.

Course Code: S.LSC.3.01

Title: Comparative Physiology I

Learning Objectives:

The course aims to :

- Introduce a student to comparative animal physiology
- Help the learner understand changes in the anatomical design of systems across phyla and the physiological principles that various life forms adopt for survival. 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. malphigian 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)
- Transport of: water in xylem – cohesion tension theory; solutes in phloem – Munch hypothesis
 - Uptake of water by roots – apoplast, symplast, transmembrane pathway; Root Pressure theory
 - Circulatory system in animals:
 - Functions and general principles of circulation
 - Open and Closed circulatory systems, single and double circulation, neurogenic and myogenic hearts
 - Comparison of circulatory routes: Systemic, Pulmonary, Portal
3. Assignment: Diseases

UNIT III Respiration And Cardiovascular Systems **15 lectures**

1. Respiration: (5)
- Physical principles of gas exchange
 - Respiration in: protozoans, insect, fish, amphibian, bird, mammals; Pneumatophores
 - Respiratory pigments - Hemocyanin, Hemerythrin, Chlorocruorin, Hemoglobin
 - Respiratory System in Humans (5)
 - Overview of the respiratory system
 - 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)
- Functions and components of Blood, Anatomy of the heart, Blood flow and Conduction system
 - Cardiac muscle contraction, ECG, Cardiac cycle & cardiac output
 - Dynamics of capillary exchange: Starling's law
3. Assignment: Diseases

Practicals

Course S.LSC.3.01

Dissection of digestive system and spiracles in cockroach

1. Study of mineral crystals in plants.
2. Effect of chemicals/drugs/salts on the heart rate of Daphnia.
3. Comparison of stomatal index of different plants.
4. Dissection of digestive system and nephridia in earthworm
5. To perform total RBC and WBC count and platelet count
6. To study salivary amylase as a digestive enzyme with respect to:
 - a. digestion of starch
 - b. effect of pH
7. To perform differential WBC count
8. To dissect and show the circulatory system of shark
9. Sample Projects:
 - a. Amylase estimation from different organisms eg: snail secretion, cockroach
 - b. Onion root tip mitotic index
 - c. Respirometer - Study of respiratory rates in stressed and non-stressed animals & plants
 - d. Effect of papain or digestive tablets
 - e. Observation of live zebra fish and their life cycle

References:

1. The Science of Biology, 8th Ed: C. Assignment: Diseases
Sadava, Heller, Onaris, Purves, Millis
2. Biology – Updated Version: 3rd Ed: Raven P.H.
3. Animal Physiology – Adaptation and Environment; 5th Ed: Knut Schmidt Nielsen
4. Biology; 8th Ed: Campbell and Reece
5. Plant Physiology, 4th Ed: Taiz and Zeiger

LIFE SCIENCE

S.Y.B.Sc.

Course Code: S.LSC.3.02

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. Microbial 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)

Practicals

Course S.LSC.3.02

Preparation and standardization of reagents

1. Isolation of casein from milk(concept of pI)
2. Titration of glycine.
3. Estimation of Vitamin C by iodometry.
4. Determination of Km of Amylase. Effect of temperature and pH.
5. Use of thin layer chromatography technique to separate different plant pigment.
6. Circular paper chromatography to separate sugars.
7. Estimation of reducing sugar by Coles Ferricyanide method.
8. Sample Projects:
 - a. Comparison of efficiency of lipase or protease in different detergents
 - b. Determination of various components- proximate principles, vitamins, minerals from various sources
 - c. Semi-purification and estimation of proteins from different sources.
 - d. Extraction of amylase from sweet potato or catalase from horse radish.
 - e. Any other.

References

1. Lehninger's Principles of Biochemistry (5th Edition) – Nelson & Cox
2. Biochemistry (6th Edition) – Lubert Stryer
3. Biochemistry –A.C. Deb

LIFE SCIENCE

S.Y.B.Sc.

Course Code: S.LSC.3.03

Title: Microbes and Public Health

Learning Objectives for course S.LSC. 3.03:

- studying microorganisms in their natural habitat
- understanding their role in the ecosystem
- studying the various microbial interactions in the ecosystem
- studying interaction of various microbial parasites of man and the disease they bring about.
- Understanding the concept of epidemiology and public health

Number of lectures: 45

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)

1. Principles of Epidemiology (5)
 - a. Classification of diseases
 - i. Occurrence: endemic, epidemic, pandemic and sporadic
 - ii. Communicable and non-communicable diseases
 - b. Measurement of disease: morbidity, mortality, life expectancy, DALY (disability-adjusted life years)
 - c. Disease reservoirs: biotic and abiotic
 - d. Transmission of disease: direct and indirect modes; Emerging diseases: Enterohaemorrhagic *E.coli* (EHEC) infections, Melioidosis
 - e. Re-emerging diseases: MDR-TB / MRSA / Malaria
2. Concepts in Public Health
 - a. Health – definition and changing perceptions [mortality to Human Development Index (HDI)] (1)
 - b. Factors influencing health outcomes (2)
 - i. Distal factors: Income, Education, Technology
 - ii. Proximal Factors: Nutrition, Physical activity, Occupational risks, Environmental risks, sexual and reproductive health, substance & alcohol abuse
 - c. Combating challenges in public health (to be done using case studies) (4)
 - i. Infectious disease – Tuberculosis / Polio
 - ii. Environmental risk – Allergic asthma (pollution) / Cholera (sanitation)
 - iii. Substance abuse – Tobacco
 - iv. Nutrition – Obesity
 - v. Lifestyle – Diabetes Mellitus / Cardiovascular disease
 - d. Public Health Programs in India (3)
 - i. National Cancer Control Program
 - ii. National Program for Control of Blindness
 - iii. National Mental Health Program

Practicals

Course S.LSC. 3.03

1. Capsule staining of *Klebsiella* and *Bacillus*.
2. Determination of microbial sensitivity to antibiotics- disc method
3. Determination of viable count of the given culture
4. Identification of organisms by biochemical tests- IMVIC
5. Phage Sensitivity Assay
6. Study of normal skin flora – Gram staining and streak plating
7. Study of different stages of malarial parasite
8. Study of life cycle of female anopheles mosquito
9. Study of permanent slides: Acid fast bacteria / *Candida albicans*
10. Sample projects:
 - a. Isolation of Phenol degraders/pesticide degraders from soil.
 - b. Isolation of *Rhizobium*, *Azotobacter* or Nitrogen fixing organisms from soil
 - c. Isolation of sulfate / phosphate solubilizing microbes
 - d. Isolation of phage from natural samples.

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

Template of Theory Question paper
Courses S.LSC.3.01, 3.02 & 3.03

CIA I – 20 marks, 45 mins.

Unit I: Objectives/Short questions, not more than 5 marks each

CIA II – 20 marks, 45 mins.

Unit II: Short questions/Presentation/Assignment, not more than 5 marks each

End Semester exam – 60 marks, 2 hours

Choice is internal- within a unit and could be between 50% to 100%

SYBSC LIFE SCIENCE - SEM 3 Exam Grid						
Course	Exam	Knowledge and Information	Understanding	Application	Analysis	Total
3.01	CIA I	10	7	-	3	20
	CIA II	10	7	-	3	20
	End sem	20	20	10	10	60
Course	Exam	Knowledge and Information	Understanding	Application/Analysis		Total
3.02	CIA I	10	7	3		20
	CIA II	10	7	3		20
	End sem	30	20	10		60
Course	Exam	Knowledge and Information	Understanding	Application	Analysis	Total
3.03	CIA I	7	7	-	6	20
	CIA II	7	7	-	6	20
	End sem	30	10	10	10	60