



**HSNC University, Mumbai**  
**(2020-2021)**

**Ordinances and Regulation**

With Respect to

**Choice Based Credit System**  
**(CBCS)**

**For the Programme Under**  
**The Faculty of Science and Technology**

For the course

**Life Sciences**

**Curriculum – First Year Undergraduate**  
**Programmes**

**Semester –I and Semester- II**

**2020-2021**

**Section C**  
**Life Sciences**  
**Part 1: Preamble**

**1. Course objective:**

The first step to appreciate life forms is to understand the molecular logic of a living cell:

- Paper One 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.
- 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.
- Paper Two is an introduction to the underlying biological mechanisms at organismic level.
- To encourage problem based learning (PBL) and corresponding with the theory syllabus the practical 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

**2. Process adopted for curriculum designing:**

- This curriculum for the First Year Students of Life Sciences has been developed by maintaining a student centric learning pedagogical approach, which has been further aimed at being outcome-oriented and curiosity-driven.
- Using creative and bloom based approach, rote -learning approach has been avoided and imaginative abilities of the students have been fostered. The curriculum has been designed to be more inclined towards self-discovery of concepts.
- Feedback from the stakeholder, including the students, subject experts, parents, alumni and industry partners has been referred to in the updation of the syllabus.
- Modifications and changes have been done in the syllabus with respect to the current needs and requirements of the industrial professionals sectors of the subject.

**3. Salient features, how it has been made more relevant:**

**Paper I**

The topics covered in Paper I, cover the basic concepts of macromolecules, students are expected to understand the underlying principles of life sciences, so that the difficult topics are then built upon those in the second term.

**Paper II**

The topics covered in Paper II, cover the basic concepts of Genetics and physiological

processes. Students are expected to learn about mutations, Mendelian laws of inheritance. This gives students advantage of perusing their interests in these topics at the post graduate level and at PhD level. The interdisciplinary approach of the topics covered helps students to know every concepts of Life sciences and then apply their knowledge in solving bigger issues in the field of medicine, environment ,agriculture.

#### **4. Learning Outcomes:**

- Students' concept of biochemical basis of plant and animal life and the underlying uniformity that forms the basis of all organisms at the cellular level.
- The study of the life sciences lends important insights into disease processes, and allows the development of novel therapeutics and innovative medical devices, thereby directly improving human health.
- The life sciences also enable an understanding of the environment and the other living species with whom we share the earth; this knowledge guides conservation efforts and literally helps us to save our shared planet.
- Life sciences provide the most powerful arguments we have, for the most important issues of our society, issues such as social justice, environmental preservation, animal protection and fundamental human rights
- Because the life sciences reveal such central principles, the best scientific and engineering minds in history, regardless of discipline, eventually turn their attention to the life sciences.
- Students who study life sciences are well trained for basic concepts of botany, zoology, genetics, and biostatistics; so that they are prepared for specialization at the post graduate level and they are encouraged for research.

#### **5. Input from stakeholders (Which Sections have been modified) with relevant introduction:**

- Inclusion of relevant topics has been done based on the inputs from the stakeholders of the department.
- In addition to Biomolecules introduction, it will be taught at molecular level wherein types of Plasmid DNA, Cosmids etc have been covered.
- More hands-on and skill-based practical sessions have been added in cell biology and microbiological experiments
- Emphasis has been given on use of digital record maintenance and understanding of specimens *in lieu* of ethics.
- Modifying syllabus to make students industry oriented. An attempt to introduce research reading and understanding of *in silico* studies has been don

### **Part 2: The Scheme of Teaching and Examination**

### Semester – I

Sr. No.	Choice Based Credit System		Subject Code	Remarks	
1	Core Course (Life Sciences)		US-FLS-101 US-FLS-102 US-FLS-1P1 US-FLS-1P2	NIL	
2	Elective Course	Discipline Specific Elective (DSE) Course			-
		2.1	Interdisciplinary Specific Elective (IDSE) Course		-
		2.2	Dissertation/Project		-
		2.3	Generic Elective (GE) Course		-
3	Ability Enhancement Courses (AEC)		US-FFC		
	Skill Enhancement Courses (SEC)		-		

### First Year Semester I Internal and External Assessment Details:

Sr. No.	Subject Code	Subject Title	Periods Per Week				Credit	Seasonal Evaluation Scheme				Total Marks	
			Units	S. L.	L	T		P	S. L. E	CT	TA		SEE
1	US-FLS-101	Life Sciences at the Molecular and Cellular Levels	3	20% *	3	0	0	2	10	20	10	60	100
2	US-FLS-102	Life Sciences as System, Organism at Community Level	3	20% *	3	0	0	2	10	20	10	60	100
3	US-FLS-P1	Practicals based on course 1 of theory Practicals based on course 2 of theory			0	0	6	2				100 (80+20)	100
Total Hours / Credit							06	Total Marks				300	

**\*One to two lectures to be taken for CONTINUOUS self-learning Evaluation.**

**Part 3 : Detail Scheme Theory**  
**First Year Semester – I Units – Topics – Teaching Hours**

S.N	Subject Code	Subject Unit Title		Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	USFLS101	I	Features of living cells	15	45 L	2	100 (60+40)
		II	Concept of Prokaryotic and Eukaryotic cells	15			
		III	Cell Organelles I	15			
2	USFLS102	I	Multicellularity and specialized function	15	45L	2	100 (60+40)
		II	Physiological Systems 1	15			
		III	Physiological System 2	15			
3	USFLSP1	I	Practicals based on course 1 of theory	3	45x2= 90L lectures per batch	2	100 (80+10+ 10)
		II	Practicals based on course 2 of theory	3			
		TOTAL				6	300

- **Lecture Duration – 45 Minutes = 0.75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit =16.87 hours equivalent to 17 Hours**

**F.Y.B.Sc. LIFE SCIENCES SYLLABUS (SEMESTER BASED CREDIT AND GRADING SYSTEM)  
TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2020**

**SEMESTER I**

**Curriculum Topics along with Self-Learning topics** - To be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

**Paper-I**

**Total Credit: 02**

**Title of Paper: Life Sciences at the Molecular and Cellular Levels**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>I</b>	<p><b>Features of living cells:</b></p> <p><b>1. Physiological Role of water:</b> Structure of water molecule, ionic interactions, ionic product of water, concept of pH, buffers.</p> <p><b>2. Proteins:</b> Amino acids: Classification, Chemical Reactions (Ninhydrin, Edmans, Sangers) of amino acids, peptides. Protein: Structure, Classification globular proteins (Hemoglobin) &amp; Fibrous proteins (keratin), Types of bonds contributing to protein structure.</p> <p><b>3. Carbohydrates:</b> Carbohydrates: Introduction Structure, physical and chemical properties of Monosaccharides, Disaccharides (maltose, sucrose, lactose), Polysaccharides (starch, glycogen and cellulose)</p>	<p><b>(15)</b></p> <p><b>04</b></p> <p><b>06</b></p> <p><b>05</b></p>
<b>II</b>	<p><b>Concept and Study of Prokaryotic and Eukaryotic cell:</b></p> <p><b>1. Microscopy:</b> Principles of light and electron microscopy</p> <p><b>2. Prokaryotic cell structure</b> E.g. <i>E. coli</i>, Factors influencing life cycle and growth curve of <i>E. coli</i>, culture media (enriched and minimal), isolation, preservation.</p> <p><b>3. Eukaryotic cell structure</b> E.g. Yeast (Unicellular), Plant and Animal cell (Multicellular)</p> <p><b>4. Evolutionary origin of organelles and Endosymbiont hypothesis</b></p> <p><b>5. Virus:</b> Virion structure, Life cycle of bacteriophage (Lytic and Lysogenic), Plant and Animal virus (One example each).</p>	<p><b>(15)</b></p> <p><b>04</b></p> <p><b>04</b></p> <p><b>05</b></p>

<b>III</b>	<b>6.Cell cycle</b> (G0, G1, S, G2, M phases)	<b>02</b>
	<b>Cell Organelles I</b>	<b>(15)</b>
	<b>1.Nucleus:</b> Structure of an Interphase nucleus: Nuclear membrane, nucleolus, Nucleosome model, Euchromatin and Heterochromatin, Lamp brush and Polytene chromosomes	<b>06</b>
	<b>2.Cytoskeletal elements:</b> <b>a. Microfilaments:</b> Structure and function in striated muscle fibers. Role in cytoplasmic streaming in plants. <b>b. Microtubules:</b> Structure as in cilia or in flagella, mechanism in movement. Function in mitotic spindle. <b>c. Intermediate filaments:</b> Structure and function.	<b>06</b>
	<b>3.Structure of cell wall:</b> <b>a.</b> Bacterial cell wall: Gram positive and Gram negative. <b>b.</b> Fungal cell wall <b>c.</b> Plant cell wall: Primary and Secondary	<b>03</b>

### Self Learning Topics to be covered by Learner

Unit	Topics
1	Proteins and Carbohydrates from Plant and Animal Sources
2	Compound Microscope – Structure, working and its maintenance; Microbes involved in food spoilage
3	Types of Chromosomes from plant and animal species

### Online Learning topics (Unit wise)

Online Resources		
Life Sciences	Source of e – learning course	Details (Path)
Semester 1 Course 1Unit 1	Swayam Portal (UG) <a href="https://epgp.inflibnet.ac.in">https://epgp.inflibnet.ac.in</a> :Swayam Portal (CEC)- Biochemistry and Cell Biology(12); UGC Moocs(UG)-Cell Biology (12) <a href="https://www.ugc.ac.in/moocs">UGC Moocs(UG) Cell Biology (66)</a>  <a href="http://ndl.iitkgp.ac.in/document/Z2JzN0ZmU2VhdW5kODBJdWRCTmg3SDJ2cU8wMHRhNkVDOmY5aTdtNklrRkp0bDFGUGZMZE5OQFNWcjRlbTllbXZXVFdnZnVDTjdTMEEvc21XYUd3K2c9PQ">http://ndl.iitkgp.ac.in/document/Z2JzN0ZmU2VhdW5kODBJdWRCTmg3SDJ2cU8wMHRhNkVDOmY5aTdtNklrRkp0bDFGUGZMZE5OQFNWcjRlbTllbXZXVFdnZnVDTjdTMEEvc21XYUd3K2c9PQ</a>	Biochemistry and Cell Biology (12)

	<p>Swayam Portal (CEC)  <a href="https://epgp.inflibnet.ac.in">https://epgp.inflibnet.ac.in</a> ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12); UGC Moocs(UG)-Cell Biology (12)  <a href="#">UGC Moocs(UG) Cell Biology (66)</a></p>	Cell Biology (12)
	<p>UGC Moocs (UG)  <a href="https://epgp.inflibnet.ac.in">https://epgp.inflibnet.ac.in</a> ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12); UGC Moocs(UG)-Cell Biology (12)  <a href="#">UGC Moocs(UG) Cell Biology (66)</a></p>	Cell Biology (66)

### References Books: US-FLS-101

Sr.No.	Unit	Reference Books
1	Unit 1	<p>1. Fundamentals of Biochemistry Ed: Voet. And Voet 4th edition, (2010) Pub: John Wiley and Sons.  2. Lehninger Principles of Biochemistry Ed: D. L.Nelson, 5th edition, (2008) Pub: CBS Publishers and Distributors  3. Principles of Biochemistry Ed: Zubay G.L, Parson W.W. and Vance D.E. 1st edition (1995) Pub: W. C. Brown.  4. Cell Biology, Genetics, Molecular biology, Evolution and Ecology -P.S. Verma and V.K. Agarwal Publishers: S. Chand and Co. Ltd., (2009).</p>
2	Unit 2	<p>5. Becker's World of the Cell: International Edition – 8<sup>th</sup> Edition Jeff Hardin Gregory Paul Bertoni, Lewis J. Kleinsmith Publishers: Pearson Dorling Kinderflay India / Pearson India (2011)  6. Molecular Cell Biology – 7<sup>th</sup> Edition Ed: Harvey Lodish, Arnold Berk, Chris A. Kaiser and 5 more (2012) Pub: Macmillan  7. Essential Cell Biology Ed: Bruce Alberts, Dennis Bray, Karen Hopkin and Alexander Johnson (2009) 3rd Edition Pub: Garland Science.  8. Cell Biology, Genetics, Molecular biology, Evolution and Ecology  9. Becker's World of the Cell: International Edition – 8<sup>th</sup> Edition Jeff Hardin</p>
3	Unit 3	<p>10. Life: The Science of Biology, William K Purves, D. Sadava, G. H. Orians and H.C. Heller 7th Edn. (2003) Sinauer Associates  11. Molecular Biology of the Cell Ed: Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter 5th Edition (2007)  12. Essential Cell Biology Ed: Bruce Alberts, Dennis Bray, Karen Hopkin</p>



		and Alexander Johnson (2009) 3rd Edition Pub: Garland Science 13. Cell Biology C. B. Powar, 2010. Himalaya Publishing House
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**Paper-II****Total Credit:02****Title of Paper: Life Sciences as System, Organism at Community Level**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>I</b>	<b>Multicellularity and Specialized Function</b>	<b>(15)</b>
	<b>1.Classification</b> –Whittaker’s 5 kingdom classification Concept of Multicellularity and division of labor (Volvox and Sponges as examples)	<b>02</b>
	<b>2.Organization into Tissues</b> Introduction to Plant and Animal tissues	<b>04</b>
	<b>3. Organization from Tissues to Organs and Systems</b>	
	<b>a. For maintenance of organism</b> – An overview of following Life Processes Nutrition/Digestion, Transport and Circulation, Support and Locomotion Respiration, Osmoregulation and Excretion.	<b>02</b>
	<b>b. Control and Coordination</b> – An overview of the following systems Endocrine, Nervous, Immune, Reproductive	<b>02</b>
	<b>4. Nutrition</b> – Autotrophic and Heterotrophic	<b>05</b>
	<b>a.</b> Autotrophic nutrition – Importance of photosynthesis in plants and in autotrophic prokaryotes eg. Nitrifying bacteria, Cyanobacteria. Nutritional adaptations – eg. Symbiotic Nitrogen fixation, Insectivorous plants.	
	<b>b.</b> Heterotrophic nutrition	
	i) Holozoic nutrition- eg. Fluid feeders (mosquito or housefly)	
	ii) Microphagous ( amoeba or paramecium)	
	iii) Macrophagous (mammals)	
	iv) Saprophytic (fungi)	
	v) Parasitic(tapeworm)	
	<b>c.</b> Evolutionary adaptation associated with diet eg. dental, stomach and intestine (ruminant)	
<b>II</b>	<b>Physiological Systems</b>	<b>(15)</b>
	<b>1.Transport and Circulation</b>	
	<b>a.</b> Transport in plants –	<b>05</b>

	<p>i) Transport of Water and Inorganic Solutes – Transpiration pull, Stomatal function and regulation, role of Proton Pumps and factors affecting Ascent of Xylem Sap.</p> <p>ii) Transport of organic solutes – Phloem Transport- Mechanism and its Regulation</p> <p><b>b. Circulation in animals</b></p> <p>i) Animals without a circulatory system eg. Hydra and Jellyfish</p> <p>ii) Open and closed circulatory system eg. Insects vs Worms</p> <p>iii) Comparative Overview of Vertebrate circulatory system</p> <p>iv) Specific adaptations – Mammals at high altitudes and Diving mammals.</p>	<p><b>05</b></p>
	<p><b>2. Support and Locomotion</b></p> <p><b>a. Support in plants – Herbaceous and Woody plants</b></p> <p><b>b. Types of skeletons</b></p> <p>i) Hydrostatic (Nematodes)</p> <p>ii) Exoskeleton (Arthropods/Molluscs)</p> <p>iii) Endoskeletons (Vertebrates)</p> <p><b>c. Role of muscle in locomotion (Activity Based Learning)</b></p> <p>i) Locomotion in Earthworm</p> <p>ii) Locomotion in humans – Axial and Appendicular skeleton and joints</p>	<p><b>05</b></p>
<p><b>III</b></p>	<p><b>Physiological systems 2</b></p>	<p><b>(15)</b></p>
	<p><b>1.Respiration and Gaseous Exchange</b></p> <p><b>a. Aerobic and Anaerobic Respiration</b></p> <p>Gas exchange in</p> <p>i) Invertebrates – Trachea in insects; Book Lungs in Scorpion ;Across the surface in Earthworm and Cutaneous in Frogs.</p> <p>ii) Vertebrates – Gills in Fish and Lungs in Mammals</p> <p>iii) Respiratory pigments – Hb, Haemocyanin O<sub>2</sub> and CO<sub>2</sub> balance</p> <p>iv) Plants – Stomata and Pneumatophores</p>	<p><b>07</b></p>
	<p><b>2.Excretion and Osmoregulation</b></p> <p><b>a. Plants – Water and Salt Regulation under normal and stressed conditions</b></p> <p><b>b. Animals – Phylogenetic overview of organs and processes</b></p> <p>i) Contractile Vacuole</p> <p>ii) Flame cells</p> <p>iii) Nephridium</p> <p>iv) Malpighian Tubules</p> <p>v) Kidney and Skin in Man</p> <p><b>c. Concept of osmoregulation and processes associated with</b></p>	<p><b>08</b></p>

<p>i) Osmoregulation - Ultrafiltration, Selective re-absorption, Secretion, Acid-Base Regulation.</p> <p>ii) Nitrogenous Excretory Products - Ammonotelism, Ureotelism and Uricotelism.</p> <p><b>d. Case studies: (Activity Based Learning)</b></p> <p>i) Mammals in Arid Regions (camel);</p> <p>ii) Salt glands in Birds</p>	
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### Self-Learning topics (Unit wise)

Unit	Topics
1	Specialization of animal cells and plant cells with respect to function; Macro and micro nutrients for plants;
2	Cardiovascular system in health and disease – exercise, hypertension and atherosclerosis
3	Osmoregulation of plants and animals inhabiting different ecosystems

### Online Resources

Life Sciences	Source of e – learning course	Details (Path)
Semester 1 Course 2	Swayam (NPTEL) <a href="https://epgp.inflibnet.ac.in/Swayam(NPTEL)/Animal%20Physiology%20(12)">https://epgp.inflibnet.ac.in/Swayam(NPTEL)/Animal Physiology (12)</a> <a href="http://ndl.iitkgp.ac.in/document/Okh4R2FGUkRNZjFicFUvWmpzQ2loVUhyU29EcE5jWWVNMUhlWm13WXp6MWw0YXIEWXJDSVBrRHNuSWxTNU9xcA">http://ndl.iitkgp.ac.in/document/Okh4R2FGUkRNZjFicFUvWmpzQ2loVUhyU29EcE5jWWVNMUhlWm13WXp6MWw0YXIEWXJDSVBrRHNuSWxTNU9xcA</a>	Animal Physiology (12)

### References Books: US-FLS-102

Sr.No.	Unit	Reference Books
1	Unit 1	1. Biological Science, Taylor, Green and Stout., 3rd edn. Ed. R. Soper. (2005) Cambridge Univ. press 2. Biology A Modern Introduction, B.S. Beckett (1994), GCSE Edn. Oxford Univ. Press. 3. Biological Science: - Scott Freeman (2004) Pub: Benjamin Cummings Publishing Company
2	Unit 2	4. Principles of Anatomy and Physiology 10 <sup>th</sup> edition (2003) Gerard J. Tortora and Sandra R.

		<p>Grabowski John Wiley &amp; Sons, Inc.  5. Biological Science, Taylor, Green and Stout., 3rd edn. Ed. R. Soper. (2005)  Cambridge Univ. press</p>
3	Unit 3	<p>6. Comparative Animal Physiology, Philip C. Withers, (1992), Saunders  College Publishing  House.  7. Biology A Modern Introduction, B.S. Beckett (1994), GCSE Edn. Oxford  Univ.Press.  8. Biological Science: - Scott Freeman (2004) Pub: Benjamin Cummings  Publishing Company  9.Principles of Anatomy and Physiology 10<sup>th</sup> edition (2003) Gerard J.  Tortoraand Sandra  R.Grabowski John Wiley &amp; Sons, Inc.</p>

## Part 4: Practicals

Paper-I-Practical

Total Credit: 01

<b>Course Code:</b>			
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>	<b>Reference Books</b>
<b>I</b>	1. a. History of Sciences (E Learning: Activity Based ) b. An introduction to Laboratory discipline and GLP (Good Laboratory practices) c. Survey of the organization of laboratory instruments, chemicals and glassware d. Lab safety (instruments and chemicals) <i>[incorporated into every practical]</i>	03	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	03	
	3. Colorimetry a. Preparation of solutions of a given chemical compound- b. Molar and percentage solutions - Concept and calculation only. c. Preparation of dilutions of required concentration from a stock solution of a colored compound d. Estimation of Lambda max of a coloured solution e. Verification of Beer Lambert’s law for a coloured solution	03	
	4. Molecular biology and Biochemistry: 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).	03	
	5. Instrumentation and techniques: a. Calibration of the pH Meter with standard buffer pH4 and pH9.2 as per GLP * Checking of pH for common foodstuff e.g. Milk/cola drink/Lime juice or any other relevant sample	03	

**Paper-II-Practical**

**Total Credit:01**

<b>Course Code:</b>			
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>	<b>Reference Books</b>
<b>I</b>	1.a. History of Science (E Learning- Activity Based)	<b>03</b>	2,3,4
	b. GLP: Handling of biological materials / chemicals /other safety issues	<b>03</b>	
	2.Study of Tissues:		
	a. Plant Tissues: Temporary mounting/ observation of permanent slides:		
	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)		
	i. Epithelial – Squamous, Cuboidal, Epithelial		
ii. Connective – Areolar, Adipose, Cartilage, Bone			
iii. Muscular – Striated, Non- Striated, Cardiac			
iv. Nervous – Medullated, Non-Medullated neurons	<b>03</b>		
<b>3.Hematology</b>			
a. Total RBC count using Hemocytometer			
b. Observe different WBCs using Giemsa/ Leishman stain	<b>03</b>		
c. Differential WBC Count			
<b>4. Diversity of Life Part I (present specimens/pictures/models)</b>			
Five Kingdom Classification –Whittaker Classification			
*Classification of Monera, Protista, Fungi			
* Classification of Plants			
<b>Digital recording and detailed classification of one plant and (one animal in 2<sup>nd</sup> semester) from campus/ local environment</b>		<b>03</b>	
<b>5.Study of Mouth parts in Insect</b>			
Comparative identification of different mosquito genera and sexual dimorphism using head morphology from permanent slides/ field samples.	<b>03</b>		
<b>6.Comparative assessment of mouth parts according to function as given below</b>			
<b>i)Types of Mouth Parts</b>			
a. Biting and Chewing Type-E.g. Cockroach (E Resource/Demonstration)			
b. Piercing and sucking Type- E.g. Mosquito			
c. Sponging Type- E.g. Housefly			
<b>ii)Mounting of Nephridium of Earthworm and permanent slide of kidney</b>			

Online Resources		
Life Sciences	Source of e – learning course	Details (Path)
Semester 1 Practical Course 1 and 2	Swayam (CEC) <a href="https://epgp.inflibnet.ac.in ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12): UGC Moocs(UG)-Cell Biology (12) UGC Moocs(UG) Cell Biology (66) https://ndl.iitkgp.ac.in/homestudy/science">https://epgp.inflibnet.ac.in ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12): UGC Moocs(UG)-Cell Biology (12) UGC Moocs(UG) Cell Biology (66)</a>  <a href="https://ndl.iitkgp.ac.in/homestudy/science">https://ndl.iitkgp.ac.in/homestudy/science</a>	Experimental Biochemistry (12)

Sr.No.	Course	Reference Books
1	1P1	1. Essential Cell Biology Ed: Bruce Alberts, Dennis Bray, Karen Hopkin and Alexander Johnson (2009) 3 <sup>rd</sup> Edition Pub: Garland Science. 2. Comparative Animal Physiology, Philip C. Withers, (1992), Saunders College Publishing House.
2	1P2	3. An Introduction to Practical <i>Biochemistry</i> 3rd Edition by <i>David Plummer</i> . 4. Life: The Science of Biology, William K Purves, D. Sadava, G. H. Orians and H.C. Heller 7th Edn. (2003)Sinauer Associates.

**Reference Books : USFLS1P1&1P2**



**Part 5**  
**First Year Semester – II**  
**Summary**

Sr. No.	Choice Based Credit System		Subject Code	Remarks	
1	Core Course ( <b>Life Sciences</b> )		US-FLS-201 US-FLS-202 US-FLS-2P1 US-FLS-2P2	NIL	
2	Elective Course	Discipline Specific Elective (DSE) Course			-
		2.1	Interdisciplinary Specific Elective (IDSE) Course		-
		2.2	Dissertation/Project		-
		2.3	Generic Elective (GE) Course		-
3	Ability Enhancement Courses (AEC)		US-FFC		
	Skill Enhancement Courses (SEC)		-		

**First Year Semester-II Internal and External Assessment**  
**Detail Scheme**

Sr. No.	Subject Code	Subject Title	Periods Per Week						Credit	Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	S. L. E		CT	TA	SEE		
1	USFLS201	Life Sciences at The Molecular and Cellular Levels	3	20%*	3	0	0	2	10	20	10	60	100	
2	USFLS202	Life Sciences as System, Organism at Community Level	3	20%*	3	0	0	2	10	20	10	60	100	
3	USFLSP2	Practicals based on course 3 and course 4 of theory			0	0	6	2				100 (80+20)	100	
Total Hours / Credit									06	Total Marks				300

\*One to two lectures to be taken for CONTINUOUS self-learning Evaluation.

**First Year Semester – II Units – Topics – Teaching Hours**

Sr.No .	Subject Code	Subject Unit Title	Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks	
1	USFLS201	I	Macromolecules	15	45 L	2	100 (60+40)
		II	Cell Organelles II	15			
		III	Energy Metabolism and Cell Division	15			
2	USFLS202	I	Classical Genetics	15	45L	2	100 (60+40)
		II	Post Mendelian Genetics	15			
		III	Ecology and Behaviour	15			
3	USFLSP2	I	Practicals based on course 3 of theory	3	45x2= 90L lectures per batch	2	100 (80+10+10)
		II	Practicals based on course 4 of theory	3			
		TOTAL			6	300	

- **Lecture Duration – 45 Minutes = 0.75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit = 16.87 hours equivalent to 17 Hours**

## Part 6: Detail Scheme Theory

### SEMESTER-II

**Curriculum Topics along with Self-Learning topics** - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

#### Paper-I

**Total Credit: 02**

**Title of Paper: Life Sciences at the Molecular and Cellular Levels**

Unit	Content	No. of Lectures
<b>I</b>	<b>Macromolecules</b>	<b>(15)</b>
	<b>1. Lipids:</b> Classification of lipids- Simple, Derived and Complex with one example each.	<b>04</b>
	<b>2. Nucleic acids:</b> a. Structure and Forms of Eukaryotic DNA-A, B, Z b. Structure of RNA - m RNA, t RNA, r RNA c. Comparison between bacterial DNA and eukaryotic DNA d. Extra chromosomal DNA- Mitochondrial, Chloroplast and Plasmid	<b>05</b> <b>06</b>
	<b>3. Separation techniques:</b> a. Chromatography - Paper and thin layer b. Agarose Gel Electrophoresis c. Centrifugation d. Precipitation Technique -Salting in and salting out	
<b>II</b>	<b>Cell Organelles II</b>	<b>(15)</b>
	<b>1. Cell Membrane:</b> a. Membrane models: i) Unit membrane ii) Fluid Mosaic Model b. Membrane lipids and proteins – An overview c. Membrane junctions: i) Tight ii) Gap iii) Desmosomes iv) Septate d. Membrane Transport: i) Diffusion ii) Osmosis iii) Passive and Active Transport iv) Endocytosis and Exocytosis	<b>07</b>
	<b>2. Endoplasmic Reticulum:</b> a. Structure including Sarcoplasmic Reticulum b. Role in: i) Protein synthesis (ER- Ribosome) ii)Transport (Signal Hypothesis)	<b>03</b>

<b>III</b>	<b>3. Ribosomes:</b> <b>a.</b> Subunits in Prokaryotes and Eukaryotes (including those within chloroplast and mitochondria); <b>b.</b> ER-Ribosome complex	<b>02</b>
	<b>4. Golgi Apparatus:</b> <b>a.</b> Origin and relationship to Endoplasmic reticulum. <b>b.</b> Role in synthesis, storage and secretion of zymogen and glycoproteins	<b>02</b>
	<b>5. Lysosomes:</b> Types and Role of Lysosomes.	<b>01</b>
	<b>Energy Metabolism and Cell Division</b>	
	<b>1. Mitochondria:</b> Structure of inner, outer membranes & the matrix with brief mention of Oxidative Phosphorylation.	<b>(15)</b>
	<b>2. Plastids:</b> <b>a.</b> Types of Plastids <b>b.</b> Structure of Chloroplast <b>c.</b> Photosynthetic pigments & a brief mention of photo-phosphorylation	<b>05</b>
	<b>3. Peroxisomes and Glyoxisomes:</b> Structure and function in plant and animal cells.	<b>02</b>
	<b>4. Mitosis and Meiosis &amp; their significance</b>	<b>03</b>

**Reference Books: US-FLS-201**

Sr.No.	Unit	Reference Books
1	Unit 1	1. Fundamentals of Biochemistry Ed: Voet. and Voet 4th edition, (2010) Pub: John Wiley and Sons 2. Lehninger Principles of Biochemistry Ed: D.L. Nelson, 5th edition, (2008) Pub: CBS Publishers and Distributors
2	Unit 2	3. Principles of Biochemistry Ed: Zubay G. L, Parson W.W. and Vance D.E. 1st edition (1995) Pub: W. C. Brown.
3	Unit 3	4. Life: The Science of Biology, William K Purves, D. Sadava, G.H. Orians and H.C. Heller 7th Edn. (2003) Sinauer Associates.

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**Paper-II****Total Credit: 02****Title of Paper: Life Sciences as System, Organism at Community Level**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>I</b>	<b>Classical Genetics</b>	<b>(15)</b>
	<b>1. Mendelian Inheritance:</b> <b>a.</b> Concept of Genes and Alleles- Using sickle cell anemia and SNP as an example <b>b.</b> Mendel's Laws <b>c.</b> Mono & Dihybrid ratios with problems, <b>d.</b> Chi square –for 3:1 ratio and 1:1 ratio.	<b>09</b>
<b>II</b>	<b>2 Chromosomal inheritance:</b> <b>a.</b> Sutton's hypothesis  <b>b.</b> Sex-linked inheritance  <b>c.</b> Study of Human pedigrees: i) Sex linked dominant and recessive ii) Autosomal dominant and recessive	<b>06</b>
	<b>Post Mendelian Genetics</b>  <b>1. Modification of Mendel's laws:</b> <b>a.</b> Gene interactions: i) incomplete dominance ii) co- dominance  <b>b.</b> Multiple genes and Multiple alleles  <b>c.</b> Epistasis – Dominant and Recessive  <b>d.</b> Gene Linkage with one suitable example  <b>e.</b> Sex limited and Sex influenced traits	<b>(15)</b> <b>07</b>
	<b>2. Mutations:</b> <b>a.</b> Point Mutations <b>b.</b> Chromosomal aberrations: i) Structural: deletion, duplication, inversion, translocation. ii) Numerical: euploidy & aneuploidy	<b>05</b>
	<b>3. Principles of Genetic Engineering and its applications</b> <b>a.</b> In Medicine -e.g.; Insulin /any other suitable example <b>b.</b> In Agriculture - e.g.; Bt Cotton /any other suitable example	<b>03</b>
		<b>(15)</b>

<b>III</b>	<b>Ecology and Behavior:</b>	
	<b>a. Principles of Ecology</b> Food chains, flow of energy, food webs, trophic levels, ecological pyramids & their efficiencies	<b>03</b>
	<b>b. Intraspecific Interactions</b> i) Commensalism ii) Mutualism iii) Parasitism iv) Ammensalism v) Symbiosis	<b>02</b>
	<b>c. An overview of Ecological succession</b> –Primary and Secondary	<b>01</b>
	<b>d. Types of Ecosystems:</b> i) Terrestrial ii) Aquatic iii) Thermal vents as an ecosystem iv) Effect of Environmental change on different ecosystems	<b>05</b>
	<b>e. Behavioral Ecology:</b> i) Basic behavioral patterns – taxis, tropism, reflex, instinct & conditioned behaviour ii) Ecological adaptations – camouflage & mimicry iii) Biological clocks and rhythms	<b>04</b>
<b>f. Biostatistics:</b> i) Graphical representations, ii) Central tendencies- mean, median, mode, iii) Measures of Variation - range, variance and standard deviation	<b>03</b>	

### Self-Learning topics (Unit wise)

Unit	Topics
1	Basic Terminologies in Mendelian Genetics ; Ethical issues with r DNA Technology
2	Genetic Diseases and Gene Therapy
3	Study of components of any one Ecosystem and their interrelationship

### Online Resource

Life Sciences	Source of e – learning course	Details (Path)
Semester 2 Course 2	Swayam (NPTEL) <a href="https://epgp.inflibnet.ac.in ;Swayam (NPTEL) Genetics (12) http://ndl.iitkgp.ac.in/document/Okh4R2FGUkRNZjFicFUvWmpzQ2loWFRBd1N6M1U3OGgwMkxsUHlrc2FvV2ZHaGZpZDg0OG11bEdyUzRrdnlkRQ">https://epgp.inflibnet.ac.in ;Swayam (NPTEL) Genetics (12) http://ndl.iitkgp.ac.in/document/Okh4R2FGUkRNZjFicFUvWmpzQ2loWFRBd1N6M1U3OGgwMkxsUHlrc2FvV2ZHaGZpZDg0OG11bEdyUzRrdnlkRQ</a>	Genetics (12)

	<p>Moocs online Course (UG)  <a href="#">Moocs online Course (UG)</a>  <a href="#">Principles of Genetics (16)</a>  <a href="http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvWmpzO2loU1NP aEl6eWpVaXpnNGUwc21iQzZKbFF3eE9YZGtiUUJZaTVMUkV1K2crdTIz VXU1TTdKSC9HVDOyaWltVDI6RV E9PQ">http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvWmpzO2loU1NP aEl6eWpVaXpnNGUwc21iQzZKbFF3eE9YZGtiUUJZaTVMUkV1K2crdTIz VXU1TTdKSC9HVDOyaWltVDI6RV E9PQ</a></p>	Principles of Genetics (16)
	<p>Swayam (NPTEL)  <a href="#">Swayam (NPTEL) Ecology and Environment (0)</a>  <a href="http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvWmpzO2loY2I1c2hBY3M5ZWxYUFpramFobnNvSU9RTGlzeTRtMHIKTWhnTE1yYjZ3eg">http://ndl.iitkgp.ac.in/document/Qkh4R2FGUkRNZjFicFUvWmpzO2loY2I1c2hBY3M5ZWxYUFpramFobnNvSU9RTGlzeTRtMHIKTWhnTE1yYjZ3eg</a></p>	Ecology and Environment (0)
	<p>Moocs online Course (UG)  <a href="#">Moocs online Course (UG)</a>  <a href="#">Environment and elements of ecology (21)</a></p>	Environment and elements of ecology (21)

### Reference Books: US-FLS-202

Sr.No.	Unit	Reference Books
1	Unit 1	<p>1. Cell Biology, Genetics, Molecular biology, Evolution and Ecology P.S. Verma and V.K. Agarwal Publishers: S. Chand and Co.Ltd., (2009)</p> <p>2. An Introduction to Genetic Analysis Ed: Griffiths A.J. et al (2000) Pub: W. H. Freeman (London) Seventh Edition</p>
2	Unit 2	<p>3. Essentials of Human Genetics, S.M. Bhatnagar, M.L. Kothari &amp; L.A. Mehta, (1994), Orient Longman's Publication.</p> <p>4. Biological Science, Taylor, Green and Stout., 3rd edn. Ed. R. Soper. (2005) Cambridge Univ. press</p> <p>5. Biological Science: - Scott Freeman (2004) Pub: Benjamin Cummings Publishing Company</p>
3	Unit 3	<p>6. Biostatistics -P. Ramakrishnan, Saras Publication, 2015 Edition</p> <p>7. Ecology E. P. Odum, 198. Saunders Philadelphia</p> <p>8. Techniques in Research C. R. Kothari, 4<sup>th</sup> edition,</p>



## Part 7: Practicals

**Paper-I-Practical**

**Total Credit:01**

<b>Course Code:</b>			
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>	<b>Reference Books</b>
<b>I</b>	1.A. History of Science	<b>03</b>	1 to 8
	1B. Eukaryotic cells and Microscopic measurements: 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	<b>03</b>	
	1. Effect of temp on movements in plants and animals using any system. The following are suggested.	<b>03</b>	
	a. Cytoplasmic streaming in Vallisneria b. *Culturing and observation of feeding in Paramecium from Hay infusion (students must be demonstrated how to develop a culture) Source- vermicompost / cow dung)		
	3. Histochemistry and enzymology: (a) *Localization of Carbohydrates, Proteins, Lipids and Nucleic acids from the following or any other convenient 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>03</b>	
	(b) Enzymology: 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	<b>03</b>		
5. Effect of anti transpirants on stomatal movements. (1 monocot, 1 dicot)	<b>03</b>		
6. Study of Electron Micrographs as listed below: Both normal and pathological a. Mitochondria b. Lysosomes c. Basement membrane/junctions d. Cilia	<b>03</b>		
7. Field work and report writing			

**Paper-II-Practical**

**Total Credit:01**

<b>Course Code:</b>			
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>	<b>Reference Books</b>
<b>I</b>	1. A. History of Science	<b>03</b>	9 to 17
	1.B. 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)	<b>03</b>	
	1. Meiosis from Tradescantia (demonstration/Photograph)	<b>03</b>	
	2. Study of Barr Body	<b>03</b>	
	3. * Animal diversity: Part II: Classification of Animals – Invertebrates (as in the chart, provided) Part III: Classification of Animals – Vertebrates (as in the chart, provided) <b>Digital recording and detailed classification of one animal from campus/ Local environment</b>	<b>03</b>	
	4. * <b>Biostatistics</b> 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: Edaphic factors Texture, water content, soil organisms (fungi using slide culture method)	<b>03</b>	
	7. Field study / Microhabitat of aquarium or pond. Data logging in ecology – temperature, light, pH (in a pond or aquarium)	<b>03</b>	
	<b>OR</b>		
	7. Effect of environmental conditions on growth of yeast cells (count using hemocytometer) - effect of temperature and nutrients (food source – 2% sucrose)	<b>03</b>	
8. Collection of blood group information from family and construction of pedigree charts	<b>03</b>		
Assignment: Perform a search on any one topic using pubmed , download about ten abstracts and prepare a summary of the literature	<b>03</b>		

Online Resource		
Life Sciences	Source of e – learning course	Details (Path)
Semester 2 Practical Course 1 and 2	Swayam (CEC) <a href="https://epgp.inflibnet.ac.in ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12)">https://epgp.inflibnet.ac.in ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12)</a>	Experimental Biochemistry (12)
	Swayam (CEC) <a href="https://epgp.inflibnet.ac.in ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12)">https://epgp.inflibnet.ac.in ;Swayam Portal (CEC)- Biochemistry and Cell Biology(12)</a>	Animal Diversity (12)
	Swayam (NPTEL) <a href="https://www.nptel.ac.in">Swayam (NPTEL)</a>	Biostatistics and Design of Experiments (12)

#### Reference Books: US-FLS 2P1& 2P2

Sr.No.	Course	Reference Books
1	2P1	<p>1. Fundamentals of Biochemistry Ed: Voet. and Voet 4th edition, (2010) Pub: John Wiley and Sons</p> <p>2. Principles of Biochemistry Ed: Lehninger D.L. Nelson, 5th edition, (2008) Pub: CBS Publishers and Distributors</p> <p>3. Becker's World of the Cell: International Edition – 8<sup>th</sup> Edition Jeff Hardin</p> <p>4. Biology A Modern Introduction, B.S. Beckett (1994), GCSE Edn. Oxford Univ. Press.</p> <p>5. Principles and Techniques Of. Biochemistry And. Molecular Biology. Seventh Edition. Edited By Keith <i>Wilson</i> And John <i>Walker</i></p> <p>6. An Introduction to Practical <i>Biochemistry</i> 3rd Edition by <i>David Plummer</i></p> <p>7. The Cell: International Edition – 8<sup>th</sup> Edition Jeff Hardin Biology A Modern Introduction, B.S. Beckett (1994), GCSE Edn. Oxford Univ. Press.</p> <p>8. Principles and Techniques Of. Biochemistry And Molecular Biology. Seventh Edition. Edited By Keith <i>Wilson</i> And John <i>Walker</i></p> <p>9. An Introduction to Practical <i>Biochemistry</i> 3rd Edition by <i>David Plummer</i></p> <p>10. Biological Science, Taylor, Green and Stout., 3rd edn. Ed. R. Soper (2005) Cambridge Univ. press</p>
2	2P2	<p>11. Comparative Animal Physiology, Philip C. Withers, (1992), Saunders College Publishing House.</p> <p>12. Cell Biology, Genetics, Molecular biology, Evolution and Ecology</p> <p>13. Becker's World of the Cell: International Edition – 8<sup>th</sup> Edition Jeff Hardin</p> <p>14. Life: The Science of Biology, William K Purves, D. Sadava, G.H. Orians and H.C. Heller 7th Edn. (2003) Sinauer Associates</p>

		15. Invertebrate Zoology. <i>E. L. Jordan</i> . & P.S. Verma S. Chand & Company 16. Biostatistics: P. Ramakrishnan, Saras Publication, 2015 Edition 17. <i>Chordate Zoology</i> and Elements of Animal Physiology. Authors, <i>E.L. Jordan</i> , <i>P. S. Verma</i> . Edition, Publisher, S Chand and Company, 1993.
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