UNIVERSITY OF MUMBAI

Syllabus for the F.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 F.Y.B.Sc. IN LIFE SCIENCES
(SEMESTER BASED CREDIT AND GRADING SYSTEM)
TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2012-2013

Semester I

USLSC 101

Life sciences at the molecular and cellular levels

(Total Lectures: 45)
(The number of periods for each topic is given in brackets)

PREAMBLE:
The first step to understand life forms is to understand the molecular logic of a living cell. This paper develops the concept of biochemical basis of plant and animal life and the underlying uniformity that forms the basis of all organisms at the cellular level.

Unit I Features of living cells : 15 lectures

1. **Molecular Logic of a living cell: (1)**
   An introduction to Life Sciences stressing the significance of the topics that follow.

2. **Physiological Role of water: (3)**
   Structure of water molecule, ionic interactions, ionic product of water, concept of pH, buffer and buffering system in cells, role of inorganic ions.

3. **Proteins: (6)**
   Amino acids: Classification, chemical reactions (Ninhydrin, Edmans, Sangers) of amino acids, peptides, protein structure, globular proteins (Hemoglobin) & Fibrous proteins (keratin), structure of proteins, types of bonds contributing to protein structure.

4. **Carbohydrates: (5)**
   Structure, chemical and physical properties of monosaccharides, disaccharides (maltose, sucrose, lactose), polysaccharides (starch, glycogen and cellulose)

Unit II Concept of prokaryotic and eukaryotic cells 15 lectures

1. **Study of prokaryotic and Eukaryotic cell: (3)**
   a. Microscopy as a tool for Cell Biology studies: Principles of light and electron microscopy
      Prokaryotic cell structure. E.g. *E. coli*
   b. Eukaryotic cell structure. E.g. Yeast (Unicellular), Plant and Animal cell (Multicellular)
   c. Evolutionary origin of organelles and endosymbiont hypothesis.

2. **Virus: (3)**
   Virion structure, Life cycle of bacteriophage (Lytic and Lysogenic), Plant and Animal

virus (One example each).

3. **Microbial growth:** **(3)**
Influencing factors, culture media (enriched and minimal), isolation, preservation, Life cycle and Growth Curve of *E. coli*.

4. **Cell cycle**(G0, G1, S, G2, M phases) **(3)**

5. **Structure of cell wall:** **(3)**
a. Bacterial cell wall: Gram positive and Gram negative.
b. Plant cell wall: Primary and secondary

Unit III: Nucleus, Cytoskeleton and Cell division **15 lectures**

1. **Nucleus :** **(4)**
Structure of an interphase nucleus : nuclear membrane, nucleolus, nucleosome model, euchromatin and heterochromatin, lampbrush and polytene chromosomes

2. **Cytoskeletal elements**: **(5)**

a. Microfilaments:
Structure and function in striated muscle fibers.
Role in cytoplasmic streaming in plants.
b. Mictolubules:
Structure as in cilia or in flagella, mechanism in movement. Function in mitotic spindle.
c. Intermediate filaments:
Structure and function.

3. **Mitosis and Meiosis** & their significance **(6)**

SEMESTER I

USLSC 102

LIFE SCIENCES AT SYSTEM, ORGANISM AND COMMUNITY LEVEL

PREAMBLE:
Organisms adapt to environment they live in which reflects as biodiversity in animals and plants. These adaptations are often physiological and have a genetic basis. This paper is an introduction to the underlying biological mechanisms at organismic level.

Unit I **15 lectures**

Multicellularity and specialized functions

1. Classification – 5 kingdoms (details in Practicals) **(2)**

-- Concept of multicellularity and division of labour (volvox and sponges as examples)

-- Specialization of animal cells and plant cells with respect to function

2. Organization into tissues **(2)**

- Introduction to plant and animal tissues (details in practicals)

3. Tissues to organs and systems **(4)**

(Just list the various systems with main organs and functions)

Group systems as i) For maintenance of organism (Nutrition/Digestion, Transport and circulation, respiration, osmoregulation and excretion and support and locomotion)

ii) Control and Coordination (Endocrine, Nervous, Immune, Reproduction)

4. **NUTRITION** – Autotrophic and Heterotrophic **(7)**

1. Autotrophic nutrition – Importance of photosynthesis in plants and in autotrophic prokaryotes (photosynthetic and chemosynthetic eg. nitrifying bacteria), cyanobacteria. Macro and micro nutrients for plants.

Nutritional adaptations – involve relationships with other organisms eg. insectivorous plants and symbiotic nitrogen fixation.

2. Heterotrophic nutrition – ex. holozoic, saprophytic (fungi) and parasitic (tapeworm)

Holozoic nutrition i) fluid feeders (ex mosquito or housefly) ii) microphagous (ex. amoeba or paramecium) iii) macrophagous (mammals)

Digestive systems of mammals (each organ of mammalian digestive system has specialized food-processing function)

Evolutionary adaptation associated with diet eg. dental, stomach and intestine (ruminant)

Unit II **15 lectures**

TRANSPORT AND CIRCULATION **(9)**

1. Transport in plants – Transport of water and inorganic solutes – transpiration, stomatal function and regulation, role of proton pumps and factors affecting ascent of xylem sap. Transport of organic solutes – mechanism and its regulation

2. Circulation in animals –i) Animals without a circulatory system eg. hydra and jellyfish ii) Open and closed circulatory system eg. insects vs worms

3. Vertebrate circulatory system – heart, single and double circulation.

Specific adaptations – mammals at high altitudes and diving mammals

Cardiovascular system in health and disease – exercise, hypertension and atherosclerosis

SUPPORT AND LOCOMOTION **(6)**

Support in plants – herbaceous and woody plants

Types of skeletons – hydrostatic (nematodes), exoskeleton (arthropods/molluscs) and endoskeletons (vertebrates)

Role of muscle in locomotion

Locomotion in earthworm

Locomotion in humans – axial and appendicular skeleton and joints

Unit III **15 lectures**

RESPIRATION AND GASEOUS EXCHANGE (7)

Aerobic and anaerobic respiration

Gas exchange in small animals (across surface) and cutaneous respiration in frogs.

Gas exchange in plants – also pneumatophores

Gaseous exchange in invertebrates – trachea in insects, book lungs in scorpion

Gaseous exchange in vertebrates – gills and lungs

Respiratory pigments – O_2 and CO_2 balance

EXCRETION AND OSMOREGULATION (8)

In plants – water and salt regulation under normal and stressed conditions

In animals – Phylogenetic review of organs and processes - contractile vacuole, flame cells, nephridium, malpighian tubules, kidney and skin in man

Concept of osmoregulation and processes associated with osmoregulation (ultrafiltration, selective re-absorption, secretion, acid-base regulation)

Nitrogenous excretory products (ammonotelism, ureotelism and uricotelism)

Case studies : mammals in arid regions (camel); salt glands in birds

F.Y.B.Sc. (LIFE SCIENCES)

SEMESTER I

PRACTICAL

USLSCP1
(Based on paper I)

1. a**.** An introduction to Laboratory discipline and GLP (Good Laboratory practices)

   b. Survey of the organization of laboratory instruments, chemicals and glasswares
   [incorporated into every practical]

2. Introduction to Elementary microbial techniques : **(3)**

a. Sterilization & Disinfection

b. Microbial Staining technique and Microscopy:

Comparative study of samples from 5 different sources to check gram + and gram – bacteria - Butter milk, tap water, sewage water food item soil, rotten – effect of heat using

a. Monochrome
b. Gram Staining
c. Cell wall staining

3. Colorimetry **(3)**

a. Preparation of solutions of a given chemical compound - Molar and percentage solutions - Concept and calculation only.

b. Preparation of dilutions of required concentration from a stock solution of a colored compound
c. Estimation of Lambda max of a coloured solution
d. Verification of Beer Lambert's law for a coloured solution

4. Molecular biology and Biochemistry: **(2)**

a. Detection of DNA from Onion or any other convenient, cost -effective system.

b. Detection of Carbohydrates (eg.wheat/rice atta), Lipids (eg.Ground nut oil) and proteins (eg. Any edible protein).

5. Instrumentation and techniques: **(2)**

a. Calibration of the pH Meter with standard buffer pH4 and pH9.2 as per GLP
b. Checking of pH for common foodstuff e.g. Milk/cola drink/Lime juice or any other relevant sample

SEMESTER I

PRACTICAL
USLSCP1
(Based on paper II)

1. Study of Tissues : **(2)**

a. Tissues – Temporary mounting of T.S. of Sunflower and Maize stem and root
i. Comparison between Dicot stem and Monocot stem
ii. Comparison between Dicot root and Monocot root

b. Animal Tissues (Permanent slides)
i. Epithellial – Squamous, Cuboidal, epithelial
ii. Connective – Aeriolar, Adipose, cartilage, bone

iii. Muscular – Striated, non- striated, Cardiac
iv. Nervous – Medulated, non-medulated neurons

2. Hematology **(2)**
   a. Total RBC count using Hemocytometer
   b. Observe different WBCs using Giemsa/ Lieishman stain

3. Mounting of Dicot / Monocot stomata (structure and function) **(1)**

4. Diversity of Life (present specimens/pictures/models) **–** **(3)**
   Five Kingdom classification
   Classification of Monera, Protoctista, Fungi
   Classification of Plants : Using common plants prescribed in the chart provided below) –

5. Study of Mouth parts in insect **(3)**
   Comparative assessment of mouth parts across genus (eg. Mosquito)

   Or

   Comparative assessment of mouth parts according to function as given below

   a. Biting and Chewing type- eg Cockroach
   b. Piercing and sucking type- eg Mosquito
   c. Sponging type- eg Housefly

6. Mounting of nephridium of earthworm and permanent slide of kidney **(1)**

Semester II

USLSC 201

Life sciences at the molecular and cellular levels

(Total Lectures: 45)
(The number of periods for each topic is given in brackets)

Unit I Features of living cells(cont'd)and biochemical separation techniques
15 lectures

1. **Lipids:** **(4)**
   Classification of lipids (simple, derived and complex with one example each).

2. **Nucleic acids:** **(6)**
   Structure of nucleosides and nucleotides, structure of nucleic acids (A,B,Z forms); the structure of DNA lends itself to its function as hereditary molecule.

3. Separation techniques: **(5)**
Paper and thin layer chromatography, principle of electrophoresis, differential centrifugation, Salting in and salting out (Ammonium sulphate fractionation).

Unit II: Intracellular compartments and protein sorting **15 lectures**

1. Cell membrane:

a. Membrane models: Unit membrane and Fluid Mosaic Model of Singer and Nicholson. (Membrane lipids and proteins in brief) **(2)**

b. Membrane junctions: Tight, gap, septate, desmosomes. **(2)**

c. Membrane Transport: Diffusion, osmosis, passive and active transport. endocytosis and Exocytosis **(3)**

2. Endoplasmic Reticulum: **(2)**

Structure (including sarcoplasmic reticulum)
Role in protein synthesis (ER- Ribosome complex) and transport (Signal Hypothesis)

3. **Ribosomes:** **(2)**
Subunits in prokaryotes and eukaryotes (including those within chloroplast and mitochondria); ER-Ribosome complex

4. The Golgi Apparatus: **(2)**
Structure, origin and relationship to Endoplasmic reticulum.
Role in synthesis, storage and secretion of zymogen and glycoproteins

5. Lysosomes: **(2)**
a. Types of lysosomes.
Primary and secondary lysosomes & their functions.
b. Lysosome associated diseases- Taysachs , Silicosis.

Unit III: Energy Conversion **15 lectures**

1. Mitochondria: **(6)**
a. Structure of inner, outer membranes & the matrix with a brief mention of oxidative phosphorylation.
b. Mitochondria associated diseases (any one example)

2. Plastids: **(5)**
Types, chloroplast morphology, structure of thylakoid membrane, photosynthetic pigments & a brief mention of photo-phosphorylation; chloroplast DNA

3. Peroxisomes and Glyoxisomes: **(4)**
Structure and function in plant and animal cells.

SEMESTER II

USLSC 202

LIFE SCIENCES AT SYSTEM, ORGANISM AND COMMUNITY LEVEL

Unit I GENETICS **15 lectures**

1 Mendelian Inheritance: **(9)**

Concept of homozygous, heterozygous, phenotype, genotype, alleles; Mendel's Laws and Mono &Dihybrid ratios with problems, chi square –for 3:1 and 1:1 ratios. Use sickle cell anemia as an example to explain the concept of gene.

2 Chromosomal inheritance: **(6)**

Sutton's hypothesis, sex-linked inheritance, study of human pedigrees (e.g. Sex linked dominant and recessive; autosomal dominant & recessive).

Unit II GENETICS **15 lectures**

1. Modification of Mendel's laws: **(7)**

Gene interactions: incomplete dominance, co-dominance;

Multiple genes; Multiple alleles: Blood group; Epistasis; Linkage; Sex limited; sex influenced

2. Mutations: **(5)**

a Point Mutations

b Chromosomal aberrations:

Structural: deletion, duplication, inversion, translocation.

Numerical: euploidy& aneuploidy **(e.g.** Downs, Turners. Klienfelter's, Cri-du-chat)

3. Principles of Genetic Engineering and its applications in Medicine (e.g.;Insulin) and in Agriculture (e.g.; Bt. Cotton) **(3)**

UNIT III

Ecology and behavior **15 lectures**

1. Principles of Ecology **(3)**

Food chains, flow of energy, food webs, trophic levels, ecological pyramids & their efficiencies

2. Ecological succession – an introduction **(1)**

3. Ecosystems – Types: (One example of each) **(4)**

(a) Terrestrial

(b) Aquatic

(c) Thermal vents as an ecosystem

4. Interspecific Interactions (3)

– Commensalism, Mutualism, Parasitism, Amensalism, Symbiosis

5. Behavioural Ecology: (3)

(a) Basic behavioural patterns – taxis, tropism, reflex, instinct & conditioned behaviour

(b) Ecological adaptations – camouflage & mimicry

(d) Biological clocks and rhythms

6. Edapic factors and soil profile (1)

SEMESTER II

PRACTICAL
USLSCP2
(Based on paper 1)

1. Eukaryotic cells and Microscopic measurements: **(2)**
   a Staining of onion peel / plant cells to reveal structure and organization of cells
   b Micrometry - Using the microscope to measure size of cells / nucleus

2. Study of Movements in Plant and Animal cells **(2)**
   a. Cytoplasmic streaming in Vallisnaria / Effect of light/temp on movements of plants and animals using any system
   b. Culturing and observation of feeding in Paramoecium from Hay infusion (students must be demonstrated how to develop a culture)

3. Histochemistry and enzymology : **(4)**

   (I) Localization of Carbohydrates, Proteins, Lipids and Nucleic acids from the following or any other convenient system
   c. Starch grains of Potato
   d. Proteins of peas / cockroach muscles
   e. Fat bodies of Cockroach/Drosophila/lipids of groundnut
   f. DNA and RNA from onion peel using methyl green pyronin staining

   (II) Enzymology :
   a. Detection of Dehydrogenase enzyme activity using sprouting grams / beans or muscle (as a study of mitochondrial function)
   b. Estimation of Catalase enzyme activity using paper disc rising-time technique

4. Effect of ageing on plant leaf pigments - using paper chromatography

5. Effect of antitranspirants on stomatal movements. (1 monocot, 1 dicot)

6. Study of Electron Micrographs as listed below: **(1)**
Both normal and pathological

a. Mitochondria b. Lysosomes
c. Basement membrane/ junctions d. Cilia

7. Field work and report writing **(1)**

SEMESTER II

USLSCP2
(Based on paper 2)

1. Determining effect of colchicine / mitotic inhibitor /mitotic activator on mitosis in onion root tip by calculating mitotic index. (Statistical analysis of the data to be done) **(1)**

2. Meiosis from tradescantia (demonstration/ Photograph) **(1)**

3. Study of Barr Body **(1)**

4. Animal Biodiversity: **(2)**
Part II : Classification of Animals – Invertebrates (as in the chart, provided)
Part III : Classification of Animals – Vertebrates (as in the chart, provided)

5. Biostatistics **(3)**
a) Purpose of Biostatistics: Data collection, Discrete and continuous variables, qualitative and quantitative Biostatistics.
(b) Study of Class Intervals and calculation of frequency
(c) Representation – tabular and graphical – line graph, frequency curve, Ogive curve, histogram and pie diagram. (Also represented using computers – Excel)
(d) Measures of central tendency – mean, median, mode and standard deviation.
(data from experiments done in class can be used for biostatistics)

6. Soil analysis **(2)**
Texture, water content, soil organisms (fungi using slide culture method)

7. Field study / Microhabitat of aquarium or pond.
Data logging in ecology – temperature, light, pH (in a pond or aquarium)

OR

7. Effect of environmental conditions on growth of yeast cells (count using hemocytometer)

- effect of temperature and nutrients (food source – 2% sucrose)

8. Genetic banding pattern in land snails to understand genetically determined differences in colour and banding pattern in snails.
9. Assignment: Perform a search on any one topic using pubmed , down load about ten abstracts and prepare a summary of the literature.

References :

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