Department of Life Sciences

A. Vision

Vision Statement of the Department

To enlighten the genesis, diversity and functioning of living organisms in order to conserve and coexist in concert with the nature

B. Mission

Mission Statementsof the Department

M1	To provide an academic environment that emphasizes creativity and critical thinking
M2	To promote education, research and creative analysis among the students in various aspects of life sciences
M3	To adapt innovative teaching and learning for better understanding

Program Educational Objectives (PEO)

After five years of successful completion of the program, the student will be able to

PEO1	To produce post graduates with knowledge and understanding of concepts across diverse areas of life sciences
PEO2	To generate skilled human resource, to be able to formulate, analyze, and solve issues in the field of life sciences
PEO3	To apply the acquired knowledge and skill to cater the needs of the academia, research and the society
PEO4	To inculcate the values of ethics and quality among students for providing sustained constructive services to the society
PEO5	To emphasize the need for continuous learning to face the challenges in professional career

D. PEO to Mission Statement Mapping

	PEO1	PEO2	PEO3	PEO4	PEO5
M1	x	x	x	x	-
M2	x	x	x	-	x
M3	x	x	x	x	x

(Tick Marks can be used)

E. Graduate Attributes for Integrated M.Sc. (Life Sciences)

Program List a few global qualities in knowledge, attitude, value and skills that a graduate will possess after undergoing the program

1. Disciplinary Knowledge: Understand various aspects of life sciences and apply tools and techniques for the betterment of their existence

2. Communication Skills: Develop the verbal and written communication skills to convey the ideas clearly and concisely

3. Critical Thinking: Capacity to generate hypothesis, design and conduct experiments, analyzes the data and interprets, and report results.

4. Problem Solving: Design and execute process to find solutions for biological problems to meet the needs of society.

5. Cooperation: Ability to work independently, yet cooperate and function effectively as a member or leader of a team.

6. ICT Skills (Modern Tools usage): Apply biological concepts and appropriate tool (technique) to solve biological problems.

7. Ethics: Demonstrate and adherence to accepted standards of ethics and responsibilities.
8. Self-Directed Learning: Developing autonomy and self-regulation in teaching-learning and professional development.
9. Reasoning: Ability to analyze the scientific data critically and systematically and the ability to draw the objective unbiased conclusions.
10. Creativity: Ability to think out-of-the-box (divergent and convergent), and innovate means to overcome challenges.
11. Societal and Environmental Concern: Appreciate and contribute to improve the quality of environment and sustainability of life.
12. Harnessing longevity of Learning: Understand the importance of continuous learning and practices it throughout life.

E. PEO to Mission Statement Mapping

	PEO1	PEO2	PEO3	PEO4	PEO5
M1	x	x	x	x	-
M2	x	x	x	-	x
M3	x	x	x	x	x

(Tick Marks can be used)

E. Program Outcomes (PO)

On the successful completion of the program, the student will be able to
(Program outcomes are common for all courses in a particular program)

PO1	Able to gain knowledge in various fields of Life Sciences and to acquire the skills modern tools and techniques
PO2	Apply the gained knowledge and skill in research and developments and contribute to the societal benefits
PO3	Interdisciplinary approach for providing better solutions and new ideas for the sustainable developments and an ability to engage in life-long learning
PO4	Generation of skilled manpower and capable to apply the knowledge for bioentrepreneurship skills
PO5	Imbibe ethical, moral and social values in personal and social life for a cultured and civilized personality

(Number of PO's is not fixed)

F. PO to PEO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	x	x	x	x	-	
PEO2	x	x	x	x	-	
PEO3	x	x	x	x	x	
PEO4	-	x	-	x	x	
PEO5	-	-	x	x	x	

(Tick Marks can be used)

(Up to this is common for a program, then one has to prepare the following separately for each course under a program)

SEMESTER - I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF111	**Botany: Plant diversity**	3	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO1	Learn about the structural details of different species of microorganisms & primitive plant	Remember
CO2	Understand the classification & distribution of microbes and primitive plant species	Understand
CO3	Illustrate the importance of the microbial and plant diversity.	Apply
CO4	Evaluate the differences in diversity of growth patterns and life cycles of microbes, algae, fungi, bryophytes, pteridophytes and gymnosperms.	Analyze
CO5	To correlate and apply the acquired knowledge for combating current environmental challenges	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	**Content**	**Hrs.**
I	**Microbes:** Viruses: Discovery, General Structure, Replication, DNA Virus (T-phage), Lytic & Lysogenic Cycle (TMV). Economic Importance, Bacteria: Discovery, General Characteristics & Cell Structure, Vegetative, Asexual & Recombination (Conjugation, Transformation & Transduction), Economic Importance of Bacteria	10
II	**Algae:** General Characteristics: Ecology & Distribution, Range of Thallus Organization & Reproduction, Classification, Morphology & Life Cycles of *Nostoc*,*Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia*, Economic Importance	10
III	**Fungi:**Introduction: General Characteristics, Ecology & Significance, Range of Thallus Organization, Cell Wall Composition, Nutrition, Reproduction & Classification, True Fungi: General Characteristics, Ecology &Significance, Life Cycle of *Rhizopus* (Zygomycota) *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations – Lichens: General Account, Reproduction & Significance, Mycorrhiza: Ectomycorrhiza & Endomycorrhiza & Significance	12

IV	**Bryophytes and Pteridophytes:** Unifying Features of Archegoniates, Transition to Land Habit, Alternation of Generations, Bryophytes: General Characteristics: Adaptations to Land Habit, Classification, Range of Thallus Organization, Classification (up to family), Morphology, Anatomy & Reproduction of *Marchantia* &*Funaria* (Developmental details not to be included). Ecology & Economic Importance of Bryophytes with Special Mention on *Sphagnum;* Pteridophytes:General Characteristics: Classification, Early Land Plants (*Cooksonia* &*Rhynia*). Classification (up to family), Morphology, Anatomy & Reproduction of *Selaginella, Equisetum* &*Pteris* (Developmental details not to be included), Heterospory & Seed Habit, Stellar Evolution, Ecological & Economical Importance.	12
V	Gymnosperms: General Characteristics, Classification. Classification (up to family), Morphology, Anatomy & Reproduction of *Cycas* &*Pinus* (Developmental details not to be included). Ecological & Economical Importance	10
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding the growth and life cycles of different organisms. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** **1. Alexopoulos CJ, Mims CW& Blackwell M.** (1996) *Introductory Mycology*. Wiley &Sons, Singapore. **2. Bhatnagar SP& Moitra A.** (1996) *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi. **3. Kumar HD.** (1999) *Introductory Phycology*. Affiliated East-West. Press Pvt. Ltd. Delhi. **4. Parihar NS.** (1991) *An Introduction to Embryophyta. Vol. I. Bryophyta*. Central Book Depot, Allahabad. **5. Raven PH, Johnson GB, Losos JB& Singer SR.** (2005) *Biology*. Tata McGraw Hill, Delhi, India. **6. Sethi IK& Walia SK.** (2011) *Textbook of Fungi & Their Allies*. MacMillan Publishers Pvt. Ltd., Delhi. **7. Tortora GJ, Funke BR& Case CL.** (2010) *Microbiology: An Introduction*.Pearson Benjamin, USA. **8. Vashishta PC, Sinha AK& Kumar A.** (2010) *Pteridophyta*. S. Chand. Delhi, India. **9. Murthy BRC and Rama Krishna K (2008) A** test book of common core Botany, First year. Vikas Publications	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiz a -tion 50%**	Includes title, introduction,statement ofthe main idea withillustration and conclusion.	Includes title, introduction,statement ofmain ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**		

1	Which one of the below mentioned sentences is FALSE with regard to algae (a) All algae are chlorophyll bearing organisms? (b) Algae have no true roots, they have only holdfasts for attachment (c) **Zygote divides to form embryo** (d) They do not possess specialized structures for internal transport system	Differentiate	Remember
2	Which one of the below mentioned pigment is present in all the photosynthetic algae? (a) **Chlorophyll A** (b) Chlorophyll B © Chlorophyll C (d) Chlorophyll D	Recognize	Remember
3	Vascular bundles consisting of conjoint, collateral vascular bundles situated on the edges of pith are observed in which of the below mentioned types (a) **Eustele** (b) Dictyostele © Solenostele (d) Actinostele	Recognize	Remember
4	Which of the following fungal group is not known to form sexual spores? (a) Mastigimycotina (b) Ascomycotina © Basidiomycotina (d) **Deuteromycotina**	Recognize	Remember
5	Which one of the below mentioned statement is FALSE with regard to Bryophytes? **(a) The gametophyte is parasitic on sporophyte** (b) The embryo is retained in the arghegonium (c) Bryophytes are ecologically persistent (d) The gametophyte can be thalloid or leafy	Recognize	Remember
6	Which of the below mentioned refers to the specialized structure in the sporangium of mosses that facilitates gradual spore discharge instead of releasing them all at once? (a) Operculum (b) Calyx **(c) Peristome** (d) Sori	Recognize	Remember
7	Which one of the below mentioned group of plants lacks	Identify	Remember

	flowers but produce seeds? (a) Bryophytes (b) Pteridophytes (c) **Gymnosperms** (d) Angiosperms		
8	Which of the below mentioned Basidiomycete fungus is poisonous and hallucinogenic and produces toxin that inhibits eukaryotic RNA Polymerase II*?* *(a)* ***Amanita muscaria*** (b) *Agaricus campestris* (c) *Ustilago maydis* **(**d) *Aspergillus flavus*	Recognize	Remember
9	The cell wall of which of the below mentioned group of algae consists of cellulose and silica? (a) **Bacillariophyta** (b) Cyanophyta (c) Rhodophyta (d) Pheophyta	Correlate	Remember
10	Which of the below mentioned statement is TRUE with regard to the Xylem development in Bryophytes (a) Xylem is Exarch in Bryophytes (b) Xylem is Endarch in Bryophytes (c) Xylem is Mesarch in Bryophytes (d) **Bryophytes never form Xylem tissue**	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Explain asexual reproduction in Fungi?	Explain	Understand
22	Discuss the cellular organization and characteristics of Rhodophycean members?	Describe	Understand
23	What are lichens? Explain different forms of lichens along with asexual reproductive structures?	Differentiate	Analyze
24	Illustrate the trends in plant evolution with suitable examples?	Demonstrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		
25	Describe the stelar system evolution in plants?	Discuss	Understand
26	With well labeled diagram/s, outline the stages in the life cycle of an Ascomycete?	Demonstrate	Apply
27	List out the differences between mosses, liverworts and hornworts will well labeled diagrams wherever required?	Judge	Evaluate

SEMESTER - I

Course Code	Course Name	L	T	P	Credits
LIF112	Botany: Plant Diversity (Practicals)		-	2	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Recognise and understand the structural details of different species of microorganisms & primitive plants	Understand
CO2	Understand the classification & distribution of microbes and primitive plant species	Understand
CO3	Demonstrate and differentiate the morphology and sexual reproductive structures of different life forms.	Apply
CO4	Distinguish the differences in life cycles of microbes, algae, fungi, bryophytes, pteridophytes and gymnosperms.	Analyze
CO5	To correlate and assemble the knowledge for understanding the mechanisms of plant evolution	Evaluate

(Number of CO's are not fixed)

b. Syllabus

Practicals	Content	Hrs.
I	EMs/Models of Viruses: T-Phage & TMV, Line Drawing/Photograph of Lytic & Lysogenic Cycle	4
II	Types of Bacteria from Temporary/Permanent Slides/Photographs; EM bacterium; BinaryFission; Conjugation; Structure of Root Nodule	4
III	Gram Staining	4
IV	Study of Vegetative &Reproductive Structures of *Nostoc, Chlamydomonas* (EM Images), *Oedogonium, Vaucheria, Fucus** & *Polysiphonia* through TemporaryPreparations & Permanent Slides. (**Fucus* - Specimen &Permanent Slides)	4
V	***Rhizopus* &*Penicillium*:** Asexual Stage from Temporary Mounts &Sexual Structures through Permanent Slides	4
VI	***Alternaria:*** Specimens/Photographs &Tease Mounts	4
VII	***Puccinia*:** Herbarium Specimens of Black Stem Rust of Wheat &Infected Barberry Leaves; Section/Tease Mounts of Spores on Wheat & Permanent Slides of Both the Hosts	4
VIII	***Agaricus*:** Specimens of Button Stage &Full Grown Mushroom; Sectioning of Gills of*Agaricus*	4
IX	**Lichens:** Study of Growth Forms of Lichens (Crustose, Foliose & Fruticose)	4
X	**Mycorrhiza:**Ectomycorrhiza & Endomycorrhiza (Photographs)	4

XI	***Marchantia:***Morphology of Thallus, w.m. Rhizoids & Scales, VSThallus throughGemma Cup, WMGemmae (all temporary slides), VSAntheridiophore, Archegoniophore,LS. Sporophyte (Permanent Slides)	4
XII	***Funaria:*** Morphology, WM Leaf, Rhizoids, Operculum, Peristome, Annulus, Spores (Temporary Slides); Permanent Slides Showing Antheridial & Archegonial Heads, LS Capsule & Protonema	4
XIII	***Selaginella:*** Morphology, WM Leaf with Ligule, TS Stem, WM Strobilus, WM Microsporophyll & Megasporophyll (Temporary Slides), LS Strobilus (Permanent Slide)	4
XIV	***Equisetum:*** Morphology, TS Internode, LS Strobilus, TS Strobilus, WM Sporangiophore,WM Spores (Wet & Dry) (Temporary Slides); TS Rhizome (Permanent Slide)	4
XV	***Pteris***: Morphology, TS Rachis, VS Sporophyll, WM Sporangium, WM Spores (Temporary Slides), TS Rhizome, WM Prothallus with Sex Organs & Young Sporophyte (Permanent Slide)	4
XVI	***Cycas:*** Morphology (Coralloid Roots, Bulbil, Leaf), TS Coralloid Root, TS Rachis, VS Leaflet,VS Microsporophyll, WM Spores (Temporary Slides), LS Ovule, TS Root (Permanent Slide)	4
XVII	***Pinus:*** Morphology (Long & Dwarf Shoots, WM Dwarf Shoot, Male & Female), WM Dwarf Shoot, TS Needle, TS Stem, LS/TS Male Cone, WM Microsporophyll, WM Microspores (Temporary Slides), LS Female Cone, TLS & RLS Stem (Permanent Slide)	4

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**x**	**x**	**x**	**x**	**-**
CO2	**x**	**x**	**x**	**x**	**-**
CO3	**x**	**x**	**x**	**x**	**-**
CO4	**x**	**x**	**x**	**x**	**-**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	**CO2**	**CO3**	**CO4**	**CO5**	**Total**
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments					

Seminar					
Test					
Attendance					
Total					

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)					
Part – B (Short Answer -5 x 4 = 20marks)					
Part – C (Essay-3 x 10 = 30 marks)					
Total					

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza-tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21			
22			
23			
24			
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			
25			

SEMESTER - I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF113	Zoology I: Animal Diversity	45	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the mechanism of binominal nomenclature and classification of Kingdom Animalia	Remember
CO 2	Remember different Phyla under Kingdom Animalia	Understand
CO 3	Describe general characters of various phyla	Apply
CO 4	Explain the affinity of animals with lower and higher phyla	Analyze
CO 5	Using the general characters, the students are able to identify any animals	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**General characters of Invertebrates:** General characters and classification up to class level with distinctive and adaptive features of Phylum Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminths, Annelida, Arthropoda, Mollusca and Echinodermata with the suitable examples of each category.	09
II	**Structure and function of organelles from Protozoa to Aschelminthes:**Protozoa - Locomotory Organelles & Locomotion in Protozoa. Porifera - Canal system in Sycon. Coelenterata - Polymorphism in	09

	Hydrozoa. Platyhelminthes – *Life history of Taeniasolium,* Nemathelminthes – Life History of *Ascarislumbricoides*and its parasitic adaptations.	
III	**Structure and function of organelles from Annelida to Echinodermata:**Annelida – Metamerism in Annelida, Arthropoda – Vision in Arthropoda and Metamorphosis in Insects, Mollusca – Torsion in Gastropods, and Echinodermata – Water-vascular system in Astroidea.	09
IV	**General characters of Protochordata and Vertebrata:**Protochordates- General Features & Phylogeny of Protochordata, General Features of Agnatha& Classification of Cyclostomes up to Classes, Pisces - General Features & Classification up to Orders; Osmoregulation in Fishes, Amphibia - General Features & Classification up to Orders; Parental Care.	09
V	**Tetrapods:**Reptiles - General Features & Classification up to Orders; Poisonous & Non-Poisonous Snakes, Biting Mechanism in Snakes, Aves - General Features & Classification up to Orders; Flight Adaptations in Birds, Mammalia - Classification up to Orders; Origin of Mammals.	09
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the nomenclature and classifications of Animal Kingdom. ✓ Practise active listening; stimulate critical thinking and analysis skills in grouping the animals in a particular class, order and family. ✓ Prepare assignments on analytical mechanisms in identifying animals and grouping them as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **Barnes RSK, et al.** (2002) *The Invertebrates: A New Synthesis*. Blackwell Science **Hall BK &Hallgrimsson B.** (2008) *Strickberger's Evolution*. Jones & Bartlett Publishers Inc. **PoughH.***Vertebrate Life*. Pearson International. **Ruppert& Barnes RD.** (2006) *Invertebrate Zoology.* Holt Saunders International Edition. **Young JZ.** (2004) *The Life of Vertebrates*. Oxford University Press.	

c. Mapping of ProgramOutcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	x	x	-	x	x
CO2	x	x	x	x	x
CO3	x	x	x	x	x
CO4	x	x	x	x	x
CO5	x	x	x	x	x

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &factsand examples	Ideas aredetailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organization 50%**	Includes title, introduction,statement ofthe mainidea with illustration and conclusion.	Includes title, introduction,statement ofmain idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**		
1	A pearl is a hard, glistening object produced within the soft tissue of living molluscs. Pearl oyster belongs to class _____ of Phylum Mollusca. A. Gastropoda B. Cephalopoda C. Scaphapoda D. ***Bivalvia***	Identify	Remember
2	Which structure is found in all early vertebrate embryos at some stages during their development? A. Primitive lungs B. Leg, flippers or wing bones C***. Notochord*** D. Fins	Identify	Remember
3	Parental care is an association between the parents and the offspring, so as to increase the chances of the survival of the young ones. The fish famous for parental care is _____. A. ***Sea horse*** B. Lobeorohita C. Gambusia D. Scoliodon	Recognize	Remember
4	Generally fishes restrict their movements within small territorial		

	limits and do not go out of their home ranges. However, a few species travel long distances moving from place to place in search of food or for breeding. This movement of a large number of fishes for the purpose of feeding or spawning, is known as migration. A catadromous fish migrates from_____. A. ***freshwater to sea*** B. sea to river C. river to estuary D. deep sea to surface water	Recognize	Remember
5	Salamander is a _____. A. fish B. reptile C. ***amphibian*** D. protochordata	Recognize	Remember
6	Among different types of respirations in aquatic and terrestrial vertebrates, cloacal respiration is found in A. ***Turtle*** B. Tortoise C. Fish D. Frog	Identify	Remember
7	Which of the following includes coelomate unsegmented organisms? A. Annelida B. ***Mollusca*** C. Arthropoda D. Echinodermata	Recognize	Remember
8	What is common between earthworm, leech and centipede? A. They have malphigian tubules. B. They are hermaphrodite. C. ***They have ventral nerve cord.*** D. They have no legs.	Recognize	Remember
9	Biodiversity means_____. A. interaction between biotic & abiotic factors ***B. variety & variability among living organisms*** C. equitable use of resources D. deforestation	Identify	Remember
10	Filariasis is a parasitic disease caused_____. A. Fasciola B. ***Wuchereria*** C. Taenia D. Ascaris	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words marks: 5 x 4 = 20**		
11	a) Locomotion in Protozoa (or) b) Coral Reefs	Understand	Explain

12	a) Ascariasis (or) b) Taeniasis	Differentiate	Understand
13	a) Hormonal regulation of metamorphosis in insects (or) b) metamorphosis in frog	Differentiate	Explain
	a) Water vascular system in Starfish (or) b) Flight adaptation in birds.	Recognize	Explain
PART – C Essay Answer The answer should not exceed 400 words Marks: 3 x 10 = 30			
14	a) Enlist the salient features of phylum Echinodermata and classify up to class level with examples (or) b) what is metamorphosis? Discuss different types of metamorphosis in insects with example.	Describe	Analyze
15	a) Write a short note on migration in fishes (or) b) Write down the general characters of phylum Porifera. Discuss the canal system in sponges.	Describe	Apply
16	a) Enlist the salient features of class Reptilia. Discuss how reptilian features are advanced over the amphibian. (or) b) What is Protochordate? Discuss different subphyla of phylum Protochordata.	Describe	Analyze

SEMESTER - I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF114	**Zoology- Practical I**		**-**	**30**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO 1	Understand the mechanism of binominal nomenclature and classification of Kingdom Animalia	Remember
CO 2	Remember different Phyla under Kingdom Animalia	Understand
CO 3	Describe general characters of various phyla	Apply
CO 4	Explain the affinity of animals with lower and higher phyla	Analyze
CO 5	Using the general characters, the students are able to identify any animals	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	**Specific Objectives**
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve

Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Study of Specimens from Protozoa to Annelida:** *Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema,* & *Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium,* Male & female *Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria.*	06
II	**Study of Specimens from Arthropoda to Echinodermata:** *Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria* & *Antedon.*	06
III	**Study of Specimens from Protochordata to Amphibia :** *Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla,*	06
IV	**Study of Specimens:** *Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any Six Common Birds from Different Orders, *Sorex, Bat, Funambulus, Loris.*	06
V	**Study of Permanent Slides:** TS & LS of Sycon, Study of Life History Stages of *Taenia*, TS of Male & Female *Ascaris.* Key for Identification of Poisonous & Non-Poisonous Snakes	06
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the nomenclature and classifications of Animal Kingdom. ✓ Practice active listening; stimulate critical thinking and analysis skills in grouping the animals in a particular class, order and family. ✓ Identify animals and grouping them as advised by the lecturer and should be able to explain the concepts verbally during practicals. ✓ Participate actively and submit record notebook on a timely manner. **References:** **Barnes RSK, et al.** (2002) *The Invertebrates: A New Synthesis*. Blackwell Science **Hall BK & Hallgrimsson B.** (2008) *Strickberger's Evolution*. Jones & Bartlett Publishers Inc. **Pough H.***Vertebrate Life*. Pearson International. **Ruppert& Barnes RD.** (2006) *Invertebrate Zoology.* Holt Saunders International Edition. **P.S. Verma -** A Manual of Practical Zoology: Invertebrates	

	P.S. Verma - A Manual of Practical Zoology: Chordates	

c. Mapping of ProgramOutcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	x	x	-	x	x
CO2	x	x	x	x	x
CO3	x	x	x	x	x
CO4	x	x	x	x	x
CO5	x	x	x	x	x

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Record	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Record	6	6	6	6	6
Seminar	-	-	-	-	-
Test	-	-	-	-	-
Punctuality/ Attendance	2	2	2	2	2
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A **Identify the Specimens – (5 x 2 = 10 marks)**	2	2	2	2	2
Part – B **Short Answer – (5 x 6 = 30 marks)**	6	6	6	6	6
Part – C **(Viva voce - 20 marks)**	4	4	4	4	4
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1							
2							

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Identify the Specimen **Multiple Choice** **Marks: 5 x 2 = 10**		
1	 Ans: *Entamoeba histolytica*	Identify	Remember
2	 Ans: Spongilla	Identify	Remember
3	 Ans: Sea Urchin	Recognize	Remember
4	 Ans: Sea Horse	Identify	Remember
5	 Ans: Salamander	Recognize	Remember

	PART – B Short Answer **The answer should not exceed 200 words marks: 5 x 6 = 30**		
6	Identify the spotter and write the classification and comment on the specimen 	Identify	Explain
7	Identify the specimens and write the classification and comment on the specimen. 	Differentiate	Understand
8	Identify the specimens and write the classification and comment on the specimen focusing on adaptation. 	Identify	Explain
9	Identify the specimens and write the classification and comment on the specimen focusing on adaptation. 	Identify	Explain
10	Identify the specimens and write the classification and comment on the specimen focusing on adaptation. 	Identify	Explain
	PART – C **Viva voce Marks: 20**		
1	What is the difference between male and female Ascaris? What is the difference between invertebrates and vertebrates?	Differentiate	Explain

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF101	**Botany: Plant Ecology and Taxonomy**	**3**	**-**	**-**	**3**

- **a. Course Outcome (CO)** understand the ecological factors associated with evolution and adaptation of plant species.
- describe the different identification systems available to classify plant species.

On the successful completion of the course, the student will be able to
(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Learn about evolution and adaptation of plant species	Remember
CO2	Understand the ecological factors associated with the evolution	Understand
CO3	Illustrate the importance of the nomenclature and classification.	Apply
CO4	Evaluate the differences in diversity of plant forms growing in diverse environmental conditions	Analyze
CO5	To evaluate and apply the acquired knowledge for identification and classification of plants	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	Content	Hrs.
I	Plant Communities and Ecological Factors: Introduction to Plant Ecology & Taxonomy, Soil: Origin, Formation, Composition, Soil Profile, Water: States of Water in the Environment, Precipitation Types, Light &Temperature: Variation Optimal &Limiting Factors, Shelford Law of Tolerance, Adaptation of hydrophytes & Xerophytes, Plant Communities characters, Edge effect, Succession; processes and types	10
II	Ecosystem and Phytogeography: Structure, Energy Flow Trophic Organisation, Food Chains & Food Webs, Ecological Pyramids Production & Productivity, Biogeochemical Cycling, Cycling of Carbon, Nitrogen &Phosphorous, Principal Biogeographical Zones; Endemism	10
III	Introduction to Plant Taxonomuy and Identification Criteria: Identification, Classification, Nomenclature; Functions of Herbarium, Important Herbaria &Botanical Gardens of the World & India, Documentation: Flora, Keys: Single Access & Multi-Access	12
IV	Taxomomic evidences: Taxonomic Evidences from Palynology, Cytology, Phytochemistry & Molecular Data; Taxonomic Heirarchy: Ranks, Categories and Taxonomic groups	12
V	Binomial Nomenclature Classification, Biometrics and Numerical: Principles & Rules (ICN); Ranks & Names; Binominal System, Typification, Author Citation, Valid Publication, Rejection of Names, Principle of Priority & its Limitations, Types of Classification-Artificial, Natural & Phylogenetic. Bentham & Hooker (upto Series), Engler & Prantl (upto Series) Characters; Variations; OTUs, Character Weighting & Coding; Cluster Analysis; Phenograms, Cladograms (Definitions & Differences)	10

	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding ecological factors associated with evolution and adaptation of plant species. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** • **Kormondy EJ.** (1996) *Concepts of Ecology*. Prentice Hall, USA. • **Sharma PD.** (2010) *Ecology &Environment*. Rastogi Publications, Meerut, India. • **Simpson MG.** (2006) *Plant Systematics*. Elsevier Academic Press, San Diego, CA, USA. • **Singh G.** (2012) *Plant Systematics: Theory &Practice*. Oxford & IBH Pvt. Ltd., New Delhi.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**-**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement ofthe main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**		
1	Which of the following option represents the correct order of steps involved in the process of ecological succession? A) Invasion – Stabilization – Competition and coaction –Reaction – Nudation **B) Nudation – Invasion – Competition and coaction – Reaction – Stabilization** C) Invasion – Nudation – Competition and coaction – Reaction – Stabilization D) Nudation – Stabilization – Competition and coaction – Invasion – Reaction	Differentiate	Remember
2	Sunlight is an important ecological factor which affects the growth and development of all living organisms and acts as a limiting factor in the environment. Based on this view, identify the correct statement regarding “Heliophytes” and “Sciophytes” from the following options A) Heliophytes can grow only under lower light intensities and Sciophytes can grow only with full	Recognize	Remember

	sun light. B) Heliophytes are generally termed as photophobous plants and the Sciophytes are commonly known as sun loving plants **C) Heliophytes grows best in full sunlight and Sciophytes grow best at lower light intensities.** D) Heliophytes have thin leaves with lower rate of photosynthesis But Sciophytes have thick leaves with higher rate of photosynthesis.		
3	Binomials with exactly identical generic name and specific epithet are designated as which of the following A) Homonym B) Isonym **C) Tautonym** D) Autonym	Recognize	Remember
4	A type specimen which is a duplicate of the holotype is collected from the same place, at the same time and collected by the same person. These specimens having same collection number and differentiated as a, b, c, d is designated as A) Neotype B) Lectotype C) Paratype **D) Isotype**	Recognize	Remember
5	Presence of bisexual, zygomorphic flowers with posterior vexillum, lateral wing petals, anterior keel petals (enclosing stamen and pistle), diadelphous stamens (1 posterior free and filaments of nine fused into a tube) are the characteristic features of which of the following plant family? A) Asteraceae **B) Papilionaceae** C) Rosaceae D) Passifloraceae	Recognize	Remember
6	The NPC classification of pollen is based on which of the following characters? **A) N: Number P: Position C: Character of pores** B) N: Name P: Plant C: Climate C) N: Nature of pollen P: Parent C: Count D) N: Nomenclature P: Part C: Condition	Recognize	Remember
7	Which one of the below mentioned denotes the stratified wall of mature pollen grains (A) **Sporoderm** (B) Ectoderm (C) Epiderm (D) Mesoderm	Identify	Remember
8	According to binomial nomenclature each plant name should have two words. Which of the below mentioned are correct	Recognize	Remember

	words? (A) **Generic and Specific epithet** (B) Family and Class epithet (C) Class and subclass epithet (D) None of these		
9	Which of the below mentioned group of plants grow in saline conditions? (A) Hydrophytes (B) Xerophytes (C) **Halophytes** (D) Mesophytes	Correlate	Remember
10	The Central National Herbarium in India is established in which of the following places? (A) Dehradun (B) **Calcutta** (C) Bombay (D) Allahabad	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Define the term "Ecological succession" and explain the events associated with climax community formation?	Explain	Understand
22	Discuss in detail about how palynological, cytological and molecular data provide evidences for inferring relationship between different taxa?	Describe	Understand
23	Describe the anatomical adaptations of xerophytes and hydrophytes?	Differentiate	Analyze
24	Describe in detail the preparation of herbarium	Demonstrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		
25	Describe in detail about the trophic organization and energy flow in an ecosystem with a suitable example and add a note on mineral cycling in ecosystem?	Discuss	Understand
26	Describe the effect of light and temperature on plants?	Demonstrate	Apply
27	Describe the Bentham and Hooker's system of botanical classification and list out its merits and demerits?	Judge	Evaluate

SEMESTER - I					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF104	Zoology- Practical II		-	30	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the general anatomy of vertebrates	Remember
CO 2	Remember the origin and affinity of anatomical features in vertebrates	Understand
CO 3	Describe the anatomical features of each class of vertebrates	Apply
CO 4	Explain the development of vertebrates	Analyze
CO 5	Using the comparative anatomy, the students are able to identify the origin and relationships among vertebrates	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Osteology:** a) Disarticulated Skeleton of Fowl & Rabbit; b) Carapace & Plastron of Turtle/Tortoise; c) Mammalian Skulls: One Herbivorous & One Carnivorous Animal.	06
II	**Frog - Study of Developmental Stages** - Whole Mounts & Sections through Permanent Slides – Cleavage Stages, Blastula, Gastrula, Neurula, Tail Bud Stage, Tadpole External & Internal Gill Stages	06
III	**Study of the Different Types of Placenta** - Histological Sections through Permanent Slides or Photomicrographs	06
IV	**Study of Placental Development** in humans by ultrasound scan picture	06
V	**Examination of Gametes** - Frog/Rat - Sperm & Ova through Permanent Slides or Photomicrographs	06

	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the nomenclature and classifications of Animal Kingdom. ✓ Practice active listening; stimulate critical thinking and analysis skills in grouping the animals in a particular class, order and family. ✓ Identify animals and grouping them as advised by the lecturer and should be able to explain the concepts verbally during practicals. ✓ Participate actively and submit record notebook on a timely manner. **References:** ✓ Fully understand the comparative anatomy of vertebrate animals. ✓ Practice active listening; stimulate critical thinking and analysis skills in the anatomical characteristics of various vertebrates. ✓ Observe the specimens for various animal's anatomical features and developmental biology of vertebrates as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit record notebook on a timely manner. **References:** **Balinsky BI.** (2008) *An Introduction to Embryology*. International Thomson Computer Press. **Bruce MC.** (1996) *Patten's Foundations of Embryology*. McGraw Hill. **Gilbert SF.** (2006) *Developmental Biology*. Sinauer Associates, Sunderland, Massachusetts, USA. **Hilderbr& M &Gaslow GE.** (1998)*Analysis of Vertebrate Structure*. John Wiley & Sons. **Kardong KV.** (2005) *Vertebrates' Comparative Anatomy. Function & Evolution*. McGraw-Hill Higher Education. **Kent GC & Carr RK.** (2000) *Comparative Anatomy of the Vertebrates*. The McGraw-Hill Companies. **Walter HE & Sayles LP. (1949) *Biology of Vertebrates*. Khosla Publishing House.** **P.S. Verma -** A Manual of Practical Zoology: Chordates	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	x	x	-	x	x
CO2	x	x	x	x	x
CO3	x	x	x	x	x
CO4	x	x	x	x	x
CO5	x	x	x	x	x

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Record	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Record	6	6	6	6	6
Seminar	-	-	-	-	-
Test	-	-	-	-	-
Punctuality/ Attendance	2	2	2	2	2
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A **Identify the Specimens – (5 x 2 = 10 marks)**	2	2	2	2	2
Part – B **Short Answer – (5 x 6 = 30 marks)**	6	6	6	6	6
Part – C **(Viva voce - 20 marks)**	4	4	4	4	4
Total	**12**	**12**	**12**	**12**	**12**

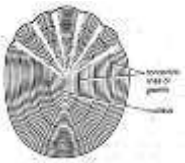
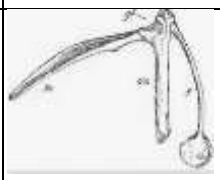
g. Rubric for Assignments

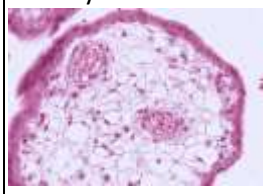
S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1							
2							

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Identify the Specimen **Multiple Choice** **Marks: 5 x 2 = 10**		
1	 Ans: *Frog's skull*	Identify	Remember
2	 Ans: Cycloid scale	Identify	Remember
3	 Ans: Frog eggs	Recognize	Remember
4	 Ans: Bird's skull	Identify	Remember
5	 Ans: Pectoral girdle of bird	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words marks: 5 x 6 = 30**		
6	Identify the spotter and write the classification and comment on the endodermal modification. 	Identify	Explain

7	Identify the slide and comment on the specimen. 	Differentiate	Understand
8	Identify the slide and comment on the specimen. 	Identify	Explain
9	Identify the type of feather and comment on it. 	Identify	Explain
10	Identify the slide and comment on the specimen 	Identify	Explain
PART – C **Viva voce** **Marks: 20**			
1	What are the different types of placenta present in mammals?	Differentiate	Explain

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF123	**Zoology II: Comparative Anatomy and Developmental Biology of Vertebrates**	**45**	**-**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the general anatomy of vertebrates	Remember
CO 2	Remember the origin and affinity of anatomical features in vertebrates	Understand
CO 3	Describe the anatomical features of each class of vertebrates	Apply
CO 4	Explain the development of vertebrates	Analyze
CO 5	Using the comparative anatomy, the students are able to identify the origin and relationships among vertebrates	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Integumentary, Skeletal, Digestive & Respiratory Systems:** Derivatives of Integument with reference to glands & digital Tips, Characteristics of Vertebrate skulls and Jaw suspension. Alimentary canal and associated gland in vertebrates. Brief account of gills, lungs, air sacs and swim bladder.	09
II	**Circulatory, Urinogenital, Nervous Systems & Sense Organs:**General plan of circulation, evolution of heart and aortic arches. Vertebrate kidney: Pronephros, Mesonephros and Metanephros. Gonads and their ducts in Elasmobranchs, Amphibia, Reptilia, Aves & Mammals. Central Nervous system in Vertebrates, classification of receptors.	09

III	**Early Embryonic Development :**Spermatogenesis & Oogenesis with reference to Mammals, Vitellogenesis in Birds; Fertilization: External (Amphibians), Internal (Mammals), Blocks to Polyspermy; Early Development of Frog & Humans (Structure of Mature Egg & its Membranes, Patterns of cleavage, Fate Map, up to formation of gastrula); types of morphogenetic movements; Fate of Germ Layers; Neurulation in frog embryo.	09
IV	**Late Embryonic Development:**Implantation of Embryo in Humans, Formation of Human Placenta & Functions, Other Types of Placenta on the Basis of Histology; Metamorphic Events in Frog Life Cycle & its Hormonal Regulation.	09
V	**Control of Development:**Fundamental Processes in Development (Brief Idea) – Gene Activation, Determination, Induction, Differentiation, Morphogenesis, Intercellular Communication, Cell movements & Cell Death.	09
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the comparative anatomy of vertebrate animals. ✓ Practice active listening; stimulate critical thinking and analysis skills in the anatomical characteristics of various vertebrates. ✓ Prepare assignments on analytical mechanisms in anatomy and developmental biology of vertebrates as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **Balinsky BI.** (2008) *An Introduction to Embryology*. International Thomson Computer Press. **Bruce MC.** (1996) *Patten's Foundations of Embryology*. McGraw Hill. **Gilbert SF.** (2006) *Developmental Biology*. Sinauer Associates, Sunderland, Massachusetts, USA. **Hilderbr& M &Gaslow GE.** (1998)*Analysis of Vertebrate Structure*. John Wiley & Sons. **Kardong KV.** (2005) *Vertebrates' Comparative Anatomy. Function & Evolution*. McGraw-Hill Higher Education. **Kent GC &Carr RK.** (2000) *Comparative Anatomy of the Vertebrates*. The McGraw-Hill Companies. **Walter HE & Sayles LP.** (1949)*Biology of Vertebrates*. Khosla Publishing House.	

c. Mapping of ProgramOutcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**-**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &factsand examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organization 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organizati on	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1	**During early development of vertebrates, where does the medulla oblongata form from?** A. Diencephalon B. Metencephalon ***C. Myelencephalon*** D. Telencephalon	Recognize	Remember
2	**Which of the following correctly displays the sequence of developmental milestones?** A. Cleavage-blastula-gastrula-morula B. Cleavage-gastrula-morula-blastula ***C. Cleavage-morula-blastula-gastrula*** D. Gastrula-morula-blastula-cleavage	Identify	Remember
3	**During the early part of the cleavage stage in frog development, the rapidly developing cells** A. Skip the mitosis phase of the cell cycle. B. Skip the S phase of the cell cycle. ***C. Skip the G1 and G2 phase of the cell cycle.*** D. Skip the cytokinesis phase of the cell cycle.	Recognize	Remember
4	**Eggs and sperm are genetically similar, but structurally very**		

	different. Why is this so? ***A. Both contain a haploid chromosome number, but eggs must provide nutrients for early development, while sperm must be able to move efficiently.*** B. Both contain a diploid chromosome number, but eggs must provide nutrients for early development, while sperm must be able to move efficiently. C. Both contain maternal chromosomes, but only sperm can control which chromosomes are passed on D. Both contain a haploid chromosome number, but only eggs can control which chromosomes are passed on.	Recognize	Remember
5	**During gametogenesis, which of the following cells are diploid?** A. Secondary oocytes B. Secondary spermatocytes ***C. Primary spermatocytes*** D. Spermatids	Recognize	Remember
6	**Centrolecithal eggs are the characteristics of** A. Placental mammals B. Birds ***C. Insects*** D. Reptiles	Identify	Remember
7	**The acrosome of sperm cell contains** A. Lysosome B. Mitochondria for energy production C. Peroxisomes ***D. Hyaluronidase for egg penetration***	Recognize	Remember
8	**During gastrulation size of embryo remains constant but metabolic rate** ***A. Increases*** B. Decreases C. Is unchanged D. None of the above	Recognize	Remember
9	**In which type of eggs, the blastomeres, if separated, develop into whole embryo** A. Mosaic ***B. Regulative*** C. Cleidoic D. Non-cleidoic	Identify	Remember
10	***Among different types of respirations in aquatic and terrestrial vertebrates, cloacal respiration is found in*** ***A. Turtle*** B. Tortoise C. Fish D. Frog	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
11	a) Oviparous Vs Viviparous (or) b) Cleidoic Vs Non-Cleidoic egg	Differentiate	Explain

12	a) Gastrula Vs Blastula (or) b) Holoblastic Vs Meroblastic cleavage	Differentiate	Understand
13	a) Amniotic Vs Anamniotic egg (or) b) Internal Fertilization Vs External Fertilization	Differentiate	Explain
14	a) Describe the aortic arches in Amphibian (or) b) 3-Chambered heart Vs 4-chambered heart	Differentiate	Explain
PART – C Essay Answer The answer should not exceed 400 words Marks: 3 x 10 = 30			
25	a) Discuss in detail the development of brain in vertebrates with diagram (or) b) Describe different types of eggs based on the amount and distribution of yolk.	Describe	Analyze
26	a) Enlist and discuss the functions of the integumentary systems in vertebrates or b) Comment on different phases of oogenesis. How oogenesis differs from spermatogenesis?	Correlate	Apply
27	a) Write a short note on Gastrulation? Enlist the differences between gastrula and blastula or b) Describe different types of accessory respiratory organs in aquatic vertebrates.	Describe	Analyze

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF213	**Zoology: Animal Physiology**	**3**	**0**	**0**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO1	Understand the functional physiological mechanisms of different tissue & organ systems in mammals	Understand
CO2	Illustrate the importance of tissues & organ systems in animals	Apply
CO3	Examine the differences in functional reflexes of diverse tissue and organ systems in mammals	Analyze
CO4	Formulate causes for functional abnormalities in reflex actions in tissues and organ systems	Create
CO5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	**Content**	**Hrs.**
I	**Nervous and Muscular Physiology:** Structure of a neuron, resting mmembrane potential, graded potential, origin of action potential & its propagation in myelinated & non-myelinated nerve fibres, ultra-structure of skeletal muscle, molecular & chemical basis of muscle contraction	09

II	**Gastrointestinal and Excretory Physiology:** Physiology of digestion in the alimentary canal; absorption of carbohydrates, proteins, lipids, structure of nephron, mechanism of urine formation, counter-current mechanism, regulation of acid-base balance, normal ph of body fluids – buffer systems in blood, functions of respiratory system & kidneys for maintenance of acid-base balance, disorders of acid-base balance	09
III	**Respiratory and Cardiovascular Physiology:** Pulmonary ventilation, respiratory volumes & capacities, transport of oxygen & carbon dioxide in blood, blood - composition & chemical properties, haematocrit, changes/abnormalities, sedimentation rate & abnormalities, erythrocytes – structure, size, function, normal count, polyglobulia, its causes & consequences. anaemia& consequences, haemoglobin – composition, types, main derivatives, haemostasis, haemocoagulation – extrinsic & intrinsic pathways, haemocoagulation factors, vitamin k – functions, haemocoagulation tests. thrombocytes, activity in haemostasis - haemopoiesis, erythropoietin, stimuli for its synthesis & secretion. structure of heart, origin & conduction of the cardiac impulse, cardiac cycle	09
IV	**Reproductive and Endocrine Physiology:** Hormonal control of spermatogenesis; physiology of female reproduction: hormonal control of menstrual cycle, structure & function of pituitary, thyroid, parathyroid, pancreas & adrenal gland	09
V	**Special Sensory Physiology:** Structure & function of sensory receptors, adequate stimulus, sensory pathways, cortical centres, somatovisceral sensory system. tactile& thermoceptive sensitivity: receptors – structure & function, sensory pathway, corical centres. pain – receptors, stimuli, types of pain, mechanisms of hypoalgaesia, vision: refraction system – structure, function. accommodation, receptors for vision, adequate stimulus, colour vision & its disorders, central & peripheral vision, binocular vision & 3d perception, sense of hearing – external, middle inner ear – structure & function. the organ of corti, sound & its intensity, relations between threshold intensity & frequency of sound waves, audiometry. auditory pathway, cortical centre, sense of balance – organs of static & dynamic balance & functions, vestibular pathway, nystagmus	09
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the several different physiological mechanisms used by animals to adapt to their environment. ✓ Practise active listening, stimulate critical thinking and analysis skills in animal physiology. ✓ Prepare assignments on analytical mechanisms in animal physiology as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:**	

	1) Berg JM, Tymoczko JL & Stryer L. (2006) Biochemistry. WH Freeman & Co. 2) Guyton AC & Hall JE. (2011) Textbook of Medical Physiology. Harcourt Asia Pvt. Ltd/WB Saunders, USA. 3) Murray RK, Granner DK, Mayes PA & Rodwell VW. (2009) Harper's Illustrated Biochemistry. Lange Medical Books/McGraw Hill. 4) Nelson DL, Cox MM & Lehninger AL. (2009) Principles of Biochemistry. WH Freeman & Co. 5) Tortora GJ & Derrickson BH. (2009) Principles of Anatomy & Physiology. John Wiley & Sons, Inc. 6) Widmaier EP, Raff H & Strang KT. (2008) Vander's Human Physiology. McGraw Hill.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-

Total	12	12	12	12	12

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts andexamples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza-tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple choice 10 x 1 = 10**		
1	**Regarding neurotransmitters all the following statements are true EXCEPT:** a) γ-aminobutyric acid (GABA) and glycine are inhibitory neurotransmitters. b) Acetylcholine, norepinephrine and epinephrine are excitatory in nature. ***c) Amacrine cells produce glutamate at the bipolar cell-ganglion cell interjunction.*** d) Horizontal cells release GABA and/or glycine.	Differentiate	Remember
2	**Which of the following represents the key function of the sarcoplasmic reticulum?** a) Releases calreticulin for binding of Ca2+ in the cytoplasm. ***b) Stores and releases Ca2+ for myocardial cell excitation-contraction coupling.*** c) Production of HCO3- within the intracellular compartment of a muscle cell. d) Release of K+ when there is hyperpolarization within the contractile cell.	Recognize	Remember
3	**Which of the following gastrointestinal hormone stimulates insulin secretion?** ***a) GIP*** b) CCK c) Gastrin d) Secretin	Recognize	Remember
4	**Which of the following is MOST likely to be the structure indicated by the arrow in the picture below?**  a) Lingual tonsil ***b) Palatine tonsil*** c)Palatopharyngeal fold d) Soft palate	Recognize	Remember
5	**Regarding pulmonary surfactants produced by type II pneumocytes, identify the FALSE statement:** a) Dipalmitoyl phosphatidylcholine (a.k.a lecithin) is the key ingredient of surfactant. b) Surfactant increases compliance, and decreases	Recognize	Remember

	elasticity. ***c) Surfactant deficiency results in low surface tension in the alveoli of the lungs, leading to alveolar collapse and atelectasis.*** d) Fetal lungs start to produce surfactants by 34-36 weeks.		
6	**Regarding generation of action potentials by the sinu-atrial node (pace maker) identify the TRUE statement:** a) SA node generates depolarization leading to 160 beats per minute. b) The impulses are transmitted to the right ventricle. ***c) Signals traverse into the right atrium via internodal pathway before converging on the atrio-ventricular node.*** d) Rhythms generated from the SA node are dissipated into the left atrium do not converge on the atrio-ventricular node.	Recognize	Remember
7	**All the following decrease ADH secretion EXCEPT:** a) Low serum osmolarity b) Atrial natriuretic peptide ***c) Volume depletion*** d) α-agonists	Recognize	Remember
8	**Which of the following represents the function of progesterone?** a) Maturation of fallopian tubes, uterus, cervix, and vagina ***b) Maintenance of luteal phase and uterine secretory activity*** c) Development of granulosa cells d) Growth of breasts	Correlate	Remember
9	**Regarding visual signaling identify the FALSE statement:** a) Rhodopsin is a visual pigment found in the photoreceptors that absorbs photons of light energy. b) The light-absorbing retinal is found in 11-cis form together with opsin. ***c) Color blindness results from convergence of light rays on rhodopsin eventually culminating in the binding of all-trans retinal to transducin.*** d) Vitamin A deficiency leads to lack of synthesis of 11-cis retinal and eventual onset of nyctalopia.	Identify	Remember
10	**Identify the CORRECT sequence of the marked parts of the inner ear:**  a) (1) Scala tympani (2) Scala media (3) Scala vestibule (4) Basilar membrane (5) Tectorial membrane (6) Organ of Corti	Identify	Remember

	b) (1) Scala vestibule (2) Scala media (3) Scala tympani (4) Basilar membrane (5) Tectorial membrane (6) Organ of Corti c) (1) Scala vestibule (2) Scala media (3) Scala tympani (4) Basilar membrane (5) Organ of Corti (6) Tectorial membrane d) (1) Scala vestibule (2) Scala media (3) Scala tympani (4) Organ of Corti (5) Tectorial membrane (6) Basilar membrane		
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Explain the mechanism of action potential and its propagation in myelinated nerve fibers	Explain	Understand
22	State the molecular and chemical events associated with muscle contraction	Illustrate	Understand
23	Discuss the differences between myopia and hyperopia. What is astigmatism?	Differentiate	Understand
24	Illustrate the organ of Corti. Explain how abnormalities in the organ affect auditory senses in animals.	Illustrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words 3 x 10 = 30**		
25	Enlist the different functions of the liver. Describe the physiological metabolic, hematologic and other functional roles of the liver and their regulation.	Describe	Analyse
26	Discuss the heart as a syncytium, events of action potential of cardiac muscle with ionic changes and describe the mechanisms/reasons behind the long action potential and plateau.	Correlate	Understand
27	Outline the significance of the conversion of tetraiodothyronine (T_4) to triiodothyronine (T_3) in extrathyroidal tissues. Describe the metabolic pathway involved in thyroid hormone synthesis.	Assess	Skill

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF214	**Zoology: Practicals III**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO1	Understand the physiology of animals by applying skills to measure physiological systems in human	Understand
CO2	Apply knowledge to understand the functional importance of tissues & organ systems for functional existence in human	Apply
CO3	Analyse and conduct experiments related to measurement of	Analyze

	physiological systems in human	
CO4	Conceive and develop strategies to differentiate tissues and cell components and describe their functions	Create
CO5	Demonstrate practical skills in the use of tools, technologies & methods in physiology	Skill

b. Syllabus

Units	Content	Hrs.
I	Phlebotomy	03
II	Physiological Measurement of Blood Pressure (Sphygmomanometry), Body Temperature (Stethoscopy), ECG, EEG, EMG (using Automated Biopac Physiological Measurement System)	09
III	Study of Permanent Slides of Spinal Cord, Duodenum, Liver, Lung, Kidney, Bone, Cartilage	09
IV	Preparation of Hemin & Hemochromogen Crystals Study of Permanent	03
V	Histological Sections of Mammalian Pituitary, Thyroid, Pancreas, Adrenal Gland	09

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**-**
CO2	**x**	**x**	**x**	**x**	**-**
CO3	**x**	**x**	**x**	**x**	**-**
CO4	**x**	**x**	**x**	**x**	**-**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments					
Seminar					
Test					
Attendance					
Total					

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A **(Objective - 10 x 1 = 10marks)**					

Part – B **(Short Answer -5 x 4 = 20marks)**					
Part – C **(Essay-3 x 10 = 30 marks)**					
Total					

g. Rubric for Assignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Content** **50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza-tion** **50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21			
22			
23			
24			
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			
25			

SEMESTER - IV					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF201	**Plant Physiology and Metabolism**	**3**	**-**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Learn about the physiological mechanisms operational in plants for healthy survival & existence.	Remember
CO 2	Understand the association of plant with the external environment and the factors contributing to existence of plant species.	Understand
CO 3	Illustrate the importance of water, light, hormones and different conditions for growth and development of plants	Apply
CO 4	Evaluate and understand how plants respond to different external & internal physiochemical factors.	Analyze
CO 5	To apply the acquired knowledge for improving plant growth and development	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	Content	Hrs.
I	**Plant Water Relation and Mineral Nutrition:** Importance of Water, Water Potential & its Components; Transpiration & its Significance; Factors Affecting Transpiration; Root Pressure & Guttation, Mineral nutrition: Essential Elements, Macro & Micronutrients; Criteria of Essentiality of Elements; Role of Essential Elements; Transport of Ions Across Cell Membrane, Active & Passive Transport, Carriers, Channels & Pumps	12
II	**Translocation in Phloem:** Composition of Phloem Sap, Girdling Experiment; Pressure Flow Model; Phloem Loading & Unloading	08
III	**Photosynthesis and nitrogen metabolism along with enzymes involved** : Photosynthetic Pigments (Chl A, B, Xanthophylls, Carotene); Photosystem I &II, Reaction Center, Antenna Molecules; Electron Transport & Mechanism of ATP Synthesis; C3, C4 &CAM Pathways of Carbon Fixation; Photorespiration, Nitrogen Metabolism: Biological Nitrogen Fixation; Nitrate & Ammonia Assimilation	12

IV	Plant Growth Regulators: Discovery & Physiological Roles of Auxins, Gibberellins, Cytokinins, ABA, Ethylene	10
V	Plant Response to Light and Temperature: Photoperiodism (SDP, LDP, Day Neutral Plants); Phytochrome (Discovery & Structure), Red & Far Red Light Responses on Photomorphogenesis; Vernalization	12
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding the physiology and metabolism of plants. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** • **Bajracharya D.** (1999)*Experiments in Plant Physiology - A Laboratory Manual*. Narosa Publishing, New Delhi. • **Hopkins WG& Huner NP.**(2009) *Introduction to Plant Physiology*. John Wiley & Sons, USA. • **Taiz L& Zeiger E.**(2010) *Plant Physiology*. Sinauer Associates Inc, USA. • **Buchanan Bob B, Gruissem W and Jones RL (**2015) Biochemistry and Molecular Biology of Plants,. Wiley Blackwell • **Raven**	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**x**	**x**	**x**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	**CO2**	**CO3**	**CO4**	**CO5**	**Total**
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction,statement ofthe main idea withillustration and conclusion.	Includes title, introduction,statement ofmain ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**		
1	Which of the below mentioned enzymes are inactive in the Orange pericarp mutant of maize? (A) Methionine synthase (B) **Tryptophan synthase** (C) Tryptophan transaminase (D) Nitrilase.	Differentiate	Remember
2	Which of the following hormones is not a growth promoter? (A) Auxin (B) Cytokinin (C) Ethylene (D) **Abscisic acid** .	Recognize	Remember
3	What happens when there is a competition between Carboxylation and Oxygenation during photosynthesis? (A)Efficiency of Photosynthesis increases (B) **Efficiency of Photosynthesis decreases** (C) Photosynthesis is unaffected (D) Competition can never happen.	Recognize	Remember
4	Indole 3-acetic acid is present in which of the below mentioned organelles?	Recognize	Remember

	Chloroplast and Cytosol (B) Mitochondria and Cytosol (C) Chloroplast and Mitochondria (D) Mitochondria and Peroxisome		
5	Paclobutrazol is an inhibitor of which of the below mentioned processes? (A) Auxin biosynthesis (B) **Gibberellin biosynthesis** (C) Ethylene biosynthesis (D) Cytokinin biosynthesis	Recognize	Remember
6	Which of the below mentioned hormone is important for resistance to pathogens? (A) Abscisic acid (B) **Salicylic acid** (C) Gibberellic acid (D) Indole 3-acetic acid.	Recognize	Remember
7	Which of the below mentioned is an inhibitor for Actin polymerization? (A) **Cytochalasin D** (B) Brefeldin (C) Triiodobenzoic acid (D) Naphthylthalmic acid.	Identify	Remember
8	Phytochromobilin is synthesized in which of the below mentioned organelles? (A) **Chloroplast** (B) Mitochondria (C) Peroxisome (D) Vacuole	Recognize	Remember
9	The light reaction of photosynthesis does not include which of the below mentioned processes? (A) Electron transport (B) Charge separation (C) ATP Synthesis (D) **CO_2 uptake**	Correlate	Remember
10	Which of the below mentioned hormone was discovered as a breakdown product of DNA? (A) Adenine (B) **Kinetin** (C) Zeatin (D) Thymine	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Explain the differences between plant hormones and animal hormones	Explain	Understand
22	Describe Emersons enhancement effect	Describe	Understand
23	Explain the advantqges of aeroponics over soil grown plangs	Differentiate	Analyze
24	Demonstrate the importance of micro and macronutrients for plant growth	Demonstrate	Apply
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			
25	Discuss the physical and chemical properties of water that are required for ascent of sap?	Discuss	Understand
26	Describe the Gibberellin signal transduction pathway with suitable diagrams?	Describe	Remembering
27	Outline the importance of light for flowering in plants.	Judge	Evaluate

	Describe the importance of blue-light and red-light receptors in plants		

SEMESTER - IV					
Course Code	Course Name	L	T	P	Credits
LIF 202	Botany Practicals - IV	-	-	3	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO 1	Understand the basic physiology of different parts of plants	Understand
CO 2	To know about the different parts and its function about the plant system	Remember
CO 3	Illustrate the importance of different physiological process in plant parts and tissues	Apply
CO 4	Examine the differences in physiological and functional role of plant parts / system	Analyze
CO 5	Utilize the skills required to extrapolate the mechanisms for plant applications with appropriate experimental tools	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	**Content**	**Hrs.**
Exp -1	Determination of Osmotic Potential of Plant Cell Sap by Plasmolytic Method	03
Exp -2	To Study the Effect of Two Environmental Factors (Light & Wind) on Transpiration by Excised Twig	09
Exp -3	Calculation of Stomatal Index & Stomatal Frequency of a Mesophyte & a Xerophyte	03
Exp -4	Demonstration of Hill Reaction	03
Exp -5	Demonstrate the Activity of Catalase & Study the Effect of pH & Enzyme Concentration	06
Exp -6	To Study the Effect of Light Intensity & Bicarbonate Concentration on O2 Evolution in Photosynthesis	03
Exp -7	Comparison of the Rate of Respiration in any Two Parts of a Plant	06
Exp -8	Separation of Amino Acids by Paper Chromatography	03
Exp -9	Demonstration Experiments (any Four): Bolting/Effect of Auxins on Rooting/Suction Due to Transpiration/RQ/Respiration in Roots	09
	Tasks and Assignments: Each student is required to adhere to the following: • Fully understand the different physiological mechanisms used by plants and its response to environment. • Practice active listening, observation, stimulate critical thinking and analysis skills in plant physiology and metabolism.	

	• Prepare assignments on analytical mechanisms in plant physiology as advised by the lecturer and should be able to explain the principle and methods of the practical experiment. • Participate in problem-based learning (PBL) assignments and record the observation and submit a record in a timely manner. **References:** Bajracharya D. (1999) Experiments in Plant Physiology - A Laboratory Manual. Narosa Publishing, New Delhi. Hopkins WG & Huner NP. (2009) Introduction to Plant Physiology. John Wiley & Sons, USA. Taiz L & Zeiger E. (2010) Plant Physiology. Sinauer Associates Inc, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**-**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (60 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	2	2	2
Seminar	3	3	3	3	3
Test	5	5	5	5	5
Attendance	2	2	2	2	2
Total	12	12	12	12	12

f. Mapping Course Outcome with External Assessment (40 Marks)

Category		CO1	CO2	CO3	CO4	CO5
Part – A Major Experiment	15 marks	3	3	3	3	3
Part – B One Minor Experiment	05 marks	1	1	1	1	1
Part – C Five spotters	05 marks	1	1	1	1	1
Part – D Record Book	05 marks	1	1	1	1	1

Part – E Viva Voce 10 marks	2	2	2	2	2
The pattern for **internal valuation** for 60 marks may be: Two internal tests of 25 marks each: average = 25 marks Seminar /Observation = 15 marks Assignment = 10 marks Attendance = 10 marks					
Total	**8**	**8**	**8**	**8**	**8**

g. Rubric for Assignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts andexamples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO3, & CO5
2	**Organiza-tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO3, & CO5

h. Rubric for Seminar

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**

1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Major Experiment **(**Aim, Principle, Material required, Procedure, Formula/calculation**)** **Marks: 1 x 15 = 15**		
1	Loss of water in plant can be measured by many tool/methods. How can you measure the quantity of water loss under high wind , under high temperature/light	Describe/ Illustrate	Remember
	Part – A: Minor Experiment **(**Aim, Principle, Material required, Procedure, Formula/calculation**)** **1 x 5 = 5**		
1	Write about stomatal frequency and neatly represent the number of stomata present in the leaf upper and lower surface	Describe/ Illustrate	Remember
	Part – C Five spotters**05 marks**		
1	Photo / specimen of Guard cells	Identify/Differentiate	Apply
	Part – D Record Book **05 marks**	Illustrate/Assess	Skill
	Part – E Viva Voce **10 marks**	Explain/ Differentiate/	Analyse /understand

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF203	**Zoology: Genetics & Evolutionary Biology (CC-Zoology)**	**3**	**-**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	**Level**
CO1	To take students through basics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains	Remember
CO2	Students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution	Understand
CO3	Students will acquire the knowledge and thorough understanding on genome organization, concept of non-mendelian genetics	Apply
CO4	Students will acquire the knowledge of evolutionary genetics	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	Principles of Mendelian Inheritance, Dominance & Recessive, Segregation, Independent Assortment, Epistasis, Allele, Multiple Alleles, Pseudo Allele, Lethal Alleles, Complementation Tests, Codominance, Incomplete Dominance, Gene Interactions, Pleiotropy, Genomic Imprinting, Penetrance & Expressivity, Phenocopy, Autosomal & Sex Linked Inheritance, Extra-Chromosomal Inheritance.	9
II	Linkage & Crossing Over, Recombination Frequency as a Measure of Linkage Intensity, Two Factor & Three Factor Crosses, Interference & Coincidence, Somatic Cell Genetics - An Alternative Approach to Gene Mapping, Sex Linkage, Pedigree Analysis, Dosage Compensation, Chromosomal Basis of Sex- Determination in Animals & Plants, Dosage Compensation of X-Linked	9

	Genes, Lampbrush Chromosome & their Function, Polytene Chromosome & Gene Expression	
III	Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy & Polyploidy; Gene Mutations: Induced Versus Spontaneous Mutations, Back Versus Suppressor Mutations, Change in Chromosome Number, Somatic Vs Germinal Mutation, Types, Causes & Detection Of Mutation	9
IV	Hardy Weinberg Principal for Calculating Recessive Gene Frequency, Calculating Frequency of Sex –Linked Alleles, Calculation of Allele Frequencies, Evolutionary Change by Mutation, Gene Flow, Genetic Drift, Natural Selection & Non-Random Mating.	9
V	Molecular Clocks, Origin of New Genes & Proteins; Gene Duplication & Divergence. Gene Families: Multigene Families – Classical Gene Families, Families with Large Conserved Domains, Families with Small Conserved Domains, Gene Superfamilies, Gene Families in Clusters, Pseudogenes, Repetitive DNA & Transposable Elements, Origin of Gene Families Organization of Genes Coding for rRNA, mRNA, Small Nuclear RNA	9
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding the structural and functional aspects of cells and basic mechanisms underlying cell signalling and cell division. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** 1. Snustad DP & Simmons MJ. (2009) Principles of Genetics. John Wiley & Sons Inc 2. Klug WS, Cummings MR & Spencer CA. (2012) Concepts of Genetics. Benjamin Cummings. 3. Gardner EJ, Simmons MJ & Snustad DP. (2008) Principles of Genetics. Wiley India 4. Futuyma DJ. (1997) Evolutionary Biology. Sinauer Associates 5. Pierce, B. A. (2005). Genetics: A conceptual approach. New York: W.H. Freeman	

	6. Smith, J. M. (1989). Evolutionary genetics. Oxford: Oxford University Press.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	X	x	-	X	x
CO2	X	x	x	X	x
CO3	X	x	x	X	x
CO4	X	x	x	X	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	15	15	15	15	60
Total	**25**	**25**	**25**	**25**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4
Assignments	2	2	-	-
Seminar	-	-	2	2
Test	7	7	7	5
Attendance	1	1	1	1
Total	10	10	10	10

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4
Part – A (Objective - 10 x 1 = 10 marks)	3	2	3	2
Part – B (Short Answer - 5 x 4 = 20 marks)	2	3	2	3
Part – C (Essay- 3 x 10 = 30 marks)	10	10	10	10
Total	**15**	**15**	**15**	**15**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO4
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO4

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**	Recognize	Remember
1	How many chromosomes (n) does the common weed Arabidopsis thaliana have in its genome? (A) 5 (B) 10 (C) 6 (D) 12	Identify	Remember
2	Deficiency of HGPRT and Glucose-6-phosphatase leads to (A) Gaucher's disease (B) Phenylketoneuria (C) Gout (D) Alkaptonuria	Recognize	Remember
3	The following events lead to changes in the DNA: Inversion, Recombination, Translocation, and Transition. Which of the above can lead to changes in the linkage map of an organism? (A) Recombination (B) Inversion and Translocation (C) Recombination and Transition (D) Inversion, Recombination and Translocation	Recognize	Remember
4	If an individual was producing dicentric chromosome you would suspect (A) A deletion (B) A duplication (C) An inversion (D) A translocation.	Recognize	Remember
5	The Philadelphia chromosome is (A) An example of gene amplification (B) A product of a reciprocal translocation (C) A characteristic of Burkitt's lymphoma (D) An example of duplication.	Recognize	Remember
6	The cytological representation of Klinefelter syndrome is (A) 44A + XO (B) 44A + XXO (C) 44A + XXY (D) 43A + XYY.	Recall	Remember
7	What would be the likely explanation for the existence of pseudogenes? (A) Gene duplication (B) Gene duplication and mutation events (C) Mutation events (D) Unequal crossing over.	Recall	Remember
8	A pair of genes in two organisms of different species which are similar and they are strongly predicated to have the same function is known as: (A) Homologous genes (B) Orthologous genes (C) Paralogous genes (D) Isoforms	Identify	Remember
9	Heyflick's limit refers to which one of the following phenomena? (A) DNA repair (B) Cell senescence in vitro (C) Protein synthesis (D) RNA transport.	Identify	Remember
10	Sickle-cell anemia is an example of Single Nucleotide Polymorphism (SNP) of (A) A to T mutation (B) T to A mutation (C) G to C mutation (D) C to G mutation.	Correlate	Remember

	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Write down the difference of the following: (A) Dominant and Recessive Epistasis Interaction (B) Autoplolyploidy & Allopolyploidy (C) Pericentric Inversion and Paracentric Inversion	Explain	Understand
22	Give a short note on the followings: (A) Polytene Chromosomes (B) Dosage Compensation & Lyon's Hypothesis	Differentiate Define	Understand
23	Base analogs, deaminating agent, hydroxylating agent and alkylating agent have mutagenic effect on DNA- Explain the statement with suitable examples	Cite Examples	Understand
24	(A) What is a complementation test and what is it used for? (B) Write down the difference between Incomplete dominance and Codominance.	Illustrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		
25	Justify the statements: ABO blood group- multiple allelic system, Group and Kin selection in evolution	Describe	Analyse
26	Write down the role of gene duplication impact on recent evolution of human genome. Write down the role of LINEs & SINEs in human genome	Explain Discuss	Understand
27	In a population of 2000 gaboon vipers, a genetic difference with respect to venom exists at a single locus. The alleles are incompletely dominant. The population shows 100 individuals homozygous for the t allele (genotype: tt, nonpoisonous), 800 heterozygotes (genotype: Tt, mildly poisonous), and 1,100 homozygous for the T allele (genotype TT, lethally poisonous). What is the frequency of t allele in the population? Are the genotypes in Hardy Weinberg equilibrium?	Assess	Skill

SEMESTER - IV					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF205	Economic Zoology	30	-	-	2

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the economic importance of animals	Remember
CO 2	Remember the economic importance of sericulture and apiculture in India as well as in other countries.	Understand
CO 3	Describe general steps involved the sericulture and apiculture	Apply
CO 4	Explain the various diseases that affect the silkworms and honey bees	Analyze
CO 5	Using the knowledge gained in the class, the students are able to get the skills to do sericulture and apiculture.	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Sericulture:** Definition, History & Present Status, Silk Route, Types of Silkworms, Distribution & Races, Exotic &Indigenous Races, Mulberry & Non-Mulberry Sericulture.	05
II	**Biology & Rearing &Diseases of Silk Worm:** Life Cycle of *Bombyxmori*, Structure of Silk Gland & Secretion of Silk, Selection of Mulberry Variety &Establishment of Mulberry Garden, Rearing House & Rearing Appliances; Disinfectants: Formalin, Bleaching Powder, RKO, Silkworm Rearing	07

	Technology: Early Age & Late Age Rearing; Types of Mountages, Spinning, Harvesting & Storage of Cocoons, Pests of Silkworm: Uzi Fly, Dermestid Beetles & Vertebrates; Pathogenesis of Silkworm Diseases: Protozoan, Viral, Fungal & Bacterial; Control & Prevention of Pests & Diseases.	
III	**Entrepreneurship in Sericulture**: Prospectus of Sericulture in India: Sericulture Industry in Different States, Employment, And Potential in Mulberry & Non-Mulberry Sericulture.	05
IV	**Apiculture: Biology & Rearing of Bees:**History, Classification &Biology of Honey BeesSocial Organization of Bee Colony, Artificial Bee Rearing (Apiary), Beehives – Newton &Langstroth; Bee Pasturage, Selection of Bee Species for Apiculture; Bee Keeping Equipment; Methods of Extraction of Honey (Indigenous & Modern).	06
V	**Bee Enemies & Diseases, Economy & Entrepreneurship in Apiculture:**Bee Diseases & Enemies, Control & Preventive Measures; Bee Economy: Products of Apiculture Industry & its Uses (Honey, Bees Wax, Propolis),Pollen etc.; Entrepreneurship in Apiculture: Bee Keeping Industry – Recent Efforts, Modern Methods in Employing Artificial Beehives for Cross Pollination in Horticultural Gardens.	07
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the steps involved in sericulture and apiculture ✓ Practice active listening; stimulate critical thinking and analysis skills in identifying the economically important species of apiculture and sericulture. ✓ Prepare assignments on analytical mechanisms of various diseases that affect the silkworms and honey bees as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **Bisht DS.** *Apiculture*. ICAR Publications. **Chun W & Da-Chung C.** (1988) *Silkworm Rearing*. FAO, Rome. **Krishnaswamy S.** (1986) *Improved Method of Rearing Young Age Silkworm*. CSB, Bangalore. **Narasimhanna MN.** (1988) *Manual of Silkworm Egg Production*. CSB, Bangalore. **Prost PJ.** (1962) *Apiculture*. Oxford & IBH, New Delhi. **Sengupta K.** (1989) *A Guide for Bivoltine Sericulture*. CSR & TI, Mysore. **Singh S.** *Beekeeping in India*. Indian Council of Agricultural Research, NewDelhi.	

c. Mapping of ProgramOutcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**-**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**

CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organization 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organizati on	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1	In sericulture, mother moth examination is conducted for the detection of which disease ***A. Pebrine*** B. Grasserie C. Flacherie D. Muscardine	Recognize	Remember
2	Name the proteins by which silk is made of A. Albumin B. Globulin ***C. Sericine*** D. Fibroin	Identify	Remember
3	When honey is stored in the honey sac, it is mixed with the_____ ***A. Enzymes for the production of fructose and glucose*** B. Saliva for increasing the quantity of honey C. Preservative to keep honey for longer period D. Water to make the nectar less vicious	Recognize	Remember
4	_____species of honeybee is more medicinal importance. A. *Apis mellifera* B. *Apis dorsata* **C. *Apis cerana indica*** D. *Apis florea*	Recognize	Remember
5	The silk fibers are held together in cocoon by a substance known as		Remember

	A. Sericin B. Cement C. Glue D. d) None of the above	Recognize	
6	Species construct hive on tall plants, building is _____ A. *Apis mellifera* B. *Apis dorsata* C. *Apis cerana indica* ***D. Apis florea***	Identify	Remember
7	Silk is made up of protein fibers and are soft and flexible. These are composed of β-pleated sheets. Silk consists of A. Central core of sericin ***B. Central core of fibroin*** C. Both A and B are correct D. Both A and B are incorrect	Recognize	Remember
8	In which bee wax gland are found in _____ A. Queen bee B. Drone ***C. Workers*** D. Both in queen and worker bees	Recognize	Remember
9	In honey bee royal jelly is secreted from _____ A. Crop gland B. Wax gland ***C. Hyppharyngeal gland*** D. Salivary gland	Identify	Remember
10	The unwinding of silk threads from cocoon is called…….process. ***A. Reeling*** B. Brushing C. Finishing D. Re-reeling	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks: 5 x 4 = 20**		
11	a) Write the systematic position of silkworm and explain why they been placed in each level in the classification (or) b) What is voltanism? Explain with example.	Describe	Explain
12	a) What is 'Silk route'? (or) b) What is causal agent of Pebrine disease.	Describe	Understand
13	a) Explain pollen basket in honey bee with diagram and (or) b) What is moulting in *Bombyx mori*? Explain different stages of moulting in *Bombyx mori*.	Describe	Explain
14	a) Moriculture. What is its significance? (or) b) Parthenogenesis in honey bee.	Differentiate	Explain
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		

15	a) Write an essay on the enemies of honey bees (or) b) Discuss the life cycle of honey bee.	Describe	Analyze
16	a) Write a short note on different stages in the life cycle of silkworm. (or) b) Discuss the various diseases in silkworms.	Correlate	Apply
17	a) Write down the economic importance of honey bees (or) b) Discuss the economic importance of sericulture in India	Describe	Analyze

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF206	**Medical diagnostics**	**2**	**0**	**0**	**2**

a. Course Outcome(CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO1	Introduction to Medical Diagnostics & its Importance	Understand
CO2	Diagnostics Methods Used for Analysis of Blood,	Analyze
CO3	Diagnostic Methods Used for Urine Analysis	Analyze
CO4	Non-infectious Diseases and Infectious Diseases	Analyze
CO5	Tumors and types	Analyze

b. Syllabus

Units	**Content**	**Hrs.**
I	**Introduction:** Introduction to Medical Diagnostics & the Significance of Diagnosis in Human Diseases	09
II	**Blood Composition,** Preparation of Blood Smear & Differential Leucocyte Count (DLC) Using Leishman's Stain, Platelet Count Using Haemocytometer, Erythrocyte Sedimentary Rate (ESR), Packed Cell Volume	09
III	**Urine Analysis:** Physical Characteristics; Abnormal Constituents	09

IV	**Non-infectious Diseases :**Causes, Types, Symptoms, Complications, Diagnosis & Prevention of Diabetes (Type I & Type II), Hypertension (Primary & Secondary), Testing of Blood Glucose Using Glucometer/Kit	09
v	**infectious Diseases :**Causes, Types, Symptoms, Diagnosis & Prevention of Tuberculosis & Hepatitis	09
VI	**Tumors:**Types (Benign/Malignant), Detection & Metastasis; Medical Imaging: X-Ray of Bone Fracture, PET, MRI & CT Scan (Using Photographs)	09
	Tasks and Assignments: Each student is required to adhere to the following: ☐To understand the diseases, diagnosis and analysis. ☐Practiceactivelistening;stimulatecriticalthinkingandanalysis skills in animalbiotechnology. ☐Prepare assignments on techniques in medical diagnostics asadvisedbythelecturerandshouldbeableto explain the concepts verbally duringdiscussions. ☐Participateinproblem-basedlearning(PBL)assignmentsand submitareportoftheconceptslearntonatimelymanner. **References:** 1) Cheesbrough M. (1976) A Laboratory Manual for Rural Tropical Hospitals - A Basis for Training Courses, UK. 2) Godkar PB & Godkar DP. (2005) Textbook of Medical Laboratory Technology. Bhalani Publishing House. 3) Guyton AC & Hall JE. (2010) Textbook of Medical Physiology. Saunders, USA. 4) Park K. (2007) Preventive & Social Medicine. BB. Publishers. 5) Prakash G. (2012) Lab Manual on Blood Analysis & Medical Diagnostics. S. Chand & Co. Ltd. 6) Robbins & Cortan. (2004) Pathologic Basis of Disease. Saunders, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40

External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment(40Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment(60Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation toCOs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No	Criteria	100%	75%	50%	25%	0%	Relation to COs

.							
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledgeof facts,terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiplechoice 10 x 1 =10**		
1	The adult has 5lit of blood which constitute about how much of the total body weight. **a) 8%** b) 10% c) 9% d) 7%	Differentiate	Remember
2	How many types of blood constituents in human blood? a)Cellular composition and acellular composition b**) Cellular and non-cellular composition** c) Cellular and unicellular composition d) all	Recognize	Remember
3	They are colourless, nucleated, amoeboid and phagocytic cells are called as? **a)Leucocytes** b) Lymphocytes c) Phagocytes d) Pinocytes Phenylethanolamine- N-methyltransferase	Identify	Remember

4	Which of the fallowing cells is example of non-phagocytic cells? a) Neutrophils and basophils b) **Basophils and Eosinophils** c) Eosinophis and Neutrophils d) Monocytes and Basophils	Correlate	Remember
5	Write the nature of Polyphagia? **a) Increased hunger in both diabetes I and II** b) Increased thrust in both Diabetes I and II c) Increased urination in both diabetes I and II d) All	Recognize	Remember
6	Tam-Horsfall mucoprotein secreted from tubular epithelial cells is example of? a) Cellular cast b) White cell cast c) Waxy cast d**) Hyline cast**	Correlate	Remember
7	In which cells prolonged high blood glucose can cause glucose absorption? a) Nephrons of the kidney **b) Lens of the eye** c) Brain nerve cells d) Alveolar cells in lungs	Recognize	Remember
8	A number of skin rashes that can occur in diabetes are collectively known as? a) Dermatitis b) Gangrene **c) Diabeticdermadromes** d) None of the above	Correlate	Remember
9	About 75% of deaths in diabetics are due to cause of? a) **Kidney failure** b) Lungs failure c) Arthritis d) Coronary artery disease	Identify	Remember

10	9. All vitamin are stored in liver **except**? a) A b) D c) K **d) B6**	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Write factors effecting of ESR (Erythrocyte sedimentation rate)	Explain	Understand
22	Write about IDDM (insulin- dependent diabetes mellitus)	Explain	Understand
23	What is Focal segmental glomerulosclerosis (FSGS)?	Explain	Understand
24	What is Focal segmental glomerulosclerosis (FSGS)?	Explain	Apply
	PART – C Essay Answer **Theanswershouldnotexceed400words 3 x 10 =30**		
25	What is called as silent killer disease? Write symptoms and precautions?	Describe	Analyse
26	Define ESR; discuss Wintrobes method of ESR estimation and factors influencing ESR, normal ranges.	Assess	Skill
27	What is TB? Write how to precaution of TB? Write any two types of drugs?	Describe	Skill

SEMESTER - II					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF311	Bioinformatics	**3**	**-**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	**Level**
CO1	Understand the basic principles & concepts of biology, computer science & mathematics.	Remember

CO2	Use existing software effectively to extract information from large databases & to use this information in computer modeling.	Understand
CO3	enhance problem-solving skills, including the ability to develop new algorithms & analysis methods	Apply
CO4	understand the intersection of life & information sciences, the core of shared concepts, language & skills the ability to speak the language of structure-function relationships, information theory, gene expression, & database queries	Analyse

b. Syllabus

Units	Content	Hrs.
I	Introduction, Branches of Bioinformatics, Aim, Scope & Research Areas of Bioinformatics. Introduction, Biological Databases, Classification Format of Biological Databases, Biological Database Retrieval System	9
II	National Center for Biotechnology Information (NCBI): Tools & Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic Local Alignment Search Tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence Analysis Tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission At DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction & Salient Features	9
III	Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM)	9
IV	Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction	9
V	Structural Bioinformatics in Drug Discovery, Quantitative Structure-Activity Relationship (QSAR) Techniques in Drug Design, Microbial Genome Applications, Crop Improvement	9
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding the	

	structural and functional aspects of cells and basic mechanisms underlying cell signalling and cell division. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** • Campbell AM & Heyer LJ. (2006) Discovering Genomics, Proteomics & Bioinformatics. Benjamin Cummings. • Ghosh Z & Bibekan& M. (2008) Bioinformatics: Principles & Applications. Oxford University Press. • Pevsner J. (2009) Bioinformatics & Functional Genomics. Wiley-Blackwell Publishing.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	X	x	-	X	x
CO2	X	x	x	X	x
CO3	X	x	x	X	x
CO4	X	x	x	X	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	15	15	15	15	60
Total	**25**	**25**	**25**	**25**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4
Assignments	2	2	-	-
Seminar	-	-	2	2
Test	7	7	7	5
Attendance	1	1	1	1
Total	10	10	10	10

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4
Part – A (Objective - 10 x 1 = 10 marks)	3	2	3	2
Part – B (Short Answer - 5 x 4 = 20 marks)	2	3	2	3
Part – C (Essay- 3 x 10 = 30 marks)	10	10	10	10
Total	**15**	**15**	**15**	**15**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO4
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO4

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**	Recognize	Remember
1	Which server is used to compare three-dimensional protein structures? A. **DALI.** B. FSSP. C. SCOP. D. CATH.	Identify	Remember
2	Homology modeling is also called as _____. A. **comparative modeling**. B. abinitio prediction. C. threading. D. surface modeling.	Recognize	Remember
3	Which one of the following is a command based offline tool for molecular structural visualization? A. Swiss-PDB Viewer. B. **RasMo**l. C. QMol. D. PyMol.	Recognize	Remember
4	Which one of the following method predicts the protein structure based on fold recognition? A. Comparative modeling. B. **Threading.** C. Abinitio. D. Homology modeling.	Recognize	Remember
5	Which one of the PAM matrix represents amino acid substitutions that occur in distantly related proteins? A. PAM1. B. **PAM250.** C. PAM60. D. PAM45.	Recognize	Remember
6	PfamA and Pfam-B is automatically generated from the _____ database.	Recall	Remember

	A. SMART. B. PRINTS. C. PROSITE. D. **PRODOM.**		
7	Multiple sequence alignment method is called as _____alignment method. A. global. B. local. C. **progressive.** D. non-progressive	Recall	Remember
8	Are profiles and hidden Markov models more potent discriminators than regular expressions? A. No, because they are used for domain databases and, having a different area of application, they can't be compared. B. **Yes, as they contain probability data for each position in the motif, this can be used to calculate match statistics such as E-values.** C. No, because even though they are more sensitive, they are less selective. D. Yes, because they are fine tuned to individual protein domains	Identify	Remember
9	The _____ tool compares protein sequence against translated nucleotide databases. A. blastp. B. tblastx. C. blastn. D. **tblastn**	Identify	Remember
10	Which one of the following is a complementary DNA database? A. Swiss-Prot. B. GenBank. C. UniSTS. D. NRDB.	Correlate	Remember
	Part-B		
21	Write short notes on PROSITE, PRINTS, CATH, PFAM, Gene Bank, RefSeq, Expressed Sequence Tags and SWISS-PROT	Explain	Understand
22	What is UniProtKB and what information does it give you?	Differentiate Define	Understand
23	Write short notes on KEGG data base	Cite Examples	Understand
24	Illustrate with SWISS-PROT and Gene Bank	Illustrate	Apply
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			

25	Explain the steps used by BLAST algorithm and mentioned blast related Program. Explain detailed BLAST sequence alignment tools.	Describe	Analyse
26	Write short notes on Global and local alignment, Compare PAM & BLOSOM matrices, RefSeq, Expressed Sequence Tags, PROSITE, PRINTS, and CATH	Explain Discuss	Understand
27	Describe Protein modeling	Assess	Skill

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF313	**Animal Biotechnology**	**3**	**0**	**0**	**3**

j. Course Outcome(CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	To understand the concept and scope of Animal biotechnology	Understand
CO2	Understand the molecular technique in gene manipulation in biotechnology.	Apply
CO3	Mechanism action of genetically modified organisms.	Analyze
CO4	Techniques and applications in animal cell culture.	Skill
CO5	Utilize the skill sets required to extrapolate the mechanisms for Research applications with appropriate experimental tools	Skill

k. Syllabus

Units	Content	Hrs.
I	**Introduction:** Concept & Scope of Animal Biotechnology	09
II	**Molecular Techniques in Gene Manipulation:**Cloning Vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC & Expression Vectors (Characteristics), Restriction Enzymes: Nomenclature, Detailed Study of Type II.Transformation Techniques: Calcium Chloride Method & Electroporation. Construction of Genomic & cDNA Libraries & Screening by Colony & Plaque Hybridization, Southern, Northern & Western Blotting; DNA Sequencing: Sanger Method, Polymerase Chain Reaction, DNA Fingerprinting & DNA Micro Array	09
III	**Genetically Modified Organisms:**Production of Cloned & Transgenic Animals: Nuclear Transplantation, Retroviral Method, DNA Microinjection, Applications of Transgenic Animals: Production of Pharmaceuticals, Production of Donor Organs, Knockout Mice. Production of Transgenic Plants: Agrobacterium-Mediated Transformation. Applications of Transgenic Plants: Insect & Herbicide Resistant Plants	09
IV	**Culture Techniques & Applications:** Animal Cell Culture, Expressing Cloned Genes in Mammalian Cells, Molecular Diagnosis of Genetic Diseases (Cystic Fibrosis, Sickle Cell Anemia), Recombinant DNA in Medicines: Recombinant Insulin & Human Growth Hormone, Gene Therapy	09

	Tasks and Assignments: Each student is required to adhere to the following: ☐ To understand about techniques and its application in Animal Biotechnology. ☐ Practice active listening; stimulate critical thinking and analysis skills in animal biotechnology. ☐ Prepare assignments on techniques in animal biotechnology as advised by the lecturer and should be able to explain the concepts verbally during discussions. ☐ Participate in problem-based learning (PBL) assignments and submit areportoftheconceptslearntonatimelymanner. **References:** 1) Beauchamp TI & Childress JF. (2008) Principles of Biomedical Ethics. Oxford University Press. 2) Brown TA. (1998) Molecular Biology Labfax II: Gene Cloning & DNA Analysis. Academic Press, California. 3) Glick BR & Pasternak JJ. (2009) Molecular Biotechnology - Principles & Applications of Recombinant DNA. ASM Press, Washington. 4) Griffiths AJF, et al. (2009) An Introduction to Genetic Analysis. Freeman & Co. NY, USA. 5) Snustad DP & Simmons MJ. (2009) Principles of Genetics. John Wiley & Sons Inc. 6) Watson JD, Myers RM, Caudy A & Witkowski JK. (2007) Recombinant DNA Genes & Genomes- A Short 1) Course. Freeman & Co. NY, USA.	

l. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

m. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40

External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

n. Mapping Course Outcome with Internal Assessment(40Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

o. Mapping Course Outcome with External Assessment(60Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

p. Rubric for Assignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation toCOs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

q. Rubric for Seminar

Sl. No	**Criteria**	**100%**	**70%**	**50%**	**25%**	**0%**	**Relation to COs**

.							
1	**Knowledge and Understanding** **50%**	Outstanding knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Extensive knowledg eof facts,term s and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicate d with logical sequences, examples and references	Communicated with sequences	Just Communi cate d	No coherent communication	Not Attended	CO3, CO4

r. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple-choice 10 x 1 =10**		
1	Animal cell culture media contain all the supplements **except**? a) Protease inhibitors and macromolecules b) Vitamins and essential amino acids c) Minerals, carbonate and bicarbonates **d) Vaccines**	Recognize	Remember
2	Who introduced the name plasmid? **a) J.Lederberg** b) Sir Edwin Southern c) James Alwine d) George Stark	Recognize	Remember
3	Northern blotting is a technique for detection of which sequences? a) **Specific mRNA** b) Specific rRNA C) Specific tRNA d) Specific DNA	Correlate	Remember

4	The gene transferred is based on the surface binding, diffusion through**?** a) Lipofection **b) Electroporetion** c) Gene gun metho d) Lipofection and Electroporetion	Correlate	Remember
5	Which one is a below given ended fragments can be joined to any other DNA fragment? a) **Blunt ended** b) Sticky ends c) Type-III RE d) All	Recognize	Remember
6	The most widely characterized polymerase is used in polymerase chain reaction is? a)Thermophilic bacteria b) **Thermos aquaticus** c) Agro bacterium d) Bacillus thurengensis .	Correlate	Remember
7	The Consist of a single polypeptide chain has an optimum polymerization temperature of? a)95^{o}C b) 82 ^{o}C c) 85^{o}C **d) 72 ^{o}C** a)	Recognize	Remember
8	In which can be use dNTPs(deoxyNTP),ddNTPs (dideoxyNTP) and DNAP composition? a) PCR b) Micro array c**) Sanger Sequencing** d) Western blotting	Correlate	Remember
9	Retroviruses can be used for the transfer of foreign genes into animal genomes about? a) 10-16bp b) 20-32bp **c) 8 to 15 kb** d) 50-100bp	Identify	Remember

10	Which one was first transgenic and genetically modified mammal in the world? a) The Herman bull **b) Super mouse** c) Dolly d) Mule	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	What is serum free media write its advantages in animal cell culture?	Explain	Understand
22	How to maintain theAseptic conditions in animal cell culture	Explain	Understand
23	What is Transgenesis? Give any two examples of transgenic animals?	Explain	Understand
24	Write about Lipofection and its applications in genetic engineering?	Explain	Apply
	PART – C Essay Answer **Theanswershouldnotexceed400words 3 x 10 =30**		
25	Write basic understanding of Plasmids with neat diagram and advantages of artificial plasmids?	Describe	Analyse
26	What is Transformation? Writ mechanism of transformation in E.coli bacteria?	Assess	Skill
27	What are transgenic animals? Why transgenic animals produced, give any five applications?	Assess	Skill

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF314	**Animal Biotechnology**	**2**	**0**	**3**	**2**

s. Course Outcome(CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	To know how to Isolation of Genomic DNA from E. coli.	Understand/ Analyze
CO2	To know how to Isolation of Plasmid DNA (pUC 18/19) from E. coli.	Analyze
CO3	To understand Restriction Digestion of Plasmid DNA.	Analyze
CO4	To understand the Construction of Circular & Linear Restriction Map from the Data Provided.	Analyze
CO5	Analyze the Calculation of Transformation Efficiency from the Data Provided.	Analyze

t. Syllabus

Units	Content	Hrs.
Exp-I	Genomic DNA Isolation from E. coli.	04
Exp-II	Plasmid DNA Isolation (pUC 18/19) from E. coli.	04
Exp-III	Restriction Digestion of Plasmid DNA.	04
Exp-IV	Construction of Circular & Linear Restriction Map from the Data Provided.	05
	Calculation of Transformation Efficiency from the Data Provided	
Exp- V	To Study the Following Techniques Through Photographs: Southern Blotting Northern Blotting Western Blotting	06
Exp-VI	DNA Sequencing (Sanger's Method)	06
Exp-VIII	PCR	04
Exp-IX	DNA Fingerprinting	05

Tasks and Assignments:

Each student is required to adhere to the following:

- ☐ To understand the animal biotechnology practical.
- ☐ Practiseactivelistening,stimulatecriticalthinkingandanalysis skills in animalbiotechnology lab practicals.
- ☐ Prepare assignments on techniques in animal biotechnology asadvisedbythelecturerandshouldbeableto explain the concepts verbally duringdiscussions.
- ☐ Participateinproblem-basedlearning(PBL)assignmentsand submitareportoftheconceptslearntonatimelymanner.

References:

1. Beauchamp TI & Childress JF. (2008) Principles of Biomedical Ethics. Oxford University Press.
2. Brown TA. (1998) Molecular Biology Labfax II: Gene Cloning & DNA Analysis. Academic Press, California.
3. Glick BR & Pasternak JJ. (2009) Molecular Biotechnology - Principles & Applications of Recombinant DNA. ASM Press, Washington.
4. Griffiths AJF, et al. (2009) An Introduction to Genetic Analysis. Freeman & Co. NY, USA.
5. Snustad DP & Simmons MJ. (2009) Principles of Genetics. John Wiley & Sons Inc.
6. Watson JD, Myers RM, Caudy A & Witkowski JK. (2007) Recombinant DNA Genes & Genomes- A Short Course. Freeman & Co. NY, USA.

u. Mapping of Program Outcomes with CourseOutcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

v. EvaluationScheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40

External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (60 Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments	2	2	2	2	2
Seminar	3	3	3	3	3
Test	5	5	5	5	5
Attendance	2	2	2	2	2
Total	12	12	12	12	12

f. Mapping Course Outcome with External Assessment (40 Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A Major Experiment 20 marks	4	4	4	4	4
Part – B One Minor Experiment 05 marks	1	1	1	1	1
Part – C Record Book 05 marks	1	1	1	1	1
Part – D Viva Voce 10 marks	2	2	2	2	2
The pattern for **internal valuation** for 60 marks may be: Two internal tests of 25 marks each: average = 25 marks Seminar /Observation = 15 marks Assignment = 10 marks Attendance = 10 marks					
Total	**8**	**8**	**8**	**8**	**8**

w.Rubric forAssignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation toCOs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5

2	**Organiza -tion** **50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

x. Rubric forSeminar

Sl. No	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
.							
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledgeof facts,terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Major Experiment **(**Aim, Principle, Material required, Procedure, Formula/calculation**)** **Marks: 1 x 20 = 20**		
1	To Study the Following Techniques Through Photographs: Southern Blotting Northern Blotting Western Blotting	Describe/ Illustrate	Remember
	Part – A: Minor Experiment **(**Aim, Principle, Material required, Procedure, Formula/calculation**)** **1 x 5 = 5**		
1	To isolation of Plasmid DNA (pUC 18/19) from E. coli. surface	Describe/ Illustrate	Remember
	Part – D Record Book **05 marks**	Illustrate/Assess	Skill
	Part – E Viva Voce **10**	Explain/	Analyse

SEMESTER - V					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF315	Drug Discovery & Design	45	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the basics of drug and druggable target.	Remember
CO 2	Understand the various methods of drug designing.	Understand
CO 3	Describe the general steps involved in drug discovery.	Apply
CO 4	Explain the methods of target and lead identification and validation in drug discovery	Analyze
CO 5	Using the knowledge gained, the students are able understand about drugs including ADME, Pharmacokinetics & Pharmacodynamics, Mode of Drug Administration, Drug-Drug Interactions, Drug-Food Interactions, Drug Metabolism, Toxiciological Studies and Drug Safety.	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Introduction to Drug Designing:** Introduction, Drug-Like Properties & Drugable Targets.	8
II	***In Silico* Pharmacology:** *In silico* Pharmacology, Docking, Molecular Simulation, Medium Throughput, High Throughput & Ultrahigh Throughput Assay Platforms, *In vitro* &*In vivo* Pharmacological Assays.	10
III	**Molecular Dynamics**: Target Identification, Target Validation, Lead; Identification & Lead Identiifcation. Economics of Drug Discovery, Structure-Related Drug-Like Criteria of Global Approved Drugs.	8

IV	**Drug Prediction:** Anti-Microbials, Anti-Obesity, Anti-Inflammatory, Anti-Viral Anti-Cancer, Anti-Angina, Anti-Atherosclerotic, Anti-Hypersenstive Anti-Alzheimer's & Parkinson's, Anti-Depressive, Anti-Epileptic Drug Discovery.	9
V	**Pharmaco-kinetics/dynamics & Drug Metabolism:** Pharmacokinetics & Pharmacodynamics, Mode of Drug Administration, Drug-Drug Interactions, Drug-Food Interactions, Drug Metabolism, Toxiciological Studies, Drug Safety, Modern Pharmaceutical & Analytical Techiniques, Small Molecule Discovery in Academia, Intellectual Property Rights	10
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the steps involved in drug discovery process. ✓ Practice active listening; stimulate critical thinking and analysis skills in identifying the drug metabolism and discovery of small molecules by *in silico* methods. ✓ Prepare assignments on analytical mechanism of action of various drugs as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **Goodman& Gilman.** *The Pharmacological Basis of Therapeutics*. Mc Graw Hill Ed. **Kalueff AV, et al.** (2009) *Experimental Animal Models in Neurobehavioral Research*. Nova Science Publishers. **Kreitzer G, et al.** *Cell Biology Assays: Essential Methods*. Elsevier. **Salmon DM.** *Practical Pharmacology for the Pharmaceutical Sciences*. Wiley & Sons.	

c. Mapping of ProgramOutcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	x	x	-	x	x
CO2	x	x	x	x	x
CO3	x	x	x	x	x
CO4	x	x	x	x	x
CO5	x	x	x	x	x

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-

Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &factsand examples	Ideas aredetailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organization 50%**	Includes title, introduction, statementof themain ideawith illustration and conclusion.	Includes title, introduction, statementof mainidea and conclusion.	organizational tools are weak or missing	No organizatio n	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1	What is the term for the process that is used to prove that a drug is safe and effective in treating specific conditions in certain patient populations? A. Drug discovery B. Preclinical development C. ***Clinical studies*** D. Patent process	Recognize	Remember
2	Selectivity in drug design refers to A. substance that interacts with the target B. can test on humans with permission ***C. Avoid unintended sites of action*** D. Optimize a number of key structures	Identify	Remember
3	Which of the following is NOT a part of the Investigational New Drug (IND) Review? A. Review a preclinical trial result B. Determination of safety in human use ***C. Authorization to ship across the state lines*** D. Identification of side effect profile	Recognize	Remember
4	How long does the new drug process take? A. 2-5 years B. 5-7 years C. 10-12 years ***D. 12-15 years***	Recognize	Remember
5	Which phase of testing in drug discovery is followed with presenting to the FDA for approval? A. Phase I B. Phase II ***C. Phase III*** D. Phase IV	Recognize	Remember
6	What is NOT a true statement about Phase 4 Trials? A. Phase 4 trials are typically not randomized/ placebo controlled ***B. Phase 4 trials may include new populations in which to test the drug*** C. Phase 4 trials are typically when the product is finalized and submitted for patent protection D. Phase 4 trials may include new formulations and/ or adjusted dosing regimens	Identify	Remember
7	In rational drug design, the target molecules are _____. I. Receptors		

	II. Enzymes III. Free oxygen ***A. I and II only*** B. I, II and III C. III only D. I only	Recognize	Remember
8	Clinical development represents the shift from _____ to _____. A. Laboratory science to patented research and manufacturing technology B. Project management responsibilities needed to manage human trials to technology C. Lead compound to patented therapeutic research ***D. Laboratory science to project management responsibilities needed to manage human trials***	Identify	Remember
9	What is Proof of Concept (POC) in drug discovery? A. Review a preclinical trial result B. Determination of safety in human use C. Small scale clinical trial of 100-250 people ***D. Demonstrating safety and efficacy during phase 2 clinical trials***	Identify	Remember
10	What is the approximate ratio of potential compounds the beginning of Development to number of products that ultimately get FDA approval? E. 1: 10 F. 1: 100 ***G. 1: 1000*** H. 1: 10000	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks: 5 x 4 = 20**		
11	a) CADD (or) b) Biopolymers	Describe	Explain
12	a) Target and Ligand b) Drug efficacy	Describe	Understand
13	a) Describe preclinical studies in drug discovery? b) Explain drug-drug interaction with example.	Describe	Explain
14	a) Explain idiosyncratic drug reaction with example? (or) b) Explain post-marketing drug withdrawal with example.	Differentiate	Explain
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		
15	a) Discuss the molecular docking in drug design (or) b) Write a short note on Clinical trials.	Describe	Analyze
16	a) Write a short note on ADME (or) b) Discuss the different routes of drug administration. Which is the best route and why?	Correlate	Apply
17	a) Define a 'Drug'. Describe the various steps involved in drug discovery (or) b) Discuss the *in silico* method of drug designing.	Describe	Analyze

SEMESTER - V					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF316	**Drug Discovery & Design**		**-**	**30**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the basics of drug and druggable target.	Remember
CO 2	Understand the various methods of drug designing.	Understand
CO 3	Describe the general steps involved in drug discovery.	Apply
CO 4	Explain the methods of target and lead identification and validation in drug discovery	Analyze
CO 5	Using the knowledge gained, the students are able understand about drugs including ADME, Pharmacokinetics & Pharmacodynamics, Mode of Drug Administration, Drug-Drug Interactions, Drug-Food Interactions, Drug Metabolism, Toxicological Studies and Drug Safety.	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate, Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Basic Pharmacological Principles:***In vitro* biochemical assays to demonstrate	06

	agonists and antagonists.	
II	**Pharmacological Inhibitors:** Non-Competitive/Competitive Inhibitors, Receptor-Ligand Interaction, Single-Point Assays, Bracketing Assays, Three-Point Assays	06
III	***In vitro* and *Ex vivo* Pharmacological Studies:** Isolation of RBC, WBC and platelets from blood and isolation of hepatocytes from liver for pharmacological studies. Cell counting and culturing of cells.	06
IV	**Biochemical Assays and their Significance:** Inhibition of neutrophil aggregation by nitric oxide donors, measurement of NADPH cytochrome c reductase, measurement of intracellular [Ca^{2+}], electrophysiology of primary & neuronal cell lines, whole-cell screening for GPCR ligands, cell fusion assay, flow cytometry based cell receptor assay, direct small-molecule kinase activation, embryonic stem cell-derived hepatocytes & adult liver cells for CYP450 toxicity evaluation,	06
V	**Pharmacological assays:***In vitro* blood brain barrier assay, anti-angiogenic assay (matrigel), cell migration & uptake assays, cell wounding assay, three-dimensional primary cell cultures for drug development.	06
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the steps involved in drug discovery process. ✓ Practice active listening; stimulate critical thinking and analysis skills in identifying the drug metabolism and discovery of small molecules by *in silico* methods. ✓ Prepare assignments on analytical mechanism of action of various drugs as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **Goodman& Gilman.** *The Pharmacological Basis of Therapeutics*. Mc Graw Hill Ed. **Kalueff AV, et al.** (2009) *Experimental Animal Models in Neurobehavioral Research*. Nova Science Publishers. **Kreitzer G, et al.** *Cell Biology Assays: Essential Methods*. Elsevier. **Salmon DM.** *Practical Pharmacology for the Pharmaceutical Sciences*. Wiley & Sons.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**-**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Record	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Record	6	6	6	6	6
Seminar	-	-	-	-	-
Test	-	-	-	-	-
Punctuality/ Attendance	2	2	2	2	2
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A **Identify the mechanism of drug action – (5 x 2 = 10 marks)**	2	2	2	2	2
Part – B **Short Answer – (5 x 6 = 30 marks)**	6	6	6	6	6
Part – C **(Viva voce - 20 marks)**	4	4	4	4	4
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1							
2							

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level

	Part – A: Identify the Basic Concept of Pharmacology **Multiple Choice** **Marks: 5 x 2 = 10**		
1	What is the term for the process that is used to prove that a drug is safe and effective in treating specific conditions in certain patient populations? A. Drug discovery B. Preclinical development C. ***Clinical studies*** D. Patent process	Recognize	Remember
2	Selectivity in drug design refers to E. substance that interacts with the target F. can test on humans with permission ***G. Avoid unintended sites of action*** Optimize a number of key structures	Identify	Remember
3	Which of the following is NOT a part of the Investigational New Drug (IND) Review? E. Review a preclinical trial result F. Determination of safety in human use ***G. Authorization to ship across the state lines*** Identification of side effect profile	Recognize	Remember
4	How long does the new drug process take? E. 2-5 years F. 5-7 years G. 10-12 years ***12-15 years***	Recognize	Remember
5	Which phase of testing in drug discovery is followed with presenting to the FDA for approval? E. Phase I F. Phase II ***G. Phase III*** H. Phase IV	Recognize	Remember
6	What is NOT a true statement about Phase 4 Trials? A. Phase 4 trials are typically not randomized/ placebo controlled ***B. Phase 4 trials may include new populations in which to test the drug*** C. Phase 4 trials are typically when the product is finalized and submitted for patent protection D. Phase 4 trials may include new formulations and/ or adjusted dosing regimens	Identify	Remember
7	In rational drug design, the target molecules are _____. IV. Receptors V. Enzymes VI. Free oxygen ***E. I and II only*** F. I, II and III G. III only H. I only	Recognize	Remember

8	Clinical development represents the shift from _____ to _____. E. Laboratory science to patented research and manufacturing technology F. Project management responsibilities needed to manage human trials to technology G. Lead compound to patented therapeutic research H. ***Laboratory science to project management responsibilities needed to manage human trials***	Identify	Remember
9	What is Proof of Concept (POC) in drug discovery? E. Review a preclinical trial result F. Determination of safety in human use G. Small scale clinical trial of 100-250 people H. ***Demonstrating safety and efficacy during phase 2 clinical trials***	Identify	Remember
10	What is the approximate ratio of potential compounds the beginning of Development to number of products that ultimately get FDA approval? I. 1: 10 J. 1: 100 ***K. 1: 1000*** L. 1: 10000	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words marks: 5 x 6 = 30**		
11	b) CADD (or) b) Biopolymers	Describe	Explain
12	a) Target and Ligand b) Drug efficacy	Describe	Understand
13	a) Describe preclinical studies in drug discovery? b) Explain drug-drug interaction with example.	Describe	Explain
14	a) Explain idiosyncratic drug reaction with example? (or) b) Explain post-marketing drug withdrawal with example.	Differentiate	Explain
15	a) Discuss Agonist and Antagonist with example (or) b) Discuss various *in vitro* and *in vivo* pharmacological assays in drug discovery.	Understand	Explain
	PART – C (Essay Answer) **Viva voce Marks: 20**		
15	b) Discuss the molecular docking in drug design (or) b) Enlist various phases of clinical trials, Phase I, Phase II, Phase III and Phase IV.	Describe	Analyze
16	b) What is ADME? (or) b) Discuss the different routes of drug administration. Which is the best route and why?	Correlate	Apply
17	a) Define a 'Drug'. Describe the various steps involved in drug discovery (or) b) What is in *silico* method of drug designing?	Describe	Analyze

SEMESTER - VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF301	**Analytical Techniques**	**3**	**-**	**-**	**3**

- **a. Course Outcome (CO)** develop technical skills in a wide range of plant science methods.
- Understand the latest technological developments & ways whereby they can be used in plant biology.
- Apply his/her knowledge to practical problems in plant biology.

On the successful completion of the course, the student will be able to
(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Learn about the different analytical techniques used in biological research.	Remember
CO 2	Understand the latest technological developments & ways whereby they can be used in plant biology	Understand
CO 3	Illustrate the importance analytical techniques for deciphering a biological phenomenon	Apply
CO 4	Develop technical skills in a wide range of plant science methods.	Create
CO 5	To apply the acquired knowledge for research applications	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	Content	Hrs.
I	**Imaging and Related Techniques:** Principles of Microscopy; Light Microscopy; Fluorescence Microscopy; Confocal Microscopy; Use of Fluorochromes: (A) Flow Cytometry (FACS); (B) Applications of Fluorescence Microscopy: Chromosome Banding, FISH, Chromosome Painting; Transmission &Scanning Electron Microscopy – Sample Preparation for Electron Microscopy, Cryofixation, Negative Staining, Shadow Casting, Freeze Fracture, Freeze Etching	14
II	**Cell Fractionation:** Centrifugation: Differential & Density Gradient Centrifugation, Sucrose Density Gradient, $CsCl_2$Gradient, Analytical Centrifugation, Ultracentrifugation, Marker Enzymes	10
III	**Radioisotopes:** Use in Biological Research, Auto-Radiography, Pulse Chase Experiment	8
IV	**Spectrophotometry and Chromatography:** Spectrophotometry: Principle & its Application in Biological Research Chromatography: Principle; Paper Chromatography; Column Chromatography, TLC, GLC, HPLC, Ion-Exchange Chromatography; Molecular Sieve Chromatography; Affinity Chromatography	12
V	**Characterization of Proteins and Nucleic acids:** Mass Spectrometry; X-Ray Diffraction; X-Ray Crystallography; Characterization of Proteins & Nucleic Acids; Electrophoresis: AGE, PAGE, SDS-PAGE	10
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding analytical techniques used in biological research. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date.	

	• Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** • **Ausubel F, et al.** (1995) *Short Protocols in Molecular Biology*. John Wiley & Sons. • **Plummer DT.** (1996) *An Introduction to Practical Biochemistry*. Tata McGraw-Hill. New Delhi. • **Ruzin SE.** (1999) *Plant Microtechnique & Microscopy*. Oxford University Press, New York, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A **(Objective - 10 x 1 = 10marks)**	2	2	2	2	2
Part – B **(Short Answer -5 x 4 = 20marks)**	10	10	-	-	-
Part – C **(Essay-3 x 10 = 30 marks)**	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiz a -tion 50%**	Includes title, introduction,statement ofthe main idea withillustration and conclusion.	Includes title, introduction,statement ofmain ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1	Trichloroacetic acid is commonly used to precipitate which of the following? (A) **Proteins** (B) Carbohydrates (C) Lipids (D) Nucleic acids	Differentiate	Remember
2	In which of the chromatographic techniques does larger molecules move rapidly through the column and elute first? (A) **Gel filtration** (B) Ion exchange (C) Affinity (D) Paper chromatography	Recognize	Remember
3	Polyacrylamide is a combination of which of the below mentioned components? (A) **Acrylamide + Bisacrylamide**(B) Acrylamide + Ammonium per sulphate (C) Acrylamide + Glycerol (D) Acrylamide + SDS	Recognize	Remember
4	Which one of the below mentioned is non denaturing gel electrophoresis? (A) **Native PAGE** (B) SDS-PAGE (C) Urea Page (D) SDS-2D Electrophoresis	Recognize	Remember
5	Which one of the below mentioned reduces the disulfide bonds in protein samples? (A) Glycerol (B) **ß-mercaptoethanol** (C) SDS (D) Glycine	Recognize	Remember
6	The use of a molecule to purify its receptor is an example of which of the following? (A)Ion exchange chromatography (B) Size exclusion chromatography (C) **Affinity chromatography** (D) Paper chromatography	Recognize	Remember
7	Which one of the below mentioned is most commonly used for blocking in western blotting procedure? (A) **Bovine serum albumin** (B) Ponceau red (C) SDS (D) Tris buffered saline	Identify	Remember
8	Which of the below mentioned technique is used in molecular biology research to study gene expression by detection of RNA? (A) Southern blot (B) **Northern blot** (C)Western blot (D) South western blot	Recognize	Remember
9	In light microscopy, which of the following is used as fixatives prior to staining technique? (A) Coomassie blue (B) **Heat** (C) Silver nitrate (d) Amido black	Correlate	Remember
10	Which technique is used to determine the protein structure including the exact orientation and arrangement of different amino acids? (A) Western blot (B) Mass spectrometry (C) X-**ray crystallography** (D) SDS-PAGE	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Explain differential centrifugation and describe its use in biological research?	Explain	Understand

22	Describe the steps involved in performing Western blotting?	Describe	Understand
23	Differentiate a mass spectrometer with a UV-Visible Spectrophotometer?	Differentiate	Analyze
24	Demonstrate the use of Pulse-chase autoradiography in biological research?	Demonstrate	Apply
PART – C Essay Answer The answer should not exceed 400 words Marks: 3 x 10 = 30			
25	Discuss the applications of fluorescence microscopy?	Discuss	Understand
26	Explain in detail different chromatographic techniques for separation of proteins?	Demonstrate	Apply
27	Compare differential centrifugation and density gradient centrifugation? Give a detailed explanation about their use in biological research?	Judge	Evaluate

SEMESTER – V					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF317	**Basic Biochemistry**	**3**	**0**	**0**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO 1	Understand the structure and function of biomolecules	Understand
CO 2	Demonstrate an understanding of fundamental principles of biomolecules	Apply
CO 3	Able to distinguish macromolecules from small molecules	Analyze
CO 4	Formulate causes of pathway defects	Create
CO 5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	**Content**	**Hrs.**
I	**Carbohydrates** Overview of Biomolecules, Definition, Physical & Chemical Properties, Structure & Importance; Classifications- Monosaccharides- Aldoses & Ketoses, Disaccharides & Polysaccharides; Different Types of Polysaccharides (Homo, Hetero & Mucopolysaccharides). Derivatives of Sugars. Glycoproteins-Structure & Function	09
II	**Amino acids and Proteins** Overview, Definition, Classification & Properties of Amino Acids; Proteins: Non-Protein Amino Acids, Peptide Bond, Structure, Classification Based on the Function, Solubility & Nutritional Value; Proteoglycans, Protein Glycosylations & its Significance-Blood Grouping, Structure & Functions of Hemoglobin	09

III	**Lipids** Classification & Properties of Lipids; Lipoproteins-Chylomicrons, HDL, LDL & VLDL. Sphingophospholipids, Cholesterol, Steroids, Bile Acids & Bile Salts; Lipid Bilayers. Glycolipids, Lipopolysaccharides	09
IV	**Enzymes** Nomenclature, Classifications, Factors Affecting Enzymes, Enzyme Kinetics, Significance of V_{max} & K_m, Enzyme Inhibition - Competitive, Non-Competitive & Uncompetitive, Enzyme Regulation-Product Inhibition, Feedback Control, Covalent Modification & Allosteric Regulation. Vitamins- Classification, General Sources, Functions, Deficiency Symptoms & Structural Aspects of Vitamins	09
V	**Nucleic Acids** Nucleosides & Nucleotides- Composition & Structure, DNA- Types, Primary & Secondary Structure, Denaturation & Renaturation; RNA- Types, Structure & Functions of tRNA, rRNA & mRNA. Nucleoproteins, Chromatin. Direction of DNA Synthesis, Overview of DNA & RNA Synthesis	09

	Tasks and Assignments: Each student is required to adhere to the following: ✓ Practice the structures of biomolecules ✓ Practice active listening, stimulate critical thinking and analysis skills in Biochemistry. ✓ Prepare assignments on analytical mechanisms in Biochemistry as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **1. Nelson DL & Cox MM.** (2012) *Lehninger Principles of Biochemistry*. WH Freeman, USA. **2. Plummer M & Plummer DT.** (1988) *Practical Biochemistry*. Tata McGraw Hill. **3. Sawhney SK & Singh R.** (2014) *Introductory Practical Biochemistry*. Narosa Publishers, India. **4. Stryer L.** (2002) *Biochemistry*. WH Freeman & Company. New York, USA. **5. Voet D & Voet G.** (2010) *Biochemistry*. John Wiley & Sons, UK. **6. Zubay G.** (1989) *Biochemistry*. Maxwell Macmillan International, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple choice 10 x 1 = 10**		
1	Which one of the following hetero-polysaccharides is found in lubricating fluid? (a) Chondroitin sulfate (b) Dermatan sulfate **(c) Hyaluronic acid** (d) Heparin	Recognize	Remember
2	Oxidation of primary alcoholic group in glucose results in the formation of; **(a) Glucuronic acid** **(b)** Gluconic acid **(c)** Glyceroldehyde **(d)** Glyceric acid	Identify	Remember
3	Stereoisomeres that differ only in configuration about one chiral center are called as; **(a) Epimers** **(b)** Monomers **(c)** Dimers **(d)** Constitutional isomers	Recognize	Remember
4	Eicosanoids are substances that act only on cells near the point of hormone synthesis instead of being transported in the blood to act on cells in other tissues or organs. They are known to be involved in human health and diseases. Which one of the following belongs to the family of eicosanoids? (a) Prostaglandins b) Thromboxanes (c) Leukotrienes **(d) All of these**	Recognize	Remember
5	Hormone Response Element (HRE) is a regulatory sequence on DNA which activates/initiates the process of transcription. The HRE is located; (a) At the site of initiation **(b) Upstream of the promoter region** (c) Downstream of the promoter region (d) Downstream of the initiator site	Recognize	Remember

6	Lauric acid, a fatty acid, belongs to the family of; (a) Short chain fatty acids **(b) Medium chain fatty acids** (c) Long chain fatty acids (d) Very long chain fatty acids	Recognize	Remember
7	The following bases belong to the fused, five and six membered ring, EXCEPT; (a) Guanine (b) Hypoxanthine **(c) Cytosine** (d) Adenine	Recall	Remember
8	_____ serves as an adaptor between mRNA and amino acids **(a) tRNA** **(b)** rRNA **(c)** Ribosome **(d)** snoRNA	Recall	Remember
9	In order to achieve a gene expression, histone proteins must relieve from DNA. Which one of the following enzymes facilitate the above mentioned process? (a) Kinase (b) Phosphatase **(c) Acetyltransferase** (d) Deacetylase	Identify	Remember
10	Which one of the following enzymes joins two different fragments of DNA? (a) Kinase (b) Lyase (c) Hyrodate **(d) Ligase**	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	What is tautomerization of a monosaccharide?	Explain	Understand
22	How gluconic acids are formed?	Differentiate Define	Understand
23	What are Chargaff's rules?	Cite Examples	Understand
24	What are derived lipids?	Illustrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words 3 x 10 = 30**		
25	Describe in detail about Proteoglycans	Describe	Analyse
26	Explain about the Meselson-Stahl experiment which proved the semi-conservative mode of replication	Explain Discuss	Understand
27	Discuss in detail about sphingolipids	Assess	Skill

SEMESTER – VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF318	**Basic Biochemistry Practical**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the basic concepts of biochemistry	Understand
CO 2	Demonstrate an understanding of fundamental principles of biochemistry	Apply
CO 3	Able to analyze defects involved in biochemical pathways	Analyze
CO 4	Formulate causes of molecular defects	Create
CO 5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	Content	Hrs.
I	Qualitative Analysis of Carbohydrates	03
II	Color Reactions of Amino Acids	03
III	Estimation of Protein by Lowry's Method	03
IV	Estimation of DNA by Diphenylamine Method	03
V	Estimation of RNA by Orcinol Method	03
VI	Separation of Cells by Centrifugation	03
VII	Blood Cells Counting	03
VIII	Measurement of Hemoglobin Content in Blood	03
IX	Blood Grouping & ESR	03
X	Qualitative Analysis of Carbohydrates	03

	Tasks: Each student is required to adhere to the following: ✓ Practice the reactions ✓ Practice active listening, stimulate critical thinking and analysis skills in Biochemistry. ✓ Understand the practical content and transform the same on to an observation note book and should be able to explain the procedure during discussions.	

	✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** 1. **Plummer M & Plummer DT.** (1988) *Practical Biochemistry*. Tata McGraw Hill. 2. **Nelson DL & Cox MM.** (2012) *Lehninger Principles of Biochemistry*. WH Freeman, USA. 3. **Sawhney SK & Singh R.** (2014) *Introductory Practical Biochemistry*. Narosa Publishers, India. 4. **Stryer L.** (2002) *Biochemistry*. WH Freeman & Company. New York, USA. 5. **Voet D & Voet G.** (2010) *Biochemistry*. John Wiley & Sons, UK. 6. **Zubay G.** (1989) *Biochemistry*. Maxwell Macmillan International, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme: Continuous assessment

	CO1	CO2	CO3	CO4	CO5	Total
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Performance in practical	4	4	4	4	4
Submission of observation book	2	2	2	2	2
Outcome of the practical	5	5	5	5	5
Attendance	1	1	1	1	1
Total	12	12	12	12	12

f. Mapping Course Outcome with External Assessment (40 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Submission of record note book	1	1	1	1	1
Viva voce	7	7	7	7	7
Total	**8**	**8**	**8**	**8**	**8**

g. Rubric for Assignments: NA

h. Rubric for Seminar: NA

i. Model Question Paper: NA

SEMESTER - V					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF319	**Medicinal Botany**	**2**	**0**	**0**	**2**

y. Course Outcome(CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Introduction to Medical Botany	Understand
CO2	Indigenous Herbs & Traditional System of Medicine	Analyze
CO3	Conservation of Endangered Plants	Analyze
CO4	Endemic Medicinal Plants	Analyze
CO5	Ethnobotany & Folk Medicines	Analyze

z. Syllabus

Units	Content	Hrs.
I	**Introduction to Medical Botany:** History, Scope & Importance of Medicinal Plants - Indigenous Medicinal Sciences	09
II	**Indigenous Herbs & Traditional System of Medicine:** Definition & Scope – Ayurveda: History, Origin, Panchamahabhutas, Saptadhatu & Tridosha Concepts, Rasayana, Plants Used in Ayurvedic Treatments, Siddha: Origin of Siddha Medicinal Systems, Basis of Siddha System, Plants Used in Siddha Medicine. Unani: History, Concept: Umoor-E-Tabiya, Tumors Treatments/Therapy, Polyherbal Formulations	09
III	**Conservation of Endangered & Endemic Medicinal Plants Definition:** Endemic & Endangered Medicinal Plants, Red List Criteria; in situ Conservation: Biosphere Reserves, Sacred Groves, National Parks; Ex situ Conservation: Botanic Gardens, Ethanomedicinal Plant Gardens. Propagation of Medicinal Plants: Objectives of the Nursery, its Classification, Important Components of a Nursery, Sowing, Prickling, Use of Green House for Nursery Production, Propagation through Cuttings,Layering, Grafting & Budding	09
IV	**Ethnobotany & Folk Medicines:** Definition; Ethnobotany in India: Methods to Study ethnobotany; Applications of Ethnobotany: Applications of Ethnobotany: National Interacts, Palaeo-Ethnobotany. Folk Medicines of Ethnobotany, Ethnomedicine, Ethnoecology, Ethnic Communities of India. Application of Natural Products to Certain Diseases – Jaundice,	09

	Cardiac, Infertility, Diabetes, Blood Pressure & Skin Diseases	
	Tasks and Assignments: Each student is required to adhere to the following: ☐ To understand the medicinal plants ,important and their applications. ☐ Practiseactivelistening,stimulatecriticalthinkingandanalysis skills in medicinal botany. ☐ Prepare assignments on techniques in animal biotechnology asadvisedbythelecturerandshouldbeableto explain the concepts verbally duringdiscussions. ☐ Participateinproblem-basedlearning(PBL)assignmentsand submitareportoftheconceptslearntonatimelymanner. **References:** 1) Purohit & Vyas. (2008) Medicinal Plant Cultivation: A Scientific Approach. Agrobios, India. 2) Trivedi PC. (2006) Medicinal Plants: Ethnobotanical Approach. Agrobios, India.	

aa. Mapping of Program Outcomes with CourseOutcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

bb. EvaluationScheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40

External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

cc. MappingCourseOutcomewithInternalAssessment(40Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

dd. MappingCourseOutcomewithExternalAssessment(60Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

ee. Rubric forAssignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation toCOs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

ff. Rubric forSeminar

Sl. No	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**

.							
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledgeof facts,terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

gg. Model QuestionPaper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Objective Type **Multiplechoice 10 x 1 =10**		
1	The black bile secreted by? a) Thymus and bladder b) Liver and Kidney c) **Kidneys and Spleen** d) Only Liver	Differentiate	Remember
2	The Unani medical name derived "Aaza" is also called common name as? a) Humors b) Spirits c**) Organs** d) Functions	Recognize	Remember
3	What are the medical uses of Alliumsativam. a) Digestgive b) Anthelmintic c**) Both a and b** d) Non of the above	Identify	Remember

4	WHO estimates that how much % of the world population relief on plant based medicines for primary health care. a) 70 **b) 80** c) 40 d) 60	Recognize	Remember
5	Which plant can grow under ultraviolet radiation? a) **Alpine** b) Acacia c) Pinophyta d) Rhododendron	Recognize	Remember
6	1. Which medicinal compound is containing in Green tea. a) Resveratrol b) Polyphenols **c)Galla catechins** d) Flavonoids	Correlate	Remember
7	The Agasthyamala Biosphere reserve is found in which state? ` ` a) Tamilnadu **b) Kerala** c) Karnataka d) Andhrapradesh	Recognize	Remember
8	The natural process in which decomposes organic matter is known as? a) Vermin compost b) **Organic compost** c) Windrow compostd) In-vessel compost	Correlate	Remember
9	The word ethanobotany coined by? a**) John William Harshberger** b) Babylon circa c)Martin d) Balix and Cox	Identify	Remember

10	What are the aims and objectives of Ethnobotany? a) Documentation b)Preservation c) Conservation **d) All of the above**	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Write natural suitable organic materials for composting?	Explain	Understand
22	What is Unani medicine? How it influencing on human health?	Explain	Understand
23	Write basic principles of Siddha medicine	Explain	Understand
24	What is folk medicine? Write its applications in rural area?	Explain	Apply
	PART – C Essay Answer **Theanswershouldnotexceed400words 3 x 10 =30**		
25	Write about endangered plants? Give any five extinct species name?	Describe	Analyse
26	What is Ayurvedik formulation? Write about Asava and Arishtas?	Assess	Understand
27	Describe about herbal drug? Write how herbal drugs are used in cancer treatment with suitable examples?	Describe	Understand

SEMESTER - VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF301	**Analytical Techniques**	**3**	**-**	**-**	**3**

- **a. Course Outcome (CO)** develop technical skills in a wide range of plant science methods.
- Understand the latest technological developments & ways whereby they can be used in plant biology.
- Apply his/her knowledge to practical problems in plant biology.

On the successful completion of the course, the student will be able to
(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO 1	Learn about the different analytical techniques used in biological research.	Remember
CO 2	Understand the latest technological developments & ways whereby they can be used in plant biology	Understand
CO 3	Illustrate the importance analytical techniques for deciphering a biological phenomenon	Apply
CO 4	Develop technical skills in a wide range of plant science methods.	Create
CO 5	To apply the acquired knowledge for research applications	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	Content	Hrs.
I	**Imaging and Related Techniques:** Principles of Microscopy; Light Microscopy; Fluorescence Microscopy; Confocal Microscopy; Use of Fluorochromes: (A) Flow Cytometry (FACS); (B) Applications of Fluorescence Microscopy: Chromosome Banding, FISH, Chromosome Painting; Transmission &Scanning Electron Microscopy – Sample Preparation for Electron Microscopy, Cryofixation, Negative Staining, Shadow Casting, Freeze Fracture, Freeze Etching	14
II	**Cell Fractionation:** Centrifugation: Differential & Density Gradient Centrifugation, Sucrose Density Gradient, $CsCl_2$Gradient, Analytical Centrifugation, Ultracentrifugation, Marker Enzymes	10
III	**Radioisotopes:** Use in Biological Research, Auto-Radiography, Pulse Chase Experiment	8
IV	**Spectrophotometry and Chromatography:** Spectrophotometry: Principle & its Application in Biological Research Chromatography: Principle; Paper Chromatography; Column Chromatography, TLC, GLC, HPLC, Ion-Exchange Chromatography; Molecular Sieve Chromatography; Affinity Chromatography	12
V	**Characterization of Proteins and Nucleic acids:** Mass Spectrometry; X-Ray Diffraction; X-Ray Crystallography; Characterization of Proteins & Nucleic Acids; Electrophoresis: AGE, PAGE, SDS-PAGE	10
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding analytical techniques used in biological research. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** • **Ausubel F, et al.** (1995) *Short Protocols in Molecular Biology*. John Wiley & Sons. • **Plummer DT.** (1996) *An Introduction to Practical Biochemistry*. Tata McGraw-Hill. New Delhi. • **Ruzin SE.** (1999) *Plant Microtechnique & Microscopy*. Oxford University Press, New York, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**x**
CO2	**x**	**x**	**x**	**x**	**x**
CO3	**x**	**x**	**x**	**x**	**x**
CO4	**x**	**x**	**x**	**x**	**x**
CO5	**x**	**x**	**x**	**x**	**x**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5

2	**Organiz a -tion 50%**	Includes title, introduction,statement ofthe main idea withillustration and conclusion.	Includes title, introduction,statement ofmain ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**		
1	Trichloroacetic acid is commonly used to precipitate which of the following? (A) **Proteins** (B) Carbohydrates (C) Lipids (D) Nucleic acids	Differentiate	Remember
2	In which of the chromatographic techniques does larger molecules move rapidly through the column and elute first? (A) **Gel filtration** (B) Ion exchange (C) Affinity (D) Paper chromatography	Recognize	Remember
3	Polyacrylamide is a combination of which of the below mentioned components? (A) **Acrylamide + Bisacrylamide**(B) Acrylamide + Ammonium per sulphate (C) Acrylamide + Glycerol (D) Acrylamide + SDS	Recognize	Remember

4	Which one of the below mentioned is non denaturing gel electrophoresis? (A) **Native PAGE** (B) SDS-PAGE (C) Urea Page (D) SDS-2D Electrophoresis	Recognize	Remember
5	Which one of the below mentioned reduces the disulfide bonds in protein samples? (A) Glycerol (B) **ß-mercaptoethanol** (C) SDS (D) Glycine	Recognize	Remember
6	The use of a molecule to purify its receptor is an example of which of the following? (A)Ion exchange chromatography (B) Size exclusion chromatography (C) **Affinity chromatography** (D) Paper chromatography	Recognize	Remember
7	Which one of the below mentioned is most commonly used for blocking in western blotting procedure? (A) **Bovine serum albumin** (B) Ponceau red (C) SDS (D) Tris buffered saline	Identify	Remember
8	Which of the below mentioned technique is used in molecular biology research to study gene expression by detection of RNA? (A) Southern blot (B) **Northern blot** (C)Western blot (D) South western blot	Recognize	Remember
9	In light microscopy, which of the following is used as fixatives prior to staining technique? (A) Coomassie blue (B) **Heat** (C) Silver nitrate (d) Amido black	Correlate	Remember
10	Which technique is used to determine the protein structure including the exact orientation and arrangement of different amino acids? (A) Western blot (B) Mass spectrometry (C) X-**ray crystallography** (D) SDS-PAGE	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Explain differential centrifugation and describe its use in biological research?	Explain	Understand
22	Describe the steps involved in performing Western blotting?	Describe	Understand
23	Differentiate a mass spectrometer with a UV-Visible Spectrophotometer?	Differentiate	Analyze
24	Demonstrate the use of Pulse-chase autoradiography in biological research?	Demonstrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		
25	Discuss the applications of fluorescence microscopy?	Discuss	Understand
26	Explain in detail different chromatographic techniques for separation of proteins?	Demonstrate	Apply
27	Compare differential centrifugation and density gradient centrifugation? Give a detailed explanation about their use in biological research?	Judge	Evaluate

SEMESTER - VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF303	Reproductive Biology	45	-	-	3

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Describe how spermatogenesis in the testis & oogenesis in the ovary are regulated during normal fertility as well as understand the various causes of infertility.	Remember
CO 2	Understand how sperm fertilize the egg, how the zygote implants in the uterus & how early embryo development progresses.	Understand
CO 3	Describe the coordination of Endocrine system with reproductive system	Apply
CO 4	Explain how the integrated function of the hypothalamus, pituitary gland & gonads (testis/ovary) are critical for normal male & female reproduction	Analyze
CO 5	Explain the difference between peptide & steroid hormones & understand the mechanisms by which these hormones regulate reproductive function in their target tissues.	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Reproductive Endocrinology:** Gonadal Hormones & Mechanism of Hormone Action, Steroids, Glycoprotein Hormones &Prostaglandins, Hypothalamo – Hypophyseal – Gonadal Axis, Regulation of Gonadotrophin Secretion in Male & Female; Reproductive System: Development & Differentiation of Gonads, Genital Ducts, External Genitalia, Mechanism of Sex Differentiation.	09
II	**Functional Anatomy of Male Reproduction:** Outline & Histological of Male Reproductive System in Rat & Human; Testis: Cellular Functions, Germ Cell, System Cell Renewal; Spermatogenesis: Kinetics & Hormonal Regulation;	09

	Androgen Synthesis & Metabolism; Epididymal Function & Sperm Maturation; Accessory Glands Functions; Sperm Transportation in Male Tract.	
III	**Functional Anatomy of Female Reproduction:** Outline & Histological of Female Reproductive System in Rat & Human; Ovary: Folliculogenesis, Ovulation, Corpus Luteum Formation & Regression; Steroidogenesis & Secretion of Ovarian Hormones; Reproductive Cycles (Rat & Human) &their Regulation, Changes in the Female Tract; Ovum Transport in the Fallopian Tubes; Sperm Transport in the Female Tract.	09
IV	**Fertilization & Development:** Fertilization; Hormonal Control of Implantation; Hormonal Regulation of Gestation, Pregnancy Diagnosis, Foeto-Maternal Relationship; Mechanism of Parturition & Its Hormonal Regulation; Lactation & its Regulation	09
V	**Reproductive Health:** Infertility in Male & Female: Causes, Diagnosis &Management; Assisted Reproductive Technology: Sex Selection, Sperm Banks, Frozen Embryos, *in vitro* Fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern Contraceptive Technologies; Demographic Terminology Used in Family Planning.	09
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the processes of spermatogenesis and oogenesis in mammals and its importance in the propagation of species. ✓ Practice active listening; stimulate critical thinking and analysis skills in the area of reproductive biology. ✓ Prepare assignments on analytical mechanisms in gametogenesis, and hormonal regulations of male and female reproduction as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **Austin CR & Short RV.** (1982) *Reproduction in Mammals*. Cambridge University Press, UK. **Degroot LJ & Jameson JL.** (2005)*Endocrinology*. WB Saunders & Company. **Hatcher RA, et al.** (1998) *The Essentials of Contraceptive Technology*. Population Information Programme. **Jones R & Lopez KH.** (2013) *Human Reproductive Biology*. Academic Press. **Knobil E, et al.** (1994) *The Physiology of Reproduction*. Raven Press Ltd.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	x	x	-	x	x
CO2	x	x	x	x	x
CO3	x	x	x	x	x
CO4	x	x	x	x	x
CO5	x	x	x	x	x

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total

Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A **(Objective - 10 x 1 = 10marks)**	2	2	2	2	2
Part – B **(Short Answer -5 x 4 = 20marks)**	10	10	-	-	-
Part – C **(Essay-3 x 10 = 30 marks)**	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

S. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Content** **50%**	Ideas are detailed, well developed, supported with specific evidence &factsand examples	Ideas aredetailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organization** **50%**	Includes title, introduction, statementof themain ideawith illustration and conclusion.	Includes title, introduction, statementof mainidea and conclusion.	organizational tools are weak or missing	No organizatio n	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation 50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1	Sex determination occurs initially through the SRY transcription factor acting on: A. Primordial germ cells ***B. Mesonephric duct cells*** C. Testes support cells D. Ovary support cells.	Recognize	Remember
2	The correct sequence of spermatogenetic stages leading to the formation of sperms in a mature human testis is ***A. Spermatogonia-spermatid-spermatocyte-sperm*** B. Spermatocyte-spermatogonia-spermatid-sperm C. Spermatogonia-spermatocyte-spermatid-sperm D. Spermatid-spermatocyte-spermatogonia-sperm	Understand	Remember
3	Which hormone causes the lining of the uterus to thicken in preparation for implantation of the embryo? A. Luteinizing hormone ***B. Progesterone*** C. Gonadotropic-releasing hormone (GnRH) D. Follicle-stimulating hormone	Recognize	Remember
4	Corpus luteum develops from an ovarian follicle during the luteal phase of menstrual cycle. Corpus luteum secretes _____ A. LH	Recognize	Remember

	B. Progesterone C. Progesterone and LH D. d) ***Progesterone and estrogen***		
5	LH hormone is luteinizing hormone. It is produced in pituitary gland. In female acute rise in LH triggers ovulation. What is the function of LH hormone? ***A. Stimulates oxidative respiration*** B. Stimulates muscle growth C. Causes colour change in skin D. Stimulates production of testosterone	Recognize	Remember
6	Wolffian duct is the mesonephric embryonic duct that leads to the development of male gonads. Wolffian duct forms _____ A. Oviduct B. Urethra C. ***Epididymis*** D. Ejaculatory duct	Identify	Remember
7	Mullerian inhibiting hormone serves which of the following functions? A. ***It inhibits the growth of female genitalia, allowing the development of the Wolffian system in males*** B. It inhibits the growth of male genitalia, allowing the development of the Wolffian system in females. C. It inhibits testosterone and estrogen D. None of these	Recognize	Remember
8	Menstruation is due to _____. A. Reduction of FSH B. Reduction of LH C. Reduction of oestrogen and progesterone ***D. Increase in LH***	Recognize	Remember
9	Which is the correct order of the stages of the menstrual cycle? A. Follicular phase—ovulation—menstruation—luteal phase B. Ovulation—luteal phase—menstruation—follicular phase C. ***Follicular phase—ovulation—luteal phase—menstruation*** D. Luteal phase—ovulation—menstruation—follicular phase	Identify	Remember
10	During the secretory phase of the uterus, progesterone induces: A. Inactivation of estradiol to estrone ***B. Proliferation of predecidual cells*** C. Myometrial contractions D. Release of matrix metalloproteases from stroma	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	a) Write a short note on Seminiferous tubules (or) b) Write a short note on hypothalamo-hypophyseal portal system.	Describe	Explain
22	a) Write down the mechanism of steroid hormone action. (or) b) Hypothalamo-hypophyseal portal system - Discuss	Describe	Understand
23	a) Draw a structure of ovary and label the parts. (or) b) Define Graafian follicle. Draw and label Graafian follicle.	Describe	Explain
24	a) During oogenesis, why polar body is formed? What is its function (or) b) Define Steroidogenesis and discuss the role of side chain cleavage enzyme.	Describe	Understand

	PART – C Essay Answer The answer should not exceed 400 words Marks: 3 x 10 = 30		
25	a) How accessory male reproductive organs contribute to fertility. (or) b) Differentiate between spermatogenesis and oogenesis.	Describe	Analyze
26	a) Discuss the hormonal regulation of follicular phase, ovulation, luteal phase and menstruation (or) b) Discuss the hormonal regulation of testicular functions in adult.	Correlate	Apply
27	a) Write the steps involved in testicular steroidogenesis (or) b) Discuss the follicular and luteal phases of menstrual cycle.	Describe	Analyze

SEMESTER - VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF304	**Reproductive Biology - Practicals**		**-**	**30**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Describe how spermatogenesis in the testis & oogenesis in the ovary are regulated during normal fertility as well as understand the various causes of infertility.	Remember
CO 2	Understand how sperm fertilize the egg, how the zygote implants in the uterus & how early embryo development progresses.	Understand
CO 3	Describe the coordination of Endocrine system with reproductive system	Apply
CO 4	Explain how the integrated function of the hypothalamus, pituitary gland & gonads (testis/ovary) are critical for normal male & female reproduction	Analyze
CO 5	Explain the difference between peptide & steroid hormones & understand the mechanisms by which these hormones regulate reproductive function in their target tissues.	Skill

(Number of CO's are not fixed)

a1. Tabular Column for action verbs

General Objectives	Specific Objectives
Remember - retrieval of Information	List, Name, Define, Identify, Recall, Recognize, Tabulate, State, Repeat
Understand – demonstration of comprehension	Translate, Interpret, Extrapolate,Define in your own words, Differentiate, Cite example, Relate, Classify, Restate, Summarize, Locate
Apply – applying knowledge in a new context	Employ, Illustrate, Use, Solve
Analyze – supporting assertions through the use of evidence, identifying causes	Compare, Contrite, Criticize, Examine, Question, Test, Distinguish
Evaluate – coming to a judgement on the value of information	Predict, Select, Appraise, Find out,
Create – combining knowledge to come to new conclusions	Assemble, Construct, Develop, Formulate, Propose, Organize, Hypothesize
Skill	Arrange for the experiment, Experiment, Demonstrate, Verify the Hypothesis, Draw, Articulate

b. Syllabus

Units	Content	Hrs.
I	**Study of Animal House:** Set Up & Maintenance of Animal House, Breeding Techniques, Care of Normal & Experimental Animals.	06
II	Examination of Vaginal Smear Rats. Estrous cycle in Rats.	06
III	**Surgical Techniques:** Principles of Surgery in Endocrinology. Ovarectomy, Hysterectorny, Castration & Vasectomy in Rats.	06
IV	**Examination of Histological Sections** from Photomicrographs/ Permanent **Slides of Rat/Human:** Testis, Epididymis & Accessory Glands of Male Reproductive Systems; Sections of Ovary, Fallopian Tube, Uterus (Proliferative & Secretory Stages), Cervix & Vagina.	06
V	**Examination of Gametes** - Human Vaginal Exfoliate Cytology, Sperm Count & Sperm Motility in Rat, Study of Modern Contraceptive Devices	06
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the processes of spermatogenesis and oogenesis in mammals and its importance in the propagation of species. ✓ Practice active listening; stimulate critical thinking and analysis skills in the area of reproductive biology. ✓ Prepare assignments on analytical mechanisms in gametogenesis, and hormonal regulations of male and female reproduction as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate actively and submit record notebook on a timely manner. **References:** **Austin CR & Short RV.** (1982) *Reproduction in Mammals*. Cambridge University Press, UK. **Degroot LJ & Jameson JL.** (2005)*Endocrinology*. WB Saunders & Company. **Hatcher RA, et al.** (1998) *The Essentials of Contraceptive Technology*. Population Information Programme. **Jones R & Lopez KH.** (2013) *Human Reproductive Biology*. Academic Press. **Knobil E, et al.** (1994) *The Physiology of Reproduction*. Raven Press Ltd.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	x	x	-	x	x
CO2	x	x	x	x	x
CO3	x	x	x	x	x
CO4	x	x	x	x	x
CO5	x	x	x	x	x

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Record	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Record	6	6	6	6	6
Seminar	-	-	-	-	-
Test	-	-	-	-	-
Punctuality/ Attendance	2	2	2	2	2
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A **Identify the Specimens – (5 x 2 = 10 marks)**	2	2	2	2	2
Part – B **Short Answer – (5 x 6 = 30 marks)**	6	6	6	6	6
Part – C **(Viva voce - 20 marks)**	4	4	4	4	4
Total	**12**	**12**	**12**	**12**	**12**

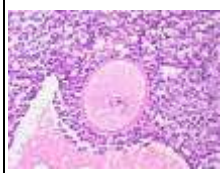
g. Rubric for Assignments

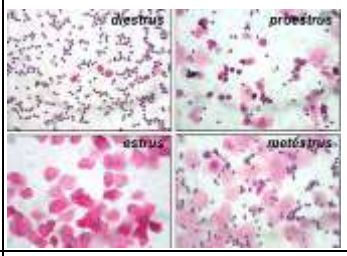
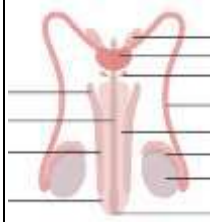
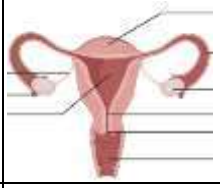
S. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

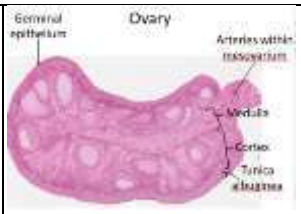
h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1							
2							

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Identify the Specimen **Multiple Choice** **Marks: 5 x 2 = 10**		
1	 Ans: *Cross section of ovary*	Identify	Remember

2	 Ans: Cross section of placenta	Identify	Remember
3	 Ans: Rat epididymis	Recognize	Remember
4	 Ans: Seminal vesicles of rats	Identify	Remember
5	 Ans: Human ovum	Recognize	Remember
	PART – B Short Answer **The answer should not exceed 200 words marks: 5 x 6 = 30**		
6	Write a short note on different phases of rat's estrous cycle. 	Identify	Explain
7	Identify and label the different parts of the male reproductive system and comment on it. 	Differentiate	Understand
8	Identify the slide and comment on the specimen. 	Identify	Explain
9	Discuss the hormonal regulation of ovarian cycle		Explain

		Understand	
10	Identify the birth control method given in the picture and explain. 	Identify	Explain
	PART – C **Viva voce** **Marks: 20**		
1	What is the difference between spermatogenesis and oogenesis? What is the mechanism of steroid hormone action? What is positive and negative mechanism of hormone action? Explain with examples.	Differentiate	Explain

SEMESTER - VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF307	**Basic Microbiology**	**3**	**0**	**0**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO1	Understand the history of microbiology, types of microbes and strategies employed for replication, survival and interaction with their environment	Understand
CO2	Apply the scientific methods and hypothesis testing in microbiological procedures	Apply
CO3	Examine the role of microorganisms in beneficial and harmful effects in plants, animals, and to humankind	Analyze

CO4	Conceive and develop strategies to employ and associate microorganisms with human welfare, disease and applications	Create
CO5	Demonstrate practical skills in the use of tools, technologies & methods in microbiology	Skill

b. Syllabus

Units	Content	Hrs.
I	**Introduction to Microbiology:** Brief History of Microbiology, Microbes & Human Welfare – Recycling Vital Elements, Sewage Treatment, Bioremediation, Insect-Pest Control by Microbes, Normal Microbiota, Biofilms, Units of Measurements of Microorganisms, Microscopy, Principles in Magnification, Resolution, Preparation of Specimens for Microscopy, Simple Stains, Differential Staining, Special Staining, Microbial Classification – Phylogenetic Relationships, Scientific Nomenclature, Taxonomic Hierarchy, Methods of Classifying & Identifying Microorganisms – Morphological Characteristics, Differential Staining, Biochemical Tests, Serology, Phage Typing, Fatty Acid Profiles, DNA Base Composition, DNA Fingerprinting, NAATs, NA Hybridization	09
II	**Microbial Anatomy:** Prokaryotic & Eukaryotic Cell, Biology of Bacteria – Cell Structure, Size, Shape, Arrangement Cell Membrane, Cell Wall, Cytoplasmic Inclusions, Mesosomes, Flagella & Motility, Slime, Glycocalyx, Capsule, Pili, Chemotaxis, Endospore, Archea – Diversity – Chlamydiae & Mycoplasmas – Virus (bacteriophages) Structure, Life cycle (Lytic & Lysogenic). Prions, Virioids, Biology of Fungi, Cell Structure, Physiology & Classification – Biology of Yeast – Reproduction. Biology of Algae, Protozoa, Helminths	09
III	**Microbial Growth and Metabolism:** Microbial Nutrition & Growth Requirements, Macro-nutrients, Micro-nutrients, Growth Factors, Sources of Nutrients, Culture Media, Pure Culture (Streak/Spread/Pour plates, Stab/Slant cultures), Preservation of Pure Cultures, Bacterial Growth, Nutritional Classification: Phototrophs, Chemotrophs, Autotrophs, Heterotrophs, Photoautotrophs, Photoheterotrophs, Chemoautotrophs, Chemoheterotrophs – Nutritional Patterns of Pathogens, Saprophytes, Auxotrophs, Enzymes, Energy Production, Carbohydrate, Protein, Lipid Metabolism, Metabolic Diversity, Metal-tolerance, Radio-resistance	09
IV	**Control of Microorganisms:** Control of Microbes – Sterilization, Disinfection, Antiseptic, Tyndalization, Pasteurization: Physical – Dry Heat, Moist Heat, UV, Ionizing Radiation, Filtration, HEPA Filter, Chemical Methods, QC of Microbial Control, Antimicrobial Drugs: Classes & Modes of Action, Measurement of Antibiotic Sensitivity, Antimicrobial Resistance – Mechanisms in Mycobacteria & Nosocomial Pathogens	09
V	**Environmental and Industrial Microbiology:**Microbial Diversity & Habitats, Soil Microbiology & Biogeochemical Cycles – Carbon Cycle, Nitrogen Cycle, Sulfur Cycle, Phosphorus Cycle, Degradation of Synthetic Chemicals in Soil & Water, Aquatic Microorganisms, Role of Microorganisms in Water Quality, Water Treatment & Sewage Treatment, Food Microbiology – Foods & Disease, Industrial Food Canning, Aseptic Packaging, Radiation & Industrial Food Preservation,	09

	High Pressure Food Preservation, Role of Microorganisms in Food Production; Industrial Microbiology – Fermentation Technology, Industrial Products, Alternative Energy Sources Using Microorganisms, Biofuels	
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Fully understand the different anatomical and physiological distinctions in microorganisms of different classes. ✓ Practice critical thinking and analytical skills in microbiology. ✓ Prepare assignments on analytical mechanisms in microbiology as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in case studies and submit a report of the concepts learnt on a timely manner. **References:** 7) Holt JS, et al. (1994) Bergey's Manual of Determinative Bacteriology. Williams & Wilkins, Baltimore, USA. 8) Madigan MT, et al. (2017) Biology of Microorganisms. Pearson Publishers, USA. 9) Mara D & Horan N. (2013) The Handbook of Water & Waste-Water Microbiology. Academic CRC Press. 10) Nester EW, Roberts CV & Nester MT. (2015) Microbiology - A Human Perspective. McGraw-Hill Education 11) Schaechter M & Leaderberg J (2009). The Desk Encyclopedia of Microbiology. Elseiver Academic Press. 12) Tortora, Funke & Case. (2013) Microbiology: An Introduction. Pearson Publishers, USA. 13) Webster J. (2007). Introduction to Fungi. Cambridge University Press, Cambridge, UK. 14) Woolverton CJ, et al. (2016) Microbiology. McGraw-Hill Education.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40

External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts andexamples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple choice 10 x 1 = 10**		
1	**Endosymbiotic nitrogen fixation is mediated by *Rhizobium leguminosarum* in which of the following plant families?** a) ***Fabaceae*** b) Malvaceae c) Rubiaceae d) Euphorbiaceae	Recognize	Remember
2	**Which of the following bacteria does not fit to Koch's postulates?** a) *Bacillus anthracis* b) *Mycobacterium tuberculosis* c) *Clostridium tetani* d)***Mycobacterium leprae***	Recognize	Remember
3	**Which of the following types of flagellar arrangement BEST describes the photomicrographe given below?** 	Recognize	Remember

	a) Monotrichous. ***b) Lophotrichous.*** c) Amphitrichous. d) Peritrichous.		
4	**Influenza viruses cause one of the major epidemic diseases of the world. Which of the following statements is FALSE regarding influenza virus?** a) Its hemagglutinin and neuraminidase proteins undergo genetic variation. ***b) Previous exposure ensures protection from subsequent exposure and infection.*** c) Shows both antigenic shift and drift. d) Its segmented genome can undergo recombination.	Distinguish	Remember
5	**Which of the following is a differential media?** a) Selenite F broth ***b) MacConkey agar*** c) Nutrient agar d) Meat extract media	Recognize	Remember
6	**Regarding an auxotroph:** a) A species or genetic strain of microbe capable of growing on a minimal medium consisting a simple carbon source (carbohydrate or CO_2) and inorganic sources of all other nutrients. b) A species or genetic strain of microbe capable of growing on a rich medium consisting a variety of organic and inorganic sources of all nutrients. **c) *A species or a mutant strain that requires one or more complex organic nutrients (such as amino acids, nucleotides, or enzymatic cofactors) for growth.*** d) A species or genetic strain of microbe capable of growing on a selective medium containing a variety of nutrients.	Differentiate	Remember
7	**The best method for sterilization of dusting powder is by** a) autoclaving. ***b) using a hot air oven.*** c) inspissation. d) tyndallization.	Recognize	Remember
8	**All are anti-pseudomonal penicillins EXCEPT:** a) Piperacillin ***b) Cloxacillin*** c) Carbenicillin d) Ticarcillin	Identify	Remember
9	**Which of the following compounds are required for the growth of saprophytic fungi?** ***a) Organic compounds*** b) Nitrates	Identify	Remember

	c) Phosphates d) Mercury		
10	**Which of the following yeast is used for the production of riboflavin?** a) *Saccharomyces cerevisiae* ***b) Eremothecium ashbyi*** c) *Saccharomyces rouxii* d) *Candida utilis*	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Discuss the factors affecting the colonization of indigenous microbiota in the mammalian gut.	Explain	Understand
22	What is meant by phage typing? Briefly state the significance of phage typing in epidemiology.	Illustrate	Understand
23	State the differences between coliforms and fecal streptococci? Outline an algorithm to report the detection of enteropathogens in public water distribution systems	Differentiate	Understand
24	Outline the basic steps employed in the industrial manufacture of red wine.	Illustrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words 3 x 10 = 30**		
25	Describe the structural forms used in the building of an icosahedron in viral particles and explain the organization (number of capsomers etc.) of the adenovirus particle.	Describe	Analyse
26	Classify the different methods of bacterial cultivation. Describe the different culture media available for the detection and identification of bacterial species.	Differentiate	Understand
27	Describe the mode of action of penicillin against the metabolism of cell wall structures of bacteria. Add a note on anti-staphylococcal penicillins and vancomycin.	Assess	Skill

SEMESTER - VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF308	**Basic Microbiology: Practicals**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO1	Understand the structural diversity of microorganisms	Understand
CO2	Apply the scientific methods for the detection of microorganisms from environmental and clinical samples	Apply
CO3	Examine the role of microorganisms in beneficial and harmful effects in plants, animals, and to humankind	Analyze
CO4	Conceive and develop strategies to employ and associate microorganisms with human welfare, disease and applications	Create

CO5	Demonstrate practical skills in the use of tools, technologies & methods in microbiology	Skill

b. Syllabus

Units	Content	Hrs.
I	Direct Microscopic Observations of Bacterial Shape – Cocci, Rods, Chains, Fungal Spores, Mycelium, Yeast Budding.	09
II	Staining Methods: Simple, Negative, Acid Fast, Gram Staining, Spore, Capsule, Metachromatic Granular Staining, Lactophenol Cotton Blue Staining - Fungal Slide Culture.	09
III	Measurement of Size of Microbes – Micrometry, Bacterial Motility by Hanging Drop Method, Enumeration of Bacterial/Yeast Cells-Viable Count (Plate Count) Total Count (Haemocytometer).	09
IV	Preparation of Media: Broth & Agar Media, Basal, Selective & Differential Culture Media, Plates, Slants, Pure Culture Techniques: Streak/Spread/Pour Plate Methods, Bacterial & Fungal Cultivations.	09
V	Bacterial DNA – Bacterial Protein Extractions & Estimations. PCR – RFLP & RAPD, Phylogenetic Analysis.	09

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**-**
CO2	**x**	**x**	**x**	**x**	**-**
CO3	**x**	**x**	**x**	**x**	**-**
CO4	**x**	**x**	**x**	**x**	**-**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments					
Seminar					
Test					
Attendance					
Total					

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)					
Part – B (Short Answer -5 x 4 = 20marks)					

Part – C **(Essay-3 x 10 = 30 marks)**					
Total					

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content** **50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza-tion** **50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21			
22			
23			
24			
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			
25			

SEMESTER – VI					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF305	**Biochemistry-Intermediary Metabolism**	**3**	**0**	**0**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the structure and function of biomolecules	Understand
CO 2	Demonstrate an understanding of fundamental principles of biomolecules	Apply
CO 3	Able to distinguish macromolecules from small molecules	Analyze
CO 4	Formulate causes of pathway defects	Create
CO 5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	Content	Hrs.
I	**Metabolism** Basic Concepts- Anabolism & Catabolism, Role of ATP in Metabolism, High Energy Compounds & Intermediates, Common Types of Reactions Involved in Metabolism	09
II	**Carbohydrate Metabolism** Glycolysis- Aerobic & Anaerobic, Regulation of Glycolysis, TCA Cycle & its Regulation; Glycogen Metabolism- Glycogenesis & Glycogenolysis, Glycogen Storage Diseases; Gluconeogenesis, Pentose Phosphate Pathway (HMP Shunt) & Glyoxylate Cycle	09
III	**Protein Metabolism** Catabolism of Amino Acid Nitrogen- Transamination, Deamination, Ammonia Formation & the Urea Cycle. Catabolism of Carbon Skeletons of Amino Acids. Conversion of Amino Acids to Special Products. Disorders of Amino Acid Metabolism	09
IV	**Metabolism of Lipids** Fatty Acid Oxidation, Biosynthesis of Fatty Acids, Elongation & Unsaturation of Fatty Acids, Comparison of Fatty Acid Oxidation with Synthesis; Triacyl Glycerol Biosynthesis, Cholesterol Biosynthesis & its Regulation, Ketone Bodies	09
V	**Nucleic Acid Metabolism** Purine- Biosynthesis, Regulation & Degradation; Pyrimidine- Biosynthesis, Regulation & Degradation; Formation of Uric Acid; Gout; Disorders Associated with Nucleic Acid Metabolism	09

Tasks and Assignments:

Each student is required to adhere to the following:

- ✓ Practice the pathways involved in metabolism
- ✓ Practice active listening, stimulate critical thinking and analysis skills in Biochemistry.
- ✓ Prepare assignments on analytical mechanisms in Biochemistry as advised by the lecturer and should be able to explain the concepts verbally during discussions.
- ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner.

References:

1. **Nelson DL & Cox MM.** (2012) *Lehninger Principles of Biochemistry*. WH Freeman, USA.
2. **Plummer M & Plummer DT.** (1988) *Practical Biochemistry*. Tata McGraw Hill.
3. **Sawhney SK & Singh R.** (2014) *Introductory Practical Biochemistry*. Narosa Publishers, India.
4. **Stryer L.** (2002) *Biochemistry*. WH Freeman & Company. New York, USA.
5. **Voet D & Voet G.** (2010) *Biochemistry*. John Wiley & Sons, UK.
6. **Zubay G.** (1989) *Biochemistry*. Maxwell Macmillan International, USA.

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple choice 10 x 1 = 10**		
1	Fructose 6 Phosphate stimulates the synthesis of Fructose 2,6 Bis-Phosphate which in turn activates, Phosphofructokinase (PFK); the product of PFK further stimulates Pyruvate kinase. Such a process is called as; (a) Feeder reverse reaction (b) Feeder access reaction **(c) Feeder forward reaction** (d) Spontaneous reaction	Recognize	Remember
2	The only enzyme of Tri Carboxylic Acid cycle which is located in the mitochondrial matrix is; **(a) Succinate dehydrogenase** **(b)** Citrate synthase **(c)** Malate dehydrogenase **(d)** Alpha keto glutarate dehydrogenase	Identify	Remember
3	In Yeast and other organisms, NAD+ is regenerated by converting Pyruvate into? **(a) Alcohol and carbon dioxide** **(b)** Acid and carbon dioxide **(c)** Alcohol and Oxygen **(d)** Acid and Hydrogen	Recognize	Remember
4	Choose the correct order for the free energy of hydrolysis of phorphorylated compounds; (a) ATP > 1,3 BPG > PEP > Glu-6-P (b) ATP > PEP > 1,3 BPG > Glu-6-P **(c) PEP > 1,3 BPG > ATP > Glu-6-P** (d) Glu-6-P > PEP > 1,3 BPG > ATP	Recognize	Remember
5	Fatty acids are partially soluble in water. The partial solubility is due to the presence of_____at the tip of the hydrocarbon chain; (a) Hydrophilic imine group (b) Hydrophilic amino group (c) Hydrophobic carboxylic group **(d) Hydrophilic carboxylic group**	Recognize	Remember

6	In Glycolytic pathway, an intermediate, 2, 3 Bisphosphoglycerate is formed during the conversion of 3 phosphoglycerate to 2 phosphoglycerate. An increase in this intermediate has been observed in cells that lack; (a) Hexokinase (b) Phosphoglycerate mutase **(c) Pyruvate kinase** (d) Triose phosphate isomerase	Recognize	Remember
7	About 10% of Sudden Infant Death Syndrome is due to the deficiency of; (a) Very long chain acyl CoA dehydrogenase **(b) Medium chain acyl CoA dehydrogenase** (c) Short chain acyl CoA dehydrogenase (d) both a & c	Recall	Remember
8	Cells that get β hydroxybutyrate can easily get converted into acetyl CoA, and thus can quickly use this ketone body as a; **(a) Source of energy** **(b)** Precursor for fatty acid synthesis **(c)** An inhibitor of cholesterol synthesis **(d)** An activator of fatty acid oxidation	Recall	Remember
9	Hypoxanthine-guanine phosphoribosyltranferase (HGPRT) catalyzes the formation of nucleotides *via* salvage pathway. Absence of activity of HGPRT has been observed in; (a) Hereditary Xanthinuria (b) Reye's syndrome (c) Pompe's disease **(d) Lesch-Nyhan syndrome**	Identify	Remember
10	Azaserine is a naturally occurring diazo compound which inhibits the synthesis of Cytidine triphosphate by inhibiting reactions involving;; **(a) Glutamine** **(b)** Histamin **(c)** Aspargine **(d)** Alanine	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Explain about the glycolytic pathway	Explain	Understand
22	Discuss about the mechanism of desaturation of fatty acids	Differentiate Define	Understand
23	Explain about Glyoxylate cycle	Cite Examples	Understand
24	Write in detail about enzyme inhibition	Illustrate	Apply

	PART – C Essay Answer The answer should not exceed 400 words 3 x 10 = 30		
25	Write in detail about the mechanism of pentose phosphate pathway including its importance	Describe	Analyse
26	Explain about the beta oxidation of fatty acids	Explain Discuss	Understand
27	Write in detail about the synthesis of Pyrimidine nucleotides including its regulation	Assess	Skill

SEMESTER – VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF306	**Biochemistry-Intermediary Metabolism Practical**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the basic concepts of biochemistry	Understand
CO 2	Demonstrate an understanding of fundamental principles of biochemistry	Apply
CO 3	Able to analyze defects involved in biochemical pathways	Analyze
CO 4	Formulate causes of molecular defects	Create
CO 5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	Content	Hrs.
I	Estimation of Ascorbic Acid.	03
II	Quantitative Estimations in Blood (such as Glucose, Cholesterol, Calcium).	03
III	Estimation of Creatinine by Jaffe's Method.	03
IV	Isolation of Proteins from Clinical Samples.	03
V	Determination of Enzyme Activity.	03
VI	Estimation of Aminotrasaminases (ALT/AST).	03
VII	Estimation of Serum Alkaline Phosphatase.	03
VIII	Effect of pH on Enzyme Activity.	03
IX	Detection of Urea in urine	03

X	Electrophoresis.	03
	Tasks: Each student is required to adhere to the following: ✓ Practice the reactions ✓ Practice active listening, stimulate critical thinking and analysis skills in Biochemistry. ✓ Understand the practical content and transform the same on to an observation note book and should be able to explain the procedure during discussions.	

	✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** 1. **Plummer M & Plummer DT.** (1988) *Practical Biochemistry*. Tata McGraw Hill. 2. **Nelson DL & Cox MM.** (2012) *Lehninger Principles of Biochemistry*. WH Freeman, USA. 3. **Sawhney SK & Singh R.** (2014) *Introductory Practical Biochemistry*. Narosa Publishers, India. 4. **Stryer L.** (2002) *Biochemistry*. WH Freeman & Company. New York, USA. 5. **Voet D & Voet G.** (2010) *Biochemistry*. John Wiley & Sons, UK. 6. **Zubay G.** (1989) *Biochemistry*. Maxwell Macmillan International, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme: Continuous assessment

	CO1	CO2	CO3	CO4	CO5	Total
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Performance in practical	4	4	4	4	4
Submission of observation book	2	2	2	2	2
Outcome of the practical	5	5	5	5	5
Attendance	1	1	1	1	1
Total	12	12	12	12	12

f. Mapping Course Outcome with External Assessment (40 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Submission of record note book	1	1	1	1	1
Viva voce	7	7	7	7	7
Total	**8**	**8**	**8**	**8**	**8**

g. Rubric for Assignments: NA

h. Rubric for Seminar: NA

i. Model Question Paper: NA

SEMESTER - VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF411	**CELL BIOLOGY**	**3**	**-**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

	Course Outcome	**Level**
CO1	Explain the universal features of cell and its organelle	Remember
CO2	Explain cell cycle and its regulation	Understand
CO3	Understand the fundamentals of cell signalling and intra-cellular trafficking	Apply
CO4	Understand techniques to characterize the cell	Analyse

b. Syllabus

Units	**Content**	**Hrs.**
I	**Dynamic Organization of Cell:** Basic properties of cell, Major types of cell: Prokaryotic, animal and plant cell, their characteristics, cell wall, composition, function of bacterial cell wall. Plasma membrane, structure, function, fluid mosaic model, membranes, lipids and proteins transport across the membrane – passive and active, Nature of Cytoskeleton, Intermediate Filaments, Microtubules, Actin Filaments, Cilia & Centrioles, Organization of the Cytoskeleton	9
II	**Cell organelles and Chromatin Structure:** Endoplasmic reticulum, Golgi complex – exocytosis; Lysosomes: phagocytosis, endocytosis, autophagy, Peroxisomes, Role of clatherin coated vesicles, Plant cell vacuoles; Structure of mitochondria and organization of respiratory	9

	chain; Structure of chloroplast and photophosphorylation; Structure of nucleus, nucleolus, nuclear membrane, transport across nuclear membrane. Chromatin organization - histone and DNA interactome.	
III	**Cellular Processes:** Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; Extracelluar matrix, collagen, proteoglycans, fibronectin, laminins, integrins, selectin, cadherins, role of tight junctions and gap junctions, Cell-ECM and cell-cell interactions.	9
IV	**Cellular Signalling, Transport and Trafficking:** Necrosis & Apoptosis - Mitochondrial & Death Receptor Pathway. Autophagy, Cell Signalling - Signalling Molecules & their Receptors, Functions of Cell Surface Receptors, Pathways of Intracellular Signal Transduction, cAMP, G Protein-Coupled Receptors, Receptors Tyrosine Kinases, Role of Ras & Raf in Oncogenesis, MAP Kinase Pathways, cell receptors and trans-membrane signalling; cell motility and migration.	9
V	**Cytology:** Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analysing DNA, RNA and proteins. Cell Fixation - Fluid Fixatives, Freezing & Section Drying, Fixation for Electron Microscopy - Buffered Osmium Solutions, Fixation of Organic & Inorganic Substances, Staining Techniques Acid & Basic, Fluorescent & Radioactive Dyes, Staining of Lipids, Steroids, Nucleic Acids, Proteins & Enzymatic Reaction Products.	9
	Tasks and Assignments: Each student is required to adhere to the following: • Acquire the skills like regularity and punctuality to classes. • Critical analysis of concepts and clarity in understanding the structural and functional aspects of cells and basic mechanisms underlying cell signalling and cell division. • Develop skill set for preparing assignments as advised by the teacher and submitting the same on the scheduled date. • Active participation in discussions in the class and be prepared for surprise tests focused more on analytical and logical questions from the already taught syllabus. **References:** **10.** Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., &	

	Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science **11.** Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman. **12.** Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM; Sunderland. **13.** Cell Biology. 7th Edition. 2013. Wiley. Gerald Karp. International Student version **14.** Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's world of the cell. Boston: Benjamin Cummings **15.** Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	X	x	-	X	x
CO2	X	x	x	X	x
CO3	X	x	x	X	x
CO4	X	x	x	X	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	Total
Internal	10	10	10	10	40
External	15	15	15	15	60
Total	**25**	**25**	**25**	**25**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4
Assignments	2	2	-	-
Seminar	-	-	2	2
Test	7	7	7	5
Attendance	1	1	1	1
Total	10	10	10	10

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4
Part – A **(Objective - 10 x 1 = 10 marks)**	3	2	3	2
Part – B **(Short Answer - 5 x 4 = 20 marks)**	2	3	2	3
Part – C	10	10	10	10

(Essay- 3 x 10 = 30 marks)				
Total	**15**	**15**	**15**	**15**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO4
2	**Organiza-tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO4

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**	Recognize	Remember
1	Which of the following is **NOT** a cell adhesion protein? a. Cadherin b. Selectin c. Immunoglobulin (Ig) superfamily d. Laminin	Identify	Remember
2	Given below are events in the cell cycle. (a) Phosphorylation of lamin A, B, C (b) Phosphorylation of Rb (Retinoblastoma protein) (c) Polyubiquitination of securin (d) Association of inner nuclear membrane proteins and nuclear pore complex proteins with chromosomes. Which one of the following reflects the correct sequence of events in the mammalian cell cycle?	Recognize	Remember
3	Which of the following is NOT a second messenger? a. Cyclic GMP b. Diacylglycerol c. Inositol triphosphate d. Phosphatidyl inositol.	Recognize	Remember
4	The transport of fructose into the enterocytes is mediated by: - a. sodium-dependent glucose transporter 1 (SGLT 1). b. glucose transporter 5 (GLUT5). c. SGLT 2. d. GLUT 4.	Recognize	Remember
5	Iron uptake by the cells from extracellular environment is mediated through (A) LDL receptor (B) Mannose receptor (C) Transferrin receptor (D) Mannose 6-phosphate receptor	Recognize	Remember
6	Which of the following are components of a phospholipid? a. cholesterol, glycerol, fatty acids b. fatty acids, phosphate group, glycerol c. glycerol, amino acids, phosphate group d. phosphate group, cholesterol, monosaccharides	Recall	Remember
7	Coupling of the reaction centers of oxidative phosphorylation is achieved by which one of the following? a. Making a complex of all four reaction centers. b. Locating all four complexes in the inner membrane. c. Ubiquinones and	Recall	Remember

	cytochrome C. d. Pumping of protons		
8	Which one of the following is a component in the signalling pathway stimulated by receptor tyrosine kinases? a. Adenylate cyclase b. Janus kinase c. Autophosphorylating receptor d. Ras activating protein	Identify	Remember
9	Mitotic cyclin-CDK activity peaks in M phase. This is because a. Mitotic cyclin is synthesised only in M phase. b. Threshold level of mitotic cyclin accumulates only in late G2. c. Cyclin subunit is activated by phosphorylation only in M phase. d. The kinase subunit is activated by dephosphorylation only in M phase	Identify	Remember
10	Which one of the following statements correctly applies to proteins which are translated on the rough endoplasmic reticulum? a. Cytoplasmic proteins which are targeted to the nucleus in response to hormone stimuli. b. Proteins targeted to lysosomes, plasma membrane and cell exterior. c. Proteins which are targeted to the nucleus through endoplasmic reticulum lumen as the lumen is in direct connection with the inter membrane space of the nucleus. d. All proteins which get targeted to peroxisomes	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21	Explain the function of a) Lysosomes b) Peroxisomes c) p16 d) Cyclin-CDK complex	Explain	Understand
22	Difference between Facilitated Diffusion, Passive Diffusion and carrier proteins	Differentiate Define	Understand
23	Write down the Functional Classification of Cell Junctions with examples	Cite Examples	Understand
24	Write down the enzymes involved in mitochondrial electron transport chain	Illustrate	Apply
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			
25	Write down differences between Apoptosis and Necrosis. Explain extrinsic and intrinsic pathway of apoptosis.	Describe	Analyse
26	Write down the role of cell cycle regulatory proteins for cell cycle progression	Explain Discuss	Understand
27	Write down the name and responses of signal proteins that act via Receptor Tyrosine Kinase	Assess	Skill

SEMESTER - VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF412	**Immunobiology**	**3**	**0**	**0**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Identify the cellular and molecular basis of immune responsiveness	Understand
CO2	Describe the roles of the immune system in both maintaining health and contributing to disease	Apply
CO3	Describe immunological response and how it is triggered and regulated	Analyze
CO4	Transfer knowledge of immunology into clinical decision-making through case studies presented in class	Create
CO5	Demonstrate practical skills in the use of tools, technologies & methods in immunology	Skill

b. Syllabus

Units	Content	Hrs.
I	**Introduction to Immunology:** Principles of Innate & Adaptive Immunity, Effector Mechanisms – The First-Lines of Defense, Complement System, Pattern Recognition, Induced Innate Responses to Infection	09
II	**Antigen Recognition:** Antigen – Types and properties, Antigen Recognition by B-Cell & T-Cell Receptors, Structure of Antibody Molecule, The Interaction of Antibody Molecule with Specific Antigen, Antigen Recognition by T Cells, Generation of Lymphocyte Antigen Receptors, Primary Ig Rearrangement, T-Cell Receptor Gene Rearrangement, Structural Variation in Ig Constant Regions, Secondary Diversification of Antibody Repertoire, Antigen Presentation to T Lymphocytes, Generation of T-Cell Receptor Ligands, the MHC & its Functions	09
III	**Development of Mature Lymphocyte Receptor Repertoires:** Signaling via Immune-System Receptors, General Principles of Signal Transduction & Propagation, Antigen Receptor Signaling & Lymphocyte Activation, Other Receptors & Signaling Pathways: Cytokine & Cytokine Receptors, Apoptosis Receptors, Development of B Lymphocytes & T Lymphocytes, Positive & Negative Selection, Survival & Maturation of Lymphocytes in Lymphoid Tissues	09
IV	**Adaptive Immune Responses:** T Cell-Mediated Immunity, Entry of Naïve T Cells & APCs Into Peripheral Lymphoid Organs, Priming of Naïve T Cells by DCs, General Properties of Effector T Cells & their Cytokines, T Cell-Mediated Cytotoxicity, Macrophage Activation by Th1 Cells, Th2 Cells, Th17 Cells & Tregs. Humoral Immune Response:	09

	B Cell Activation by Helper T Cells, Distribution & Functions of Ig Classes, Destruction of Antibody-Coated Pathogens via Fc Receptors, Dynamics of Adaptive Immunity, the Mucosal Immune System & Organization, Mucosal Responses to Infection & Regulation	
V	**Applied Immunology:**Failures of Host Defense Mechanisms: Evasion & Subversion of Immune Defenses, Immunodeficiency Diseases, Allergy & Other Hypersensitivity Disorders & Mechanisms, Autoimmunity & Transplantation: the Making & Breaking of Self-Tolerance, Autoimmune Diseases & Mechanisms, Genetic & Environmental Basis of Autoimmunity, Responses to Alloantigens, Transplant Rejection, Manipulation of Immune Responses, Treatment of Adverse Responses, Anti-Tumor Responses & Vaccination. Immunodiagnostics: Serological Reactions: Immunoprecipitation, Flocculation, Agglutination, ELISA, RIA, Complement Fixation, Western Blotting, Flow Cytometry, Cytokine Arrays	09
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Adopt holistic approach to understand the different structural and functional correlates of protection against infectious agents. ✓ Practice critical thinking and analytical skills in immunology. ✓ Prepare assignments on analytical mechanisms in immunology as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in case studies and submit a report of the concepts learnt on a timely manner. **References:** 15) Abbas AK, Lichtman AH & Pillai S. (2014) Cellular & Molecular Immunology. Elsevier, USA. 16) Delves PJ, Martin SJ, Burton DR & Roitt IM. (2016) Essential Immunology. Wiley-Blackwell, UK. 17) Janeway CA, Travers P, Walport M & Shlomchik MJ. (2016) Janeway Immunobiology. Garland Science. 18) Paul WE. (2012) Fundamental Immunology. Lippincott Williams & Wilkins, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts andexamples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

			conclusion.				

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple choice 10 x 1 = 10**		
1	**Which of the following classes of innate immune cells is NOT commonly found in healthy tissues?** a) Macrophages **b) *Neutrophils*** c) Dendritic cells d) Mast cells	Recognize	Remember
2	**Regarding sensing of pathogenic patterns in the host, which of the following statements is INCORRECT?**	Recognize	Remember

	A) Surface CD285 is known to recognize envelope proteins of viruses. B) CD282 forms heterodimers with both CD281 as well as CD286 to recognize lipids derived from gram positive and negative bacteria. C) CD289 is implicated with the recognition of viral DNA within the endosomal compartments of neutrophils. D) ***NOD1 is the TLR equivalent present in the cytoplasm of macrophages that can recognise γ-d-glutamyl-meso-diaminopimelic acid of Gram negative bacteria.***		
3	**Which of the following is a transcription factor essential for a Th cell to secrete IL-17A and IL-22?** A) GATA-3 B) T-bet C) EOMES **D) *Retinoic acid-related orphan receptor-γT***	Recognize	Remember
4	**Which of the following statements is INCORRECT in regards to IgG subclasses?** A) IgG3 has a long hinge region, which renders it vulnerable to cleavage by proteolysis attributing to it's poor half-life in the circulation. B) IgG3 is the predominant mucosal antibody in the lower respiratory tract, and deficient levels could lead to chronic lung disease. **C) *IgG2 is efficient in crossing the placenta and can be detected in the cord blood.*** D) IgG4 is anti-inflammatory and is implicated in 'Fab arm-exchange' resulting in asymmetric antibodies with two different antigen-combining sites.	Distinguish	Remember
5	**Which of the following statements is TRUE in human immune system?** **A) *The T cell α chain locus is in chromosome 14*.** B) The T cell β chain locus is situated in chromosome 2. C) The Ig heavy chain locus is present in chromosome 22. D) The Igκ light chain is located in chromosome 14.	Recognize	Remember
6	**Developing B cells possess which of the following recombination enzymes?** A) Artemis **B) *RAG1*** C) AID. D) Helicase	Differentiate	Remember
7	**The best method for sterilization of dusting powder is by**	Recognize	Remember

	a) autoclaving. ***b) using a hot air oven.*** c) inspissation. d) tyndallization.		
8	**All are anti-pseudomonal penicillins EXCEPT:** a) Piperacillin ***b) Cloxacillin*** c) Carbenicillin d) Ticarcillin	Identify	Remember
9	**Which of the following compounds are required for the growth of saprophytic fungi?** ***a) Organic compounds*** b) Nitrates c) Phosphates d) Mercury	Identify	Remember
10	**Which of the following yeast is used for the production of riboflavin?** a) *Saccharomyces cerevisiae* ***b) Eremothecium ashbyi*** c) *Saccharomyces rouxii* d) *Candida utilis*	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Discuss the factors affecting the colonization of indigenous microbiota in the mammalian gut.	Explain	Understand
22	What is meant by phage typing? Briefly state the significance of phage typing in epidemiology.	Illustrate	Understand
23	State the differences between coliforms and fecal streptococci? Outline an algorithm to report the detection of enteropathogens in public water distribution systems	Differentiate	Understand
24	Outline the basic steps employed in the industrial manufacture of red wine.	Illustrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words 3 x 10 = 30**		
25	Describe the structural forms used in the building of an icosahedron in viral particles and explain the organization (number of capsomers etc.) of the adenovirus particle.	Describe	Analyse
26	Classify the different methods of bacterial cultivation. Describe the different culture media available for the detection and identification of bacterial species.	Differentiate	Understand
27	Describe the mode of action of penicillin against the metabolism of cell wall structures of bacteria. Add a note on anti-staphylococcal penicillins and vancomycin.	Assess	Skill

SEMESTER - VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF413	**Immunobiology: Practicals**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Understand the importance of immune cells and humoral factors in defense responses against infectious agents	Understand
CO2	Apply the scientific methods for assessing the role of immune cells in host defense	Apply
CO3	Examine the frequency and functions of immune cells and humoral factors in host immunity	Analyze
CO4	Conceive and develop strategies to apply technology to determine the functions of immune correlates of protection	Create
CO5	Demonstrate practical skills in the use of tools, technologies & methods in immunology	Skill

b. Syllabus

Units	Content	Hrs.
I	Extraction of Human PBMCs by Ficoll-Hypaque Overlay Method.	03
II	Quantification of Immune Cells in PBMCs by Haemocytometer.	03
III	Immunostaining of T cells, Acquisition by Flow Cytometry & Data Analysis (FlowJo).	12
IV	Serology: WIDAL for Enteric Fever & VDRL for Syphilis.	06
V	Serology: Immunoelectrophoresis. Serology: ELISA & Immunoblotting	09

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**-**
CO2	**x**	**x**	**x**	**x**	**-**
CO3	**x**	**x**	**x**	**x**	**-**
CO4	**x**	**x**	**x**	**x**	**-**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total

Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Assignments					
Seminar					
Test					
Attendance					
Total					

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Part – A (Objective - 10 x 1 = 10marks)					
Part – B (Short Answer -5 x 4 = 20marks)					
Part – C (Essay-3 x 10 = 30 marks)					
Total					

g. Rubric for Assignments

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza-tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	**Criteria**	**100%**	**75%**	**50%**	**25%**	**0%**	**Relation to COs**

1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21			
22			
23			
24			

PART – C Essay Answer The answer should not exceed 400 words Marks: 3 x 10 = 30			
25			

SEMESTER - VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF416	**Endocrinology**	**3**	**0**	**0**	**3**

hh. Course Outcome(CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Introduction to Endocrinology	Understand
CO2	Structure of Thyroid Gland – Biosynthesis of Thyroid Hormones, Biological Functions of Thyroid Hormones,	Analyze
CO3	Adrenal Hormones synthesis and biological action	Analyze
CO4	Pancreatic & Gastric Hormonesand biological action	Analyze
CO5	Reproductive Hormones functions and regulations	Analyze

ii. Syllabus

Units	Content	Hrs.
I	**Introduction to Endocrinology :** Scope of Endocrinology, Endocrine Glands, Hormones & Hormone Action, Classification Based on Chemical Structure, Hormone Secretion & Functions of Hypothalamus & Pituitary Gland, Pineal Gland – CircadianRhythm	09
II	**Thyroid Hormones :** Structure of Thyroid Gland – Biosynthesis of Thyroid Hormones, Biological Functions of Thyroid Hormones, Regulation of Thyroid Secretion, Hormones of Parathyroid Glands & their Biological Action	09
III	**Adrenal Cortex** – Glucocorticoids, Mineralocorticoids & their Biological Function, Renin Angiotensin System;Adrenal Medulla – Catecholamines – Synthesis & Biological Action	09
IV	**Pancreatic & Gastric Hormones** Pancreatic (Islets of Langerhans) Hormones – Insulin, Glucagon – Biosynthesis, Regulation, Biological Action,Gastrointestinal Hormones	09
v	**Reproductive Hormones** Male Reproductive System; Structure of Testes, Biosynthesis of	09

	Testosterone, Regulation & Functions. FemaleReproduction System; Structure of Ovary, Biosynthesis of Estrogen, Feed Back Regulation & Functions FemaleReproductive Cycle – Estrous, Menstrual; Placental Hormones – Parturition – Lactation	
	Tasks and Assignments: Each student is required to adhere to the following: ☐To understand about hormones and its mechanism of action. ☐Practiceactivelistening,mechanism of action anddefects in endocrinology. ☐Prepare assignments on techniques in animal biotechnology asadvisedbythelecturerandshouldbeableto explain the concepts verbally duringdiscussions. ☐Participateinproblem-basedlearning(PBL)assignmentsand submitareportoftheconceptslearntonatimelymanner. **References:** 3) Hadley ME. (1992) Endocrinology. Prentice Hall, New Delhi, India. 4) Lohar PS. (2005) Endocrinology - Hormones & Human Health. MPJ Publishers, India. 5) Norman AW & Litwack G. (1987) Hormones. Academic Press. 6) Turner CD & Bagnarr JT. (1994) General Endocrinology. WB Saunder Company, USA. 7) Wilson JD & Foster DW. (1992) William's Textbook of Endocrinology. WB Saunders Company, USA.	

jj.Mapping of Program Outcomes with CourseOutcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

kk. EvaluationScheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40

External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

ll. MappingCourseOutcomewithInternalAssessment(40Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

mm. MappingCourseOutcomewithExternalAssessment(60Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

nn. Rubric forAssignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation toCOs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

oo. Rubric forSeminar

Sl. No	Criteria	100%	75%	50%	25%	0%	Relation to COs

.							
1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledgeof facts,terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

pp. Model QuestionPaper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiplechoice 10 x 1 =10**		
1	…… is the potent vasoconstrictive peptide that causes blood vessels to narrow and increased blood pressure. a) **Angiotention-I** b) Angiotention – II c) Angiotention converting Protein d) Angiotention-III	Differentiate	Remember
2	Biosynthesis of hydrocortisone and Corticosterone are produced at? a) **Zona fasciculata** b) Zona glomerulosa c) Zona reticularis d) Both a and b	Recognize	Remember
3	Which enzyme is involved in biosynthesis of Noradrenaline to Adrenaline? a) Thyrosine hydroxylase b) Dopamine β-hydroxylase c) Hydroxy phenyl alanine **d) Phenylethanolamine- N-methyltransferase**	Identify	Remember

4	Which one is given below act as secondary messengers? a) cAMP b) Calcium calmodulin b) c) Diacyl glycerol, Inositol tryphosphate **d) All**	Correlate	Remember
5	Before closure of epiphyses is cause of? a) **Gigantism**b) Acromegaly c) dwarfism d) b and c	Recognize	Remember
6	Increasing hungry by diabetes is called as? a) Polydipsia b) poly urea **c) Poly phagia** d) Polygonia	Correlate	Remember
7	Angiotensin II also stimulates the secretion from which one of the below given hormone? a) **Aldosterone** b) Adrinalin c) Menarallocorticoid d) Glucocortocoid	Identify	Remember
8	All the below regarding hormones are anterior pituitary hormones **except**? a) Prolactin b) Adreno cortico tropic hormone c) **Anti diuretic hormone** d) Thyroid stimulating hormone	Recognize	Remember
9	Grave's disease also called as? a) Exophthalmic goiter b)Autoimmune disease c) Thyrotoxicosis **d) All**	Identify	Remember

10	Amyotrophy is the example of……. a) Cardiac pain **b) Muscle pain** c) Abdominal pain d) Joint pain	Correlate	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Write the factors affecting of hGH?	Explain	Understand
22	Write about IDDM (insulin- dependent diabetes mellitus)	Explain	Understand
23	Functions of testosterone?	Describe	Understand
24	Write about chief cells and oxyphil cells contain gland?	Explain	Apply
	PART – C Essay Answer **Theanswershouldnotexceed400words 3 x 10 =30**		
25	What is master gland? Write in details about the master gland?	Describe	Analyse
26	Write about Catecholamines and its biological Action?	Assess	Skill
27	Write about Estrogen and Progesterone? Draw the neat diagram of female Reproductive system with labels?	Describe	Skill

SEMESTER – VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF414	**Molecular Biology**	**3**	**0**	**0**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	**Level**
CO 1	Understand the basic concepts of molecular biology	Understand
CO 2	Demonstrate an understanding of fundamental principles of molecular biology	Apply
CO 3	Able to analyze defects involved in molecular regulatory mechanisms	Analyze
CO 4	Formulate causes of molecular defects	Create
CO 5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	Content	Hrs.
I	**Introduction to Molecular Biology** Discovery of DNA- Evidence for DNA as the Genetic Material; Central Dogma of Molecular Biology; DNA Replication- Types of Replication, Evidence for Semiconservative Replication - Meselson & Stahl Experiment. Enzymes & Necessary Proteins Involved in DNA Replication	09
II	**DNA Replication** Replication in Prokaryotes- Replication Bubble, Bidirectional Replication, Replicon, DNA Polymerases, Lagging & Leading Strand Synthesis, Okazaki Fragments, Mechanism of Replication, Action of SSB, Primase, DNA Gyrase. The Fidelity of DNA Replication, Overview Mechanism of Eukaryotic Replication. Telomeres, Telomerase & End Replication. Inhibitors of Replication	09
III	**Transcription and RNA processing** Definitions of Coding Strand, Template Strand, Sense Strand & Antisense Strand, Promotor, Transcription in Prokaryotes- RNA Polymerases, Mechanism of Transcription- Initiation, Elongation & Termination (Rho- Dependent & Independent Termination), Housekeeping Genes. Transcription in Eukaryotes- Mechanism, Posttranscriptional Processing & its Significance- Capping, Tailing, Splicing, Processing of rRNA & tRNA. RNA Editing	09
IV	**Protein biosynthesis** Genetic Code, Wobble Mechanism & its Significance, Types of RNA Molecules, Structure of tRNA, Composition of Prokaryotic & Eukaryotic Ribosomes, Protein Biosynthesis in Prokaryotes & Eukaryotes- Activation of Amino Acids, Initiation, Chain Elongation, Translocation & Termination. Translational Machinery- Mechanism of Initiation- Elongation & Termination	09

V	**Post-translational modifications** Regulation of Protein Synthesis, Post-Translational Modifications in Prokaryotes & Eukaryotes, Inhibitors of Protein Synthesis. Protein Modifications, Folding & Export of Proteins; Gene Mutations & DNA Repair	09
	Tasks and Assignments: Each student is required to adhere to the following: ✓ Practice the basic concepts of molecular mechanisms ✓ Practice active listening, stimulate critical thinking and analysis skills in Molecular Biology. ✓ Prepare assignments on analytical mechanisms in Molecular Biology as advised by the lecturer and should be able to explain the concepts verbally during discussions. ✓ Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** 1. **Alberts B, et al.** (2002) *Molecular Biology of the Cell*. Garland Science, New York, USA. 2. **Freifelder D.** (2004) *Molecular Biology*. Narosa Publishing House, India. 3. **Graur D & Li W-H.** (1991) *Fundamentals of Molecular Evolution*. Sunderland Publishers. 4. **Karp G.** (2013) *Cell & Molecular Biology*. John Wiley & Sons Inc., UK. 5. **Krebs JE, Goldstein ES & Kilpatrick ST.** (2018) *Genes XII*. Oxford University Press, Cell Press, London..	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10 marks)	2	2	2	2	2
Part – B (Short Answer - 5 x 4 = 20 marks)	10	-	-	-	10
Part – C (Essay- 3 x 10 = 30 marks)	-	10	10	10	-
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence & facts and examples	Ideas are detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza -tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent communication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple choice 10 x 1 = 10**		
1	The origin of replication in prokaryotes contains 245 bp that includes two repeat sequences. The DnaA protein binds to one of the specific repeat sequences to initiate replication. Choose the correct DNA sequence to which the DnaA protein binds. (a) Three repeats of 13 bp sequence **(b) Four repeats of 9 bp sequence** (c) Four repeats of 7 bp sequence (d) Three repeats of 15 bp sequence	Recognize	Remember
2	As the helicase unwinds the DNA, it becomes overwound and generate positive supercoils. The torsional stress is relieved by a protein that breaks the DNA strands thus creates negative supercoiling. Chooses the correct protein. (a) Lyase (b) Isomerase (c) DnaC **(d) Gyrase**	Identify	Remember
3	In eukaryotic replication, helicase loading occurs at all replicators during; (a) G0 phase **(b) G1 phase** (c) G2 phase (d) S phase	Recognize	Remember

4	α-amanitin is a fungal toxin which inhibits eukaryotic RNA polymerases. This toxin inhibits the three eukaryotic RNA polymerases to very different extents. Which one of the following order (higher to lower) is correct in respect of sensitivity towards α- amanitin? **(a) RNA polymerase II > RNA polymerase III > RNA polymerase I** **(b)** RNA polymerase III > RNA polymerase II > RNA polymerase I **(c)** RNA polymerase I > RNA polymerase III > RNA polymerase II **(d)** RNA polymerase II > RNA polymerase I > RNA polymerase III	Recognize	Remember
5	The introns that can remove themselves from pre-RNAs in the absence of any proteins are called self-splicing introns. Self-splicing introns are of two types: Type I and Type II. Group I mechanism results in the release of an intron with; (a) an unusual lariat structure (b) an unusual lariat structure with an extra Guanosine attached to the 5' end **(c) a linear transcript with an extra Guanosine attached to the 5' end** (d) a linear transcript without any extra Guanosine attached to the 5' end	Recognize	Remember
6	Translocation process is spontaneous after peptide bond is formed; because, **(a) the deacetylated tRNA in the P site has a higher affinity for the E site and the peptidyl t-RNA in the A-site has a high affinity for the P-site** **(b)** the deacetylated tRNA in the A site has a higher affinity for the P site and the peptidyl t-RNA in the A-site has a high affinity for the P-site **(c)** the deacetylated tRNA in the P site has a higher affinity for the E site and the peptidyl t-RNA in the P-site has a high affinity for the A-site **(d)** the deacetylated tRNA in the A site has a higher affinity for the E site and the peptidyl t-RNA in the P-site has a high affinity for the E-site	Recognize	Remember
7	The prokaryotic DNA polymerase I has two fragments, of which one is called Klenow fragment. The Klenow fragment ranges between; (a) 252 and 323 amino acid residues (b) 1 and 251 amino acid residues **(c) 324 and 928 amino acid residues** (d) 1 and 323 amino acid residues	Recall	Remember

8	Replication starts from certain regions of chromosome with specific sequences, called Autonomously Replicating Sequence (ARS). ARS comprises of; (a) ARS consensus sequence (ACS) (b) Auxiliary protein binding site (c) Unwinding region **(d) All of the above**	Recall	Remember
9	RNA editing, a post-transcriptional process, is achieved with the help of guide RNA (gRNA). Which one of the following statements about the gRNA is NOT correct? (a) Part of the gRNA is complementary to the mRNA in vicinity of editing **(b) gRNA chemically modifies transfer RNA** (c) The process involves insertion of a single nucleotide (d) The process involves deletion of Uridines	Identify	Remember
10	The introns that can remove themselves from pre-RNAs in the absence of any proteins are called self-splicing introns. Self-splicing introns are of two types: Type I and Type II. Type I mechanism results in the release of an intron with; (a) an unusual lariat structure (b) an unusual lariat structure with an extra Guanosine attached to the 5' end **(c) a linear transcript with an extra Guanosine attached to the 5' end** (d) a linear transcript without any extra Guanosine attached to the 5' end	Identify	Remember
	PART – B Short Answer **The answer should not exceed 200 words 5 x 4 = 20**		
21	Explain the mechanism of action of ligase	Explain	Understand
22	Write the experimental evidence carried out to prove the statement that RNA is transcribed from only one of the two DNA strands	Differentiate Define	Understand
23	Write the modifications that occur after the protein synthesis	Cite Examples	Understand
24	Write in detail about the mechanisms of actions of different DNA polymerases	Illustrate	Apply
	PART – C Essay Answer **The answer should not exceed 400 words 3 x 10 = 30**		
25	Describe the process of replication in prokaryotes	Describe	Analyse
26	Explain about the synthesis of tRNA and its modifications	Explain Discuss	Understand
27	What are the major differences between prokaryotes and eukaryotes with respect to transcription	Assess	Skill

SEMESTER – VII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF415	**Molecular Biology Practical**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Understand the basic concepts of molecular biology	Understand
CO 2	Demonstrate an understanding of fundamental principles of molecular biology	Apply
CO 3	Able to analyze defects involved in molecular regulatory mechanisms	Analyze
CO 4	Formulate causes of molecular defects	Create
CO 5	Utilize the skillsets required to extrapolate the mechanisms for human applications with appropriate experimental tools	Skill

b. Syllabus

Units	Content	Hrs.
I	Isolation of Genomic DNA from Human Blood	03
II	Quantification of DNA Using Spectrophotometer	03
III	Primer Designing	03
IV	Polymerase Chain Reaction	03
V	Restriction Digestion	03
VI	Purification of DNA	03
VII	Polyacrylamide Gel Electrophoresis & Silver Staining of Protein	03
VIII	Isolation of Genomic DNA from Dicot & Monocot Plants	03
IX	Isolation of RNA from Leaves	03
X	Western Blot Analysis of Expressed Plant Proteins	03
	Tasks: Each student is required to adhere to the following: **1.** Practice the reactions **2.** Practice active listening, stimulate critical thinking and analysis skills in Molecular Biology. **3.** Understand the practical content and transform the same on to an observation note book and should be able to explain the procedure during discussions.	

	4. Participate in problem-based learning (PBL) assignments and submit a report of the concepts learnt on a timely manner. **References:** **1. Cox M, et al.** (2015). *Molecular Biology: Principles and Practice.* Freeman Macmillan **2. Alberts B, et al.** (2002) *Molecular Biology of the Cell*. Garland Science, New York, USA. **3. Freifelder D.** (2004) *Molecular Biology*. Narosa Publishing House, India. **4. Graur D & Li W-H.** (1991) *Fundamentals of Molecular Evolution*. Sunderland Publishers. **5. Karp G.** (2013) *Cell & Molecular Biology*. John Wiley & Sons Inc., UK. **6. Krebs JE, Goldstein ES & Kilpatrick ST.** (2018) *Genes XII*. Oxford University Press, Cell Press, London..	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	x	X	-	x	x	x
CO2	x	X	x	x	x	X
CO3	x	X	x	x	x	X
CO4	x	X	x	x	x	X
CO5	x	X	x	x	x	X

d. Evaluation Scheme: Continuous assessment

	CO1	**CO2**	**CO3**	**CO4**	**CO5**	**Total**
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Performance in practical	4	4	4	4	4
Submission of observation book	2	2	2	2	2
Outcome of the practical	5	5	5	5	5
Attendance	1	1	1	1	1
Total	12	12	12	12	12

f. Mapping Course Outcome with External Assessment (40 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Submission of record note book	1	1	1	1	1
Viva voce	7	7	7	7	7
Total	**8**	**8**	**8**	**8**	**8**

g. Rubric for Assignments: NA

h. Rubric for Seminar: NA

i. Model Question Paper: NA

SEMESTER - III					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF402	**Infectious Diseases: Practicals**	**0**	**0**	**2**	**2**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO1	Understand the importance of diagnostic procedures available to detect infectious agents	Understand
CO2	Apply the scientific methods for the prompt detection of infectious agents	Apply
CO3	Design experiments to develop newer tools and diagnostics	Analyze
CO4	Conceive and develop strategies to apply modern technology to diagnose infectious agents	Create
CO5	Demonstrate practical skills in the use of tools, technologies & methods in diagnostic microbiology	Skill

b. Syllabus

Units	Content	Hrs.
I	Blood Culture & Automation in ID Diagnosis: BACTEC System.	03
II	Investigation of Urine, Wound, Tissue & Genital Samples.	12
III	Examination of Respiratory & Gastrointestinal Samples.	12
IV	Basics in Diagnosis of Human Mycoses.	09
V	Laboratory Investigations of Viral Infections.	09

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**x**	**x**	**x**	**x**	**-**
CO2	**x**	**x**	**x**	**x**	**-**
CO3	**x**	**x**	**x**	**x**	**-**
CO4	**x**	**x**	**x**	**x**	**-**
CO5	**x**	**x**	**x**	**x**	**-**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	12	12	12	12	12	60
External	8	8	8	8	8	40
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments					
Seminar					
Test					
Attendance					
Total					

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)					
Part – B (Short Answer -5 x 4 = 20marks)					
Part – C (Essay-3 x 10 = 30 marks)					
Total					

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts and examples	Ideas are detailed, developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiza-tion 50%**	Includes title, introduction, statement of the main idea with illustration and conclusion.	Includes title, introduction, statement of main idea and conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs

1	**Knowledge and Understanding** **50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4
2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	**Model Questions**	**Specification**	**Level**
	Part – A: Objective Type **Multiple Choice Marks: 10 x 1 = 10**		
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	PART – B Short Answer **The answer should not exceed 200 words Marks:5 x 4 = 20**		
21			
22			
23			
24			
PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**			
25			

SEMESTER - VIII					
Course Code	**Course Name**	**L**	**T**	**P**	**Credits**
LIF403	**NEUROBIOLOGY**	**3**	**-**	**-**	**3**

a. Course Outcome (CO)

On the successful completion of the course, the student will be able to

(Course outcomes are specific for a particular course. CO should be specific, measurable, achievable, realistic and time-bound)

	Course Outcome	Level
CO 1	Divisions of Nervous System, Anatomy of Brain & Spinal Cord, Structure & Types of Neurons, Types of Glial Cells & their Functions	Understand
CO 2	Cerebral Circulation, Neurotransmitters, Cognitive Neuroscience, Diseases of the Nervous System	Apply
CO 3	Synthesis, Storage & Function of Acetylcholine, GABA, Glutamate, Serotonin, Dopamine, Norepinephrine, Epinephrine in Brain	Analyze
CO 4	Knowledge of diseases of nervous system through case studies presented in the lectures and create an innovative mind to bench to bed approach	Create
CO 5	Demonstrate practical skills in the use of diagnostic tools, state of art technologies & research methods in basic and applied neurobiology	Skill

(Number of CO's are not fixed)

b. Syllabus

Units	Content	Hrs.
I	**Introduction to the Nervous System:** Divisions of Nervous System, Anatomy of Brain & Spinal Cord, Structure & Types of Neurons, Types of Glial Cells & their Functions	09
II	**Cerebral Circulation:** Blood Brain Barrier Formation & Function, Cerebrospinal Fluid Secretion & Function, Blood Flow to Brain, Formation of Synapse, Synaptic Transmission, Electrical & Chemical Transmission, Membrane Potentials (Resting & Action Potentials)	09
III	**Neurotransmitters:** Synthesis, Storage & Function of Acetylcholine, GABA,Glutamate, Serotonin, Dopamine, Norepinephrine, Epinephrine in Brain	09
IV	**Cognitive Neuroscience:** Types of Memory, Limbic System, Structure of Hippocampus & Associated Structures, Mechanisms of Long Term Potentiation & Memory Formation	09
V	**Diseases of the Nervous System:** Neuronal Dysfunction & Mechanisms Underlying Alzheimer's Disease, Multiple Sclerosis, Parkinson Disease, Epilepsy, Amyotrophic Lateral Sclerosis	09
	Tasks and Assignments: -how neuroscience can explain the common problems afflicting people	

	today through case studies - functional human neuroanatomy and neuronal communication learned on this subject will help to perceive the outside world, move our bodies voluntarily, stay alive, and play well with others by doing brain games task -task on the preparation of chart and group discussion cognitive neuroscience **References:** 1. Guyton AC & Hall JE. (2010) Textbook of Medical Physiology. 2. Saunders, USA. Krebs C, Weinberg J & Akesson E. (2012) Neuroscience. 3. Lippincott Williams & Wilkins, USA. Robbins & Cortan. (2004) Pathologic Basis of Disease. 4. Saunders, USA. Sherwood L. (2016) Human Physiology - From Cells to Systems. Pearson India. Squire L, et al. (2012) Fundamental Neurosciences. Academic Press, USA.	

c. Mapping of Program Outcomes with Course Outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	**X**	**X**	**X**	**X**	**X**
CO2	**X**	**X**	**X**	**X**	**X**
CO3	**X**	**X**	**X**	**X**	**X**
CO4	**X**	**X**	**X**	**X**	**X**
CO5	**X**	**X**	**X**	**X**	**X**

(Tick Marks can be used)

d. Evaluation Scheme

	CO1	CO2	CO3	CO4	CO5	Total
Internal	8	8	8	8	8	40
External	12	12	12	12	12	60
Total	**20**	**20**	**20**	**20**	**20**	**100**

e. Mapping Course Outcome with Internal Assessment (40 Marks)

	CO1	CO2	CO3	CO4	CO5
Assignments	2	2	-	-	2
Seminar	-	-	2	2	-
Test	5	5	5	5	5
Attendance	1	1	1	1	1
Total	8	8	8	8	8

f. Mapping Course Outcome with External Assessment (60 Marks)

Category	CO1	CO2	CO3	CO4	CO5
Part – A (Objective - 10 x 1 = 10marks)	2	2	2	2	2
Part – B (Short Answer -5 x 4 = 20marks)	10	10	-	-	-
Part – C (Essay-3 x 10 = 30 marks)	-	-	10	10	10
Total	**12**	**12**	**12**	**12**	**12**

g. Rubric for Assignments

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Content 50%**	Ideas are detailed, well developed, supported with specific evidence &facts andexamples	Ideasare detailed, Developed and supported with evidence and facts mostly specific.	Ideas are presented but not particularly developed or supported;	Content is not sound	Not attended	CO1, CO2, CO5
2	**Organiz a -tion 50%**	Includes title, introduction,statement ofthe main idea withillustration and conclusion.	Includes title, introduction,statement ofmain ideaand conclusion.	organizational tools are weak or missing	No organization	Not attended	CO1, CO2, CO5

h. Rubric for Seminar

Sl. No.	Criteria	100%	75%	50%	25%	0%	Relation to COs
1	**Knowledge and Understanding 50%**	Exceptional knowledge of facts, terms and concepts	Detailed knowledge of facts, terms and concepts	Considerable knowledge of facts, terms and concepts	Minimal knowledge of facts, terms and concepts	Not Attended	CO3, CO4

2	**Presentation** **50%**	Well Communicated with logical sequences, examples and references	Communicated with sequences	Just Communicated	No coherent comunication	Not Attended	CO3, CO4

i. Model Question Paper

Sl. No.	Model Questions	Specification	Level
	Part – A: Objective Type **Multiple Choice** **Marks: 10 x 1 = 10**		
1	**When potasisum ions are expelled outside during neuronal firing the following event happens.** A. Negative Ions are Lost from Inside Neurons and Produces Negative Charge. B. Negative Ions are Lost from Inside Neurons and Produces Positive charge. **C. Positive Ions are Lost from Inside Neurons and Produces Negative Charge.** D. Positive Ions are Lost from Inside Neurons and Produces Positive Charge.	Recognize	Remember
2	**Under supplyof which of the following leads to Seizures and termers.** A. Acetylcholine B. Dopamine **C. GABA** D. Glutamate	Recognize	Remember
3	**γ-secretase processing of C99 releases the amyloid beta proteins, one is of the following form is toxic to the neurons and forms plagues in Alzheimers disease.** A. Amyloid-beta 40 (Aβ40) B. β-amyloid 1-X peptides C. β-amyloid X-15 peptides **D. Amyloid-beta 42 (Aβ42)**	Differentiate	Remember
4	**Which one of the following glial cells provide the scaffolds for developing neurons as they migrate to their end destinations?**	Differentiate	Remember

	A. Microglia B. Oligodendrocytes C. Ependymal cells **D. Radial glia**		
5	**The clinically important compound which reversibly inhibits AChE.** A. Scopolamine **B. Physostigmine** C. Atrophine D. Bromocyptin	Identify	Remember
6	Choline enters the central nervous system through a A. Receptor mediated transport process B. Diffusion C. Aqueous mediated **D. Carrier-mediated transport process**	Distinguish	Remember
7	**In the recurrent inhibition the following neuronal cell works with the pyramidal cell to stop firing.** A. Stellate Cell **B. Basket Cell** C. Chandlier Cell D. Unipolar Brush Cell	Identify	Remember
8	**Serotonin neurotransmitter neurons are located in which part of the Brain?** A. Locus Cerulus B. Caudate putamen C. Ventral Tegmentum **D. Raphe nuclei**	Identify	Remember
9	**Second order neurons pass signals from which of the order mentioned below?** A. Spinal cord to Medulla. B. Spinal cord to Pons**.** **C. Spinal cord to Thalamus.** D. Spinal cord to Hypothalamus.	Distinguish	Remember
10	**Which is the brain's "reward circuit.“?** **A. Basal Ganglia** B. Cerebelllum C. Temporal cortex D. Frontal cortex	Distinguish	

	PART – B Short Answer **The answer should not exceed 200 words arks:5 x 4 = 20**		
21	Write short notes on flow of CSF in human brain	Illustrate	Understand
22	What is meant by the neurovascular unit? What is the importance of such unit in brain?	Explain	Apply
23	Explain the transport routes across Blood Brain Barrier?	Differentiate	Understand
24	Draw the Mechanisms of Neuronal Action potential and explain the events.	Differentiate	Understand
	PART – C Essay Answer **The answer should not exceed 400 words Marks: 3 x 10 = 30**		
25	Elaborate on Limbic system with special emphasis on hippocampus and long term potentiation in detail.	Describe	Analyse
26	Discuss on Alzheimer's disease and its pathophysiological events in Brain.	Differentiate	Understand
27	Discuss on GABA and Glutamate as neurotransmitters and why Glutamate is needed for memory formation ?	Assess	Skill