UNIVERSITY OF MUMBAI
No. UG/ 99 of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the B.Sc. degree course , **vide** this office Circular No. UG/155 of 2012-13, dated 22nd March, 2013 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by Ad-hoc Board Studies in Life Science at its meeting held on 30th May, 2016 has been accepted by the Academic Council meeting held on 24th June, 2016 **vide** item No. 4.57 and that in accordance therewith, the revised syllabus as per the Credit Based Semester and Grading System for F.Y. B.Sc. Life Science (Sem.I & II), which are available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
25th October, 2016

To,

The Principals of the affiliated Colleges in Science.

A.C/4.57/24.06.2016

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No. UG/99 -A of 2016 MUMBAI-400 032 25 October, 2016

Copy forwarded with Compliments for information to:-

1) The Deans, faculties of Science,
2) The Chairman, Board of Studies in Life Science,
3) The Professor-cum-Director, Institute of Distance & Open Learning (IDOL)
4) The Director, Board of College and University Development,
5) The Co-Ordinator, University Computerization Centre,
6) The Controller of Examinations.

(Dr.M.A.Khan)
REGISTRAR

PTO..

F.Y.B.Sc. LIFE SCIENCES SYLLABUS
(SEMESTER BASED CREDIT AND GRADING SYSTEM)
TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2016-2017

SEMESTER I

Course code	Unit	Topic Heading	Credits	L/Week
USLSC 101	I	Features of living cells	2	1
	II	Concept of prokaryotic and eukaryotic cells		1
	III	Nucleus, Cytoskeleton and Cell Wall		1

Course Code	Unit	Topic Heading	Credits	L/Week
USLSC 102	I	Multicellularity and specialized function	2	1
	II	Physiological Systems 1		1
	III	Physiological Systems 2		1

USLSCP 1	Life sciences at the molecular and cellular levels	1	3
USLSCP 2	Life sciences at system, organism and community level	1	3

SEMESTER II

Course Code	Unit	Topic Heading	Credits	L/Week
USLSC 101	I	Macromolecules	2	1
	II	Intracellular compartments and protein sorting		1
	III	Energy Metabolism and Cell Division		1

Course Code	Unit	Topic Heading	Credits	L/week
USLSC 102	I	Genetics 1	2	1
	I	Genetics 2		1
	I	Ecology and Behavior		1

USLSCP 1	Life sciences at the molecular and cellular levels	1	3
USLSCP 2	Life sciences at system, organism and community level	1	3

F.Y.B.Sc. Life Science Syllabus modified for Credit System
To be implemented from the Academic year 2016-2017

SEMESTER I

PAPER – I
LIFE SCIENCES AT THE MOLECULAR AND CELLULAR LEVELS

PREAMBLE:

The first step to appreciate 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 underling uniformity that forms the basis of all organisms at the cellular level.

Course Code	Title	Credits
USLSC101	**THEORY**	**2 Credits (45 lectures)**
Unit I : Features of living cells : **1. Molecular Logic of a living cell:** An introduction to Life Sciences stressing the significance of the topics that follow. **2. Physiological Role of water:** Structure of water molecule, ionic interactions, ionic product of water, concept of pH, buffers. **3. Proteins:** 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:** Structure, chemical and physical properties of monosaccharides, disaccharides (maltose, sucrose, lactose), polysaccharides (starch, glycogen and cellulose)		**15 lectures** **(1)** **(3)** **(6)** **(5)**
Unit II Concept of prokaryotic and eukaryotic cells **1. Study of Prokaryotic and Eukaryotic cell:** 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:** Virion structure, Life cycle of bacteriophage (Lytic and Lysogenic), Plant and Animal virus (One example each).		**15 lectures** **(4)** **(4)**

3. Microbial growth: Influencing factors, culture media (enriched and minimal), isolation, preservation, life cycle and growth curve of *E. coli*.	**(5)**
4. Cell cycle(G0, G1, S, G2, M phases)	**(2)**
Unit III: Nucleus, Cytoskeleton and Cell Wall	**15 lectures**
1. Nucleus : Structure of an interphase nucleus : Nuclear membrane, nucleolus, nucleosome model, euchromatin and heterochromatin, lampbrush and polytene chromosomes	**(6)**
2. Cytoskeletal elements: **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.	**(6)**
3. Structure of cell wall: a. Bacterial cell wall: Gram positive and Gram negative. b. Fungal cell wall c. Plant cell wall: Primary and secondary	**(3)**

SEMESTER I

PAPER – II

LIFE SCIENCES AT SYSTEM, ORGANISM AND COMMUNITY LEVEL

Preamble:

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

Course Code	Title	Credits
USLSC102	**THEORY**	**2 Credits (45 lectures)**
UNIT I : Multicellularity and specialized function		**15 lectures**
1. **Classification** – 5 kingdoms (details in Practical) -- Concept of multicellularity and division of labor (volvox and sponges as examples) -- Specialization of animal cells and plant cells with respect to function		**(2)**
2. **Organization into tissues** - Introduction to plant and animal tissues (details in practical)		**(2)**
3. **Tissues to organs and systems** (Just introduce and not describe in details 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)**
4. **Nutrition** – Autotrophic and Heterotrophic 1. <u>Autotrophic nutrition</u> – 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. <u>Heterotrophic nutrition</u> – ex. holozoic, saprophytic (fungi) and parasitic (tapeworm)		**(7)**

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: Physiological Systems - 1 **1.Transport and Circulation** 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 **2. Support and Locomotion** 1.Support in plants – herbaceous and woody plants Types of skeletons – hydrostatic (nematodes), exoskeleton (arthropods/molluscs) and endoskeletons (vertebrates) 2.Role of muscle in locomotion Locomotion in earthworm Locomotion in humans – axial and appendicular skeleton and joints	**15 lectures** **(9)** **(6)**
UNIT III : Physiological systems - 2 **1. Respiration and Gaseous Exchange** Aerobic and anaerobic respiration Gas exchange in small animals (across surface) and cutaneous respiration in frogs. Gas exchange in plants – also pneumatophores	**15 lectures** **(7)**

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 **2. Excretion and Osmoregulation** 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	**(8)**

SEMESTER – I
PRACTICALS

To encourage problem based learning (PBL) and corresponding with the theory syllabus the practicals have been introduced either as stand alone, or those that may be converted into short projects which have been highlighted with an asterisk (*). These project based experiments could be recorded in a project format in addition to the journal work

Course Code	Title	Credits
USLSCP1	**PRACTICALS**	**2 Credits**
	PRACTICALS – I	**45 lectures**
1.	a. An introduction to Laboratory discipline and GLP (Good Laboratory practices) b. Survey of the organization of laboratory instruments, chemicals and glassware c. Lab safety (instruments and chemicals) ***[incorporated into every practical]***	**(1)**
2.	Introduction to Elementary microbial techniques : a. ***** Sterilization & Disinfection b. Microbial Staining technique and Microscopy: c. Comparative study of samples from 5 different sources to check gram positive and gram negative bacteria - Butter milk, tap water, sewage water, food item soil, rotten – effect of heat using i. Monochrome / ***** Gram Staining ii. Cell wall staining	**(1)** **(1)** **(3)**
3.	Colorimetry a. Preparation of solutions of a given chemical compound - Molar and percentage solutions - Concept and calculation only.	**(1)**

b. Preparation of dilutions of required concentration from a stock solution of a colored compound	**(1)**
c. Estimation of Lambda max of a coloured solution	**(1)**
d. Verification of Beer Lambert's law for a coloured solution	**(1)**
4. Molecular biology and Biochemistry:	**(2)**
a. * Isolation and Detection of DNA (by observing spools) from Onion/ cauliflower/ broccoli/ any other convenient, cost -effective system. DPA detection optional / demonstration.	
b.***** Detection of Carbohydrates (eg.wheat/rice atta), Lipids (eg.Ground nut oil) and proteins (eg. any edible protein).	**(1)**
5. Instrumentation and techniques:	
a. Calibration of the pH Meter with standard buffer pH4 and pH9.2 as per GLP	**(1)**
b. ***** Checking of pH for common foodstuff e.g. Milk/cola drink/Lime juice or any other relevant sample	**(1)**
PRACTICAL II	**45 lectures**
1. A. GLP : Handling of biological materials / chemicals /other safety issues	**(1)**
B. Study of Tissues :	
a. Tissues – Temporary mounting/ observation of permanent slides of	**(3)**
i. T.S. of Sunflower and Maize stem and root	
ii Comparison between Dicot stem and Monocot stem	
iii Comparison between Dicot root and Monocot root	
iv Mounting of Dicot / Monocot stomata (structure and function)	
b. Animal Tissues (Permanent slides)	**(1)**
i. Epithelial – Squamous, Cuboidal, epithelial	
ii. Connective – Areolar, 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. Diversity of Life (present specimens/pictures/models) –	**(3)**
Five Kingdom Classification	
*Classification of Monera, Protista, Fungi	
* Classification of Plants	
Digital recording and detailed classification of one plant and (one animal in 2nd semester) from campus/ local environment	
	(1)

4. Study of Mouth parts in insect Comparative identification of different mosquito genera and sexual dimorphism using head morphology from permanent slides/ field samples. 5. Comparative assessment of mouth parts according to function as given below a. Biting and Chewing type- eg Cockroach (if available) b. Piercing and sucking type- eg Mosquito c. Sponging type- eg Housefly 6. Mounting of nephridium of earthworm and permanent slide of kidney	**(1)** **(2)** **(1)**

SEMESTER II

PAPER – I
LIFE SCIENCES AT THE MOLECULAR AND CELLULAR LEVELS

Course Code	Title	Credits
USLSC201	**THEORY**	**2 Credits (45 lectures)**
Unit I : Macromolecules		**15 lectures**
1. Lipids: Classification of lipids (simple, derived and complex with one example each).		**(1)**
2. Nucleic acids: 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. **Making a 3D model of DNA using origami / or any other material – to be given as student assignment** (http://geneed.nlm.nih.gov/specialty.php?spageID=2#topic45 ftp://ftp.sanger.ac.uk/pub/yourgenome/downloads/activities/origami-dna/dnaorigamiinstblanka4.pdf)		**(4)** **(5)**
3. Separation techniques: **P**aper and thin layer chromatography, principle of electrophoresis, differential centrifugation, Salting in and salting out (Ammonium sulphate fractionation).		**(5)**
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, desmosomes, septate.		**(2)**
c. Membrane Transport: Diffusion, osmosis, passive and active transport. endocytosis and Exocytosis		**(3)**
2. Endoplasmic Reticulum: Structure (including sarcoplasmic reticulum) Role in protein synthesis (ER- Ribosome complex) and transport (Signal Hypothesis)		**(2)**

3. **Ribosomes:** Subunits in prokaryotes and eukaryotes (including those within chloroplast and mitochondria); ER-Ribosome complex	**(2)**
4. The Golgi Apparatus: Structure, origin and relationship to Endoplasmic reticulum. Role in synthesis, storage and secretion of zymogen and glycoproteins	**(2)**
5. Lysosomes: a. Types of lysosomes. Primary and secondary lysosomes & their functions. b. Lysosome associated diseases - Tay Sachs , Silicosis.	**(2)**
Unit III: Energy Metabolism and Cell Division	**15 lectures**
1. Mitochondria: **a.** Structure of inner, outer membranes & the matrix with a brief mention of oxidative phosphorylation. b. Mitochondria associated diseases (any one example)	**(5)** **(4)**
2. Plastids: Types, chloroplast morphology, structure of thylakoid membrane, photosynthetic pigments & a brief mention of photo-phosphorylation; chloroplast DNA	
3. Peroxisomes and Glyoxisomes: Structure and function in plant and animal cells.	**(3)**
4. Mitosis and Meiosis & their significance	**(3)**

SEMESTER II

PAPER – II

LIFE SCIENCES AT SYSTEM, ORGANISM AND COMMUNITY LEVEL

Course Code	Title	Credits
USLSC202	**THEORY**	**2 Credits (45 lectures)**
Unit I <u>Genetics</u> **1 Mendelian Inheritance:** 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:** Sutton's hypothesis, sex-linked inheritance, study of human pedigrees (e.g. Sex linked dominant and recessive; autosomal dominant & recessive).		**15 lectures** **(9)** **(6)**
Unit II <u>Genetics</u> **1. Modification of Mendel's laws**: Gene interactions: incomplete dominance, co-dominance; Multiple genes; Multiple alleles: Blood group; Epistasis; Linkage; Sex limited; sex influenced **2. Mutations:** 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)		**15 lectures** **(7)** **(5)** **(3)**

UNIT III **<u>Ecology and behavior</u>** **1.** **Principles of Ecology** Food chains, flow of energy, food webs, trophic levels, ecological pyramids & their efficiencies **2. Interspecific Interactions** – Commensalism, Mutualism, Parasitism, Amensalism, Symbiosis **3. Ecological succession –** an introduction **4. Ecosystems** – Types: (One example of each) (a) Terrestrial (b) Aquatic (c) Thermal vents as an ecosystem **5. Behavioural Ecology:** (a) Basic behavioural patterns – taxis, tropism, reflex, instinct & conditioned behaviour (b) Ecological adaptations – camouflage & mimicry (d) Biological clocks and rhythms **6.Biostatistics:** Graphical representations, Central tendencies (mean, median, mode), Measures of Variation (range, variance and standard deviation) Examples to be dealt with in practical.	**15 lectures** **(3)** **(2)** **(1)** **(2)** **(4)** **(3)**

SEMESTER – II
PRACTICALS

Course Code	Title	Credits
USLSCP2	**PRACTICALS**	**2 Credits**

PRACTICALS – I — **45 lectures**

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/ different pollen grains

2. Effect of temp on movements in plants and animals using any system. **(2)**
   The following are suggested.
   a. Cytoplasmic streaming in Vallisnaria
   b. *Culturing and observation of feeding in Paramoecium from Hay infusion
   (students must be demonstrated how to develop a culture)
   Source- vermicompost / cowdung)

3. Histochemistry and enzymology : **(4)**
   (a) *Localization of Carbohydrates, Proteins, Lipids and Nucleic acids from the following or any other convenient system
   A Starch grains of Potato / of seeds and other tubers
   B Proteins of peas / cockroach muscles
   C Fat bodies of Cockroach/Drosophila/lipids of groundnut
   D DNA and RNA from onion peel using methyl green pyronin staining

   (b) Enzymology : **(4)**
   i. Detection of Dehydrogenase enzyme activity using sprouting grams / beans or muscle (as a study of mitochondrial function)

   ii *Estimation of Catalase enzyme activity using paper disc rising-time technique (use different seeds as source)

4. Effect of ageing on plant leaf pigments / separation of amino acids - using paper chromatography **(1)**

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

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

PRACTICALS – II	**45 lectures**
1. Determining effect of colchicine / mitotic inhibitor /environmental pollutant / 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: Part II : Classification of Animals – Invertebrates (as in the chart, provided) Part III : Classification of Animals – Vertebrates (as in the chart, provided) **Digital recording and detailed classification of one animal from campus/ local environment**	**(1)**
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)	**(4)**
6. Soil analysis: Edaphic factors Texture, water content, soil organisms (fungi using slide culture method)	**(3)**
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)	**(2)**
8. Collection of blood group information from family and construction of pedigree charts	**(1)**
9. Assignment: Perform a search on any one topic using pubmed , download about ten abstracts and prepare a summary of the literature.	**(1)**

References:

USLSC 101 and 201

1. Cell Biology, Genetics, Molecular biology, Evolution and Ecology
P.S. Verma and V.K. Agarwal
Publishers : S. Chand and Co.Ltd., (2009)

2. Becker's World of the Cell: International Edition – 8th Edition
Jeff Hardin Gregory Paul Bertoni, Lewis J. Kleinsmith
Publishers: Pearson Dorling Kinderflay India / Pearson India (2011)

3. Life: The Science of Biology,
William K Purves, D. Sadava, G. H. Orians and H.C. Heller 7th Edn. (2003)
Sinauer Associates

4. Molecular Cell Biology – 7th Edition
Ed: Harvey Lodish, Arnold Berk, Chris A. Kaiser and 5 more (2012)
Pub: Macmillan

5. Molecular Biology of the Cell
Ed: Bruce Alberts, Alexander Johnson, Julian Lewis , David Morgan , Martin Raff, Keith Roberts, Peter Walter 5th Edition (2007) or 6th Edition (2014)
Pub: Garland Science

6. Essential Cell Biology
Ed: Bruce Alberts, Dennis Bray, Karen Hopkin and Alexander Johnson (2009) 3rd Edition
Pub: Garland Science

7. Fundamentals of Biochemistry
Ed: Voet. and Voet 4th edition, (2010)
Pub: John Wiley and Sons

8. Lehninger Principles of Biochemistry
Ed: D.L. Nelson, 5th edition, (2008)
Pub: CBS Publishers and Distributors

9. Principles of Biochemistry
Ed: Zubay G.L, Parson W.W. and Vance D.E. 1st edition (1995)
Pub: W. C. Brown

References:

USLSC 102 and 202

1. Biological Science , Taylor, Green and Stout., 3rd edn. Ed. R. Soper .(2005)
Cambridge Univ. press

2. An Introduction to Genetic Analysis Ed: Griffiths A.J. et al (2000)
Pub: W. H. Freeman(London) Seventh Edition

3. Comparative Animal Physiology, Philip C.Withers,(1992),
Saunders College Publishing House.

4. Biology A Modern Introduction, B.S.Beckett (1994),
GCSE Edn. Oxford Univ. Press.

5. Essentials of Human Genetics, S.M.Bhatnagar, M.L.Kothari & L.A.Mehta, (1994),
Orient Longman's Publication.

6. Cell Biology, Genetics, Molecular biology, Evolution and Ecology – P.S. Verma and V.K. Agarwal (2009)
Publishers : S. Chand and Co.Ltd.,

7. Biological Science : - Scott Freeman (2004)
Pub: Benjamin Cummings Publishing Company

8. Principles of Anatomy and Physiology 10th edition (2003)
Gerard J. Tortora and Sandra R. Grabowski
John Wiley & Sons, Inc.