SCHEME

for

BACHELOR OF SCIENCE PROGRAMME

in

LIFE SCIENCES

(w.e.f Session 2023-2024)

J. C. Bose University of Science & Technology, YMCA

Faridabad, Haryana

DEPARTMENT OF LIFE SCIENCES

FACULTY OF LIFE SCIENCES

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA

FARIDABAD

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY

VISION

J. C. Bose University of Science and Technology aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

DEPARTMENT OF LIFE SCIENCES

VISION

A department that can effectively harness its multidisciplinary strengths to create an academically stimulating atmosphere; evolving into a well-integrated system that synergizes the efforts of its competent faculty towards imparting intellectual confidence that aids comprehension and complements the spirit of inquiry.

MISSION

• To create well-rounded individuals ready to comprehend scientific and technical challenges offered in the area of specialization.

• To counsel the students so that the roadmap becomes clearer to them and they have the zest to turn the blueprint of their careers into a material reality.

• To encourage critical thinking and develop their research acumen by aiding the nascent spirit for scientific exploration.

• Help them take economic, social, legal and political considerations when visualizing the role of technology in improving quality of life.

• To infuse intellectual audacity that makes them take bold initiatives to venture into alternative methods and modes to achieve technological breakthroughs.

B.Sc. Life Sciences

The programme has been developed to generate student knowledge and skills in multidisciplinary areas of Botany, Zoology, Applied Life Sciences, Environmental Sciences. The programme has been restructured using the guidelines of the NEP 2020. The programme features multiple entry and exit policies along with specially designed courses aimed towards generating employability skills and technical expertise.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO 1: Grooming holistically trained students in fundamental, applied and recent concepts and technical skills in life sciences.

PEO 2: Generating awareness of the utilization of the knowhow in translation research, entrepreneurial efforts and employability.

PEO 3: Developing socially, ethically and environmentally conscious skilled workforce.

PEO 4: Able to communicate among themselves and others for dissemination and generation of knowledge in life sciences and allied areas.

Semester Wise Credits Distribution							
	Discipline	Minor	Multidiscipli	Ability	Skill Enhancement	Value	Total Credits

PROGRAMME OUTCOMES (POs)

PO1	**Knowledge**	**:**	Develop concept and deep understanding of various components of life sciences including biological diversity, morphology, anatomy, reproductive biology, physiology, metabolism, genetic engineering, ecological and environmental studies and applied sciences
PO2	**Problem analysis**	**:**	Student should be able to apply the concepts learned to identify lacuna/problem, develop hypothesis with review of literature to design experimental methodology to generate data for analysis.
PO3	**Resolution of problems**	**:**	Student should be able to analyse the data generated and record observations from different sources for interpretation to resolve problems or bridge the gap in existing processes.
PO4	**Research**	**:**	Develop an inquisitive mind to identify potential areas of exploration and be able to generate experimental methodology with appropriate analytical methods to arrive at verified theories.
PO5	**Modern tool usage**	**:**	Identify the principles and usage of different equipments used for data acquisition as well as generate an understanding of the software based methods for data analysis and representation.
PO6	**Impact on society**	**:**	Generate an understanding of impacting quality of human life, society and its development
PO7	**Ethics and Safety**	**:**	Apply bioethical principles and knowledge of biosafety in all experimental and entrepreneurial ventures
PO8	**Individual and team work**	**:**	Able to perform skilled tasks with ability to innovate and mentoring others in a work environment
PO9	**Environment and sustainability**	**:**	Develop a holistic understanding of the environmental and ecological concerns for generating green sustainable ventures and biodiversity conservation.
PO10	**Communication**	**:**	Generate ability for effective verbal and written communication with scientific and non scientific communities.
PO11	**Entrepreneurial endeavours**	**:**	Apply the theoretical and practical knowledge to generate employability
PO12	**Life-long learning**	**:**	Develop the zest for updation of knowledge along with acquisition of modern skills.

	specific courses (DSC)	**(MIC)/Vocational (VOC)**	**nary courses (MDC)**	**Enhancement Courses (AEC)**	**Courses (SEC)/Internship/Dissertation**	**Added Courses**	
I	12	2	3	2	3	2	24
II	12	2	3	2	3	2	24
Students exiting the programme after securing 44 credits will be awarded UG Certificate in Life Sciences provided they secure 4 credits in work based vocational courses offered during summer term or internship in Industry / Laboratory/University in addition to 4 credits from skill-based courses earned during first and second semester. ***Exit Criteria 48+4= 52 credits***							
III	12	4	3	2	3		24
IV	12	4	-	2	-`	2	20
Students exiting the programme after securing 86 credits will be awarded UG Diploma in Life Sciences provided they secure additional 4 credits in skill-based Summer Internship in Industry/ Laboratory/ University during first year or second year summer term. ***Exit Criteria 92+4= 96 Credits***							
V	12	4	-	-	Internship @ 4C	-	20
VI	12	8 (MIC+VOC)	-	-		-	20
Exit Criteria = 132 Credits							
VII	20	4	-	-			24
VIII (4Yr UG Hons.)	20	4	-	-			24
VIII(4Yr UG Hon with Research)	8	4			Research Project/Dissertation @ 12 credits		24
Total							**180**
**** students with 75% and above will be eligible for B.Sc Honours with Research.***							

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD
B.Sc (LIFE SCIENCES)

Scheme of Studies/Examination

Semester-I

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	DSC	NBLS-101	Plant Diversity-I	3	0	0	3	25	75	100
2	DSC	NBLS-102	Animal Diversity-I	3	0	0	3	25	75	100
3.	DSC	NBLS-103	Phycology and Mycology	3	0	0	3	25	75	100
4	DSC	NBLS-104	Life Sciences Laboratory Course-I	0	0	6	3	30	70	100
5	MIC	NBLS/ MIC-101	Conceptual organic Chemistry-I	2	0	0	2	25	75	100
6	MDC *	OMTHO-23-101	Basic Mathematics	3	0	0	3	25	75	100
		NBLS/ MDC-101	Computer Network & Internet Technology							
7	AEC*	AEC-101-N1	Writing skills and art of rhetoric	2	0	0	2	25	75	100
		AEC-105-N1	English-1							
8	SEC	NBLS-105	Enology and Brewery	0	0	6	3	30	70	100
9	VAC	VAC-101-N1	Environmental Studies I	2	0	0	2	25	75	100
Total				**18**	**0**	**12**	**24**			**900**

***option between two courses.**

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Scheme of Studies/Examination
Semester- II

S. No.	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	DSC	NBLS-201	Resource Utilization and Plant Diversity-II	3	0	0	3	25	75	100
2	DSC	NBLS-202	Animal Diversity-II	3	0	0	3	25	75	100
3.	DSC	NBLS-203	General Microbiology	3	0	0	3	25	75	100
4	DSC	NBLS-204	Life Sciences Laboratory Course-II	0	0	6	3	30	70	100
5	MIC	NBLS/MIC-201	Conceptual organic chemistry- II	2	0	0	2	25	75	100
6	MDC*	MDC-23-01	Entrepreneurship	3	0	0	3	25	75	100
		NBLS/MDC-201	Information Security							
7	AEC*	AEC-102-N1	Communication, meditation and resolution	2	0	0	2	25	75	100
		AEC-106-N1	English-2							
8	SEC	NBLS-205	Mushroom Production	0	0	6	3	30	70	100
9	VAC	VAC-102-N1	Environmental Studies-II	2	0	0	2	25	75	100
Total				**18**	**0**	**12**	**24**			**900**

***option between two courses.**

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Scheme of Studies/Examination
Semester- III

S. No	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	DSC	NBLS-301	Plant anatomy and morphology	3	0	0	3	25	75	100
2	DSC	NBLS-302	Comparative anatomy of chordates	3	0	0	3	25	75	100
3.	DSC	NBLS-303	Introduction to Biotechniques	3	0	0	3	25	75	100
4	DSC	NBLS-304	Life Sciences Laboratory Course-III	0	0	6	3	30	70	100
5	MIC	NBLS/MIC-301	Inorganic Chemistry-I	4	0	0	4	25	75	100
6	MDC*	BSE-AM-19-402	Advertising and new media	3	0	0	3	25	75	100
		NBLS/MDC-301	Fundamentals of Database System							
7	AEC	AEC-103-N3	Effective Corporate Communication	2	0	0	2	25	75	100
8	SEC	NBLS-305	Biosafety & Laboratory validation	0	0	6	3	30	70	100
Total				**18**		**12**	**24**			**800**

***option between two courses.**

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Scheme of Studies/Examination
Semester- IV

S. No	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	DSC	NBLS-401	Plant Physiology	3	0	0	3	25	75	100
2	DSC	NBLS-402	Human Physiology	3	0	0	3	25	75	100
3	DSC	NBLS-403	Immunology	3	0	0	3	25	75	100
4	DSC	NBLS-404	Life Sciences Laboratory Course-IV	0	0	6	3	30	70	100
5	MIC/VOC	NB NBLS/MIC -401	Physical Chemistry-I	4	0	0	4	25	75	100
6	AEC	AEC-107-N	Communicative Hindi	2	0	0	2	25	75	100
		AEC-104-N1	Sanskrit							
7	VAC	VAC-108-N1	Health Psychology	2	0	0	2	25	75	100
		VAC-104-N1	Indian Knowledge System							
Total				**18**		**6**	**20**			**700**

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Scheme of Studies/Examination
Semester- V

S. No	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	DSC	NBLS-501	Plant pathology	3	0	0	3	25	75	100
2	DSC	NBLS-502	Genetics	3	0	0	3	25	75	100
3	DSC	NBLS-503	Biochemistry and Metabolism	3	0	0	3	25	75	100
4.	DSC	NBLS-504	Evolutionary Biology	3	0	0	3	25	75	100
5.	DSC	NBLS-504	Life Sciences Laboratory Course-V	0	0	6	3	30	70	100
6.	MIC	NBLS/MIC-501	Physical Chemistry-II	4	0	0	4	25	75	100
7.	Internship	NBLS-505	Internship	0	0		4		100	100
Total				**13**		**6**	**23**			**700**

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Scheme of Studies/Examination
Semester- VI

S. No	Category	Course Code	Course Title	Hours per week			Credits	Marks for Sessional	Marks for End Term Examination	Total
				L	T	P				
1	DSC	NBLS-601	Ecology and Environmental Biology	3	0	0	3	25	75	100
2	DSC	NBLS-602	Cell Biology	3	0	0	3	25	75	100
3	DSC	NBLS-603	Molecular Biology	3	0	0	3	25	75	100
4	DSC (Elective)	NBLS-E601	Reproductive Biology of Plants	3	0	0	3	25	75	100
		NBLS-E601	Developmental biology of Animals							
5.	DSC	NBLS-605	Life Sciences Laboratory Course-VI	0	0	6	3	30	70	100
6.	MIC	NBLS/MIC-601	Inorganic Chemistry-II	4	0	0	4	25	75	100
7.	VOC	NBLS-606	Biostatistics	2	2		4	25	75	100
Total				**15**	**2**	**06**	**23**			**700**

VAC and AEC (*As per the course floated by the University)

Category	Course Name	Code
VAC	Environmental Studies – I (EVS-I) – 02 Credits	VAC-101-N1
	Environmental Studies – II (EVS-II) – 02 Credits	VAC-102-N1
	Yoga and Meditation – 02 Credits	VAC-103-N1
	Indian Knowledge System – 02 Credits	VAC-104-N1
	Universal Human Values – 02 Credits	VAC-105-N1
	Environment and Ecology	VAC-106-N1
	Natural Resources & Biodiversity Conservation	VAC-107-N1
	Health Psychology	VAC-108-N1
	Cultural Heritage & Nation Building	VAC-109-N1
AEC	Writing Skills and the Art of Rhetoric (WSAAR)-02 Credits	AEC-101-N1
	Communication, Meditation, and Resolution (CMR) – 02 Credits	AEC-102-N1
	Effective Corporate Communication (ECC)- 02 Credits	AEC-103-N3
	Sanskrit – 02 Credits	AEC-104-N1
	English-1	AEC-105-N1
	English-2	AEC-106-N1
	Communicative Hindi	AEC-107-N1

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS-101
SUBJECT NAME: PLANT DIVERSITY-I

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective: The course aims towards developing knowledge of the non flowering plants including their classification, life cycle and significance.

Unit-I

- Introduction to Archegoniate: Unifying features of archegoniate, Transition to land habit, Alternation of generations.
- Bryophytes: General characteristics, Adaptations to land habit, Range of thallus organization, Classification (upto classes)
- Morphology, anatomy, life cycle and reproduction (excluding developmental details) of Riccia, Marchantia, Anthoceros and Funaria.
- Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit-II

- Pteridophytes: General characteristics, classification (upto classes)
- Morphology, anatomy and reproduction (excluding developmental details) of *Selaginella*, *Equisetum* and *Pteris*.
- Heterospory and seed habit, stelar evolution.
- Ecological and economical importance of Pteridophytes.

Unit-III

- Gymnosperms: General characteristics, classification (up to family)
- Morphology, anatomy and reproduction (excluding developmental details) of *Cycas, Pinus* and *Gnetum*
- Ecological and economical importance.
- Introduction to Paleobotany and its significance, Major contributions in the field with special reference to Prof. Birbal Sahani.
- Plant fossils: types, process and significance. Geological time scale; Early land plants (*Cooksonia* and *Rhynia*).

References:

- Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
- Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

- Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

Course Outcome: After completion of the course, the student will be able to
CO1: Understand the key features and significance of different classes of bryophytes
CO2: Develop an understanding of the classification of pteridophytes and gymnosperms with an insight of paleobotany
CO3: Generate an understanding of the life cycle of key members of pteridophytes and gymnosperms with their ecological relevance.

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS-102
SUBJECT NAME: ANIMAL DIVERSITY-I

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives: The course aims towards generating an understanding of the classification invertebrates along with their key morphological characters.

Unit-I

- Concept of protista, parazoa and metazoan, General classification of non chordates
- Characteristics of porifiers, Canal system and spicules in sponges; Characteristics of cnidarians, Nematocysts, Nerve Net and Body Structure in Cnidarians, Life cycle of *Obelia* corals and coral reefs.
- Characteristics of Ctenophora and Platyhelminthes. Life cycle of *Fasciola hepatica* and *Pheretima* (Earthworm)

Unit-II

- Characteristics of Nemathelminthes. Life cycle of *Ascaris lumbricoides*, parasitic adaptations in helminthes
- Characteristics of Arthropods and brief classification. Life cycle of *Aedes*. Metamorphosis in insects and types of respiratory control. Social interactions in bees. Economic importance of Arthropods

Unit-III

- General characters and classification of Mollusca and Echinodermata up to classes; Life History of *Pila*, *Podium* in Mollusca, Torsion in Gastropoda, Shell in Mollusca, Pearl formation
- Larval forms in Echinodermata in brief, Ambulacral System
- General characteristics of Hemichordata, Urochordata, Cephalochordata (Brief life cycle of *Amphioxus*), Retrogressive metamorphosis in Urochordata

References

- Barnes, R.S.K, Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009) The Invertebrates: A New Synthesis. Blackwell Science
- Kotpal R.L, (2019) Modern Textbook of Zoology: Invertebrates. Rastogi Publication
- Kotpal R.L, (2015) Modern Textbook of Zoology: Vertebrates. Rastogi Publication
- Dhami J K. (1979) Invertebrate Zoology, S Chand Publication
- Pough, H. (2012) Vertebrate life. Pearson International
- Ruppert, E.E. and Barnes, R.D. (2006) Invertebrate Zoology. Holt Saunders International edition.

Course Outcome: After completion of the course, the student will be able to

CO1: Identify the key features of different invertebrate groups
CO2: Understand the morphology and life cycle of key specimens of different invertebrate phyla.
CO3: Generate concept of the progressive development and complexity of the non-chordates

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS-103
SUBJECT NAME: PHYCOLOGY AND MYCOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective: The course aims towards developing understanding the diversity of unicellular/multicellular eukaryotes and their variations in habit, habitat, lifecycle and economic significance.

Unit-I

- Algae: History, general characteristics, ecology and distribution, range of thallus organization and reproduction
- Classification of algae, comparative account of algal pigments, food reserves, flagellation, chloroplast in different groups.
- Salient features of algal groups. Study of morphology, reproduction and life cycles of representative genera: *Nostoc, Chlamydomonas, Oedogoium, Vaucheriia, Fucus* and *Polysiphonia*

Unit- II

- Fungi: Introduction, General characters, nutrition and reproduction.
- Classification for Fungi. Characteristics of true fungi

- Salient features of Mastigomycotina, Zygomycotina, Ascomycotina, Basidomycotina and Deuteromycotina.
- Study of morphology, reproduction and life cycle of *Rhizopus, Penicillium, Agaricus and Puccinia*

Unit- III

- Economic importance of algae and fungi
- Mycorrhiza, types and significance, parasitic and endophytic fungal interactions
- Lichens- general account, types, structure, reproduction and significance

References:

- Fritsch, F.E. 1945. Structure reproduction of the Algae Vol. l & II, Cambridge University Press, London.
- Vashishta, B.R. 1990 Botany for degree students, Algae. S. Chand & Co. Ltd., Ram Nagar, New Delhi.
- Venkateshwaran, V.A. Text book of Algae. Marahi Book depot, Guntur.
- Alexopoulos, C.J., C.W. Mims and M. Blackwell. 2007. Introductory Mycology. IV Edition. Wiley India (P) Ltd., Daryaganj, New Delhi..
- Robet Edward Lee.1980 Phycology, Cambridge Unversity Press, London.
- Vashista. B.R. 1981 Botany for Degree students Fungi. S. Chand & Co. Ltd., Ram Nagar, New Delhi.

Course Outcome: After completion of the course, the student shall be able to

CO1: Generate an understanding of the diversity of algae, fungi and lichens
CO2: Develop concepts of life cycle and morphogenesis using key examples
CO2: Apply the knowledge in developing applications of algae and fungi

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS-104
SUBJECT NAME: LIFE SCIENCES LABORATORY COURSE-I

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

Course Objective: To develop hand-on skill in preparation of temporary mounts of different biological specimens and identifying them on basis of permanent slide and specimen studies.

1. Study of various non flowering plants using temporary mounts, permanent slides and specimens
   Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
   Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
   Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s rhizome (permanent slide).
   Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
   Pinus- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), L.S. female cone, t.l.s. & r.l.s. stem (permanent slide).

2. Study of the following specimens: *Sycon, Hyalonema, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Limulus, Periplaneta, Apis, Chiton, Dentalium, Pila, Octopus, Pentaceros, Echinus, Cucumaria , Balanoglossus, Herdmania, Branchiostoma,*
3. Study of the following permanent slides- T.S. and L.S. of *Sycon*,
4. T.S. of Male and female *Ascaris*
5. Preparation of temporary mounts of fungal specimens using lactophenol cotton blue staining.
6. Isolation of fungi using warcup method.
7. Isolation of algae from water/soil.
8. Preparation of temporary mounts of algal specimens.
9. Study of plant repositories of India

Course Outcome: After completion of the course, the student shall be able to
CO1: Identify biological diversity on the basis of specimens and permanent slides
CO2: Prepare temporary mounts of different specimens for morphological studies
CO3: Differentiate between different non flowering taxa, algae and fungi

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS-105
SUBJECT NAME: ENOLOGY AND BREWING

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

Course Outcome: The course aims towards developing hands on training in the field of alcoholic fermentation giving skills for future employability.

1. Determination of residue on evaporation of whisky/fermented fruit juice sample.
2. Alcohol production from corn/sorghum/sweet potato/molasses

3. To determine the volatile acidity and alcohol content of fermented grape/apple/barley/wheat sample.
4. Determination of Methyl Alcohol (as CH_3OH) content in given sample
5. Determination of alcohol content of spirit by densitometer OR hydrometer
6. Determination of starch content in grain flour sample.
7. Determination of gluten content in grain flour sample
8. Detection of microbial contamination in non-alcoholic fruit beer
9. Determination of reducing sugar of given sample by Lane and Eynon method
10. Isolation of lactic acid bacteria, acetic acid bacteria and yeast from wine/fermented fruit juice.
11. Estimation of acidity in molasses/fruit juice fermented broth
12. Estimation of residual sugar in molasses/fruit juice fermented broth
13. Estimation of alcohol content of in molasses/fruit juice fermented broth
14. Determination of sludge content of molasses
15. Determination of yeast & molds of molasses
16. Demonstration of inoculum set up
17. Study of effluent treatment of distillery plant.

**performing ateast 10 experiments from the above mentioned list are mandatory.*

Course Outcome: After completion of this course, the student will be able to

CO1: Develop an understanding of the parameters used in quality analysis of alcoholic beverages
CO2: Understand the method of developing fermentation process for alcohol production
CO3: Acquire skills in maintaining inoculum

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS-201
SUBJECT NAME: RESOURCE UTILIZATION AND PLANT DIVERSITY-II

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objective: The course aims towards exploring the diversity of angiosperms while developing the concepts of plant taxonomy and realising the scope of utilization of different plants.

Unit-I

- Introduction to plant taxonomy and components. Concept of taxa, categories, taxonomic hierarchy. Brief overview of species concept.

- Types of classification: artificial, natural and phylogenetic.
- ICN: origin, principles and rules. Binomial nomenclature, typification, author citation, principle of priority
- Role of botanical gardens, floras, herbarium in taxonomy.

Unit-II

- Use and significance of numerical taxonomy and chemotaxonomy.
- Comparative study of the following systems with merits and demerits: Bentham and Hooker, Hutchinson, and APG IV.
- Study of the vegetative and reproductive features of the following families:
  Ranunculaceae, Paparavaceae, Cucurbitaceae, Solanaceae, Apocynanceae, Rutaceae, Poaceae, Areacaeae, Orchidaceae, Brassicaceae, Fabaceae, Malvaceae, Euphorbiaeceae, Asteraceae, Lamiaceae.

Unit- III

- Introduction to ethnobotany. Concept of Vavilovian centres of origin
- Study of the following economically important groups of plants

a) Cereals and Millets: wheat, rice and bajra
b) Legumes: Chickpea and soybean
c) Oils: Mustard and groundnut
d) Cash crops (production, harvesting and processing): sugarcane and cotton
e) Medicinal Plants: Rauwolfia, Digitalis, Cannabis
f) Spices: types of spices, Black pepper, turmeric and cardamom

References:

- A Hand Book of Systematic Botany: S.C. Dutta, Asia.
- A Text Book of Economic Botany: V. Verma, Emkay publications, New Delhi.
- An Introduction to the Taxonomy of Angiosperms: Y.D. Tiagi & S. Khetrapal, Ramesh Book Depot, Jaipur.
- Economic Botany of the Tropics – S.L. Kochhar
- Economic Botany: Bendre & Kumar, Rastogi Publications, Meerut.
- Economic Botany: S. Kumar, Campus Books, New Delhi.
- Economic Botany: Sambamurthy.
- Fundamentals of Plant systematics - Albert E. Radford.
- Taxonomy of Angiospesms by O.P. Sharma.

Course Outcome: After completion of the course, the student shall be able to
CO1: Develop an understanding of the concepts of plant identification, nomenclature and classification
CO2: Identify different families on the basis of their vegetative and reproductive characters

CO3: Generate an understanding of the scope of utilization of different plants

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS-202
SUBJECT NAME: ANIMAL DIVERSITY-II

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objective: To generate an understanding of the diversity of vertebrates

Unit-I

- General introduction to Chordates and outline classification
- Brief introduction to Agnatha and classification of cyclostomes upto class
- General characteristics of Pisces (Chondrichthyes and Osteichthyes), classification up to
- Order; Migration, Osmoregulation and Parental care in fishes

Unit-II

- General features of Amphibia, classification up to Order ; Origin of Tetrapoda (Evolution of terrestrial ectotherms); Parental care in Amphibians
- General characteristics of Reptilia and classification up to order; Affinities of Sphenodon; Poison apparatus and Biting mechanism in snakes

Unit-III

- General characteristics and classification up to order, *Archaeopteryx*-- a connecting link, Flight adaptations and migration in birds
- General characters and classification up to order; Affinities of Prototheria, Structural and Functional Adaptations of Mammals, Dentition in Mammals
- Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

References:

- Pough, H. (2012) Vertebrate life. Pearson International
- Young, J. Z. (2004) The Life of Vertebrates. Oxford university press.
- Kotpal, R. L. (2019). Modern Text Book of Zoology: Vertebrates. Rastogi Publications, 4th Edition
- David Hickman, Jr., Cleveland; Roberts, Larry; Keen, Susan; Larson, Allan; Eisenhour (2021). Animal Diversity. McGraw Hill Education, 9th Edition.
- Pough, F. H., Janis, C. M., & Heiser, J. B. (2013). Vertebrate life. Pearson Higher Ed. 9th Edition.

- Hildebrand, M., Goslow, G. E., & Hildebrand, V. (1998). Analysis of vertebrate structure, Wiley, 3rd Edition
- Kardong, K. V. (2019). Vertebrates: comparative anatomy, function, evolution. McGraw-Hill Education. 8th Edition

Course Outcome: After completion of the course, the student shall be able to

CO1: Identify different phyla of chordates on the basis of the key diagnostic features

CO2: Develop an understanding of the various functional adaptations of different chordate taxa

CO3: Generate concepts on the influence of plate movement on speciation and development of distinct zoogeographical realms

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS-203
SUBJECT NAME: GENERAL MICROBIOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objective: The course aims towards generating conceptual understanding of prokaryotic diversity and physiology along with introducing the concept of acellular entities

Unit I

- History of microbiology, contributions of Pasteur, Koch, Jenner, Winogradsky, Beijerinck, Fleming.
- Introduction to prokaryotic diversity: brief overview of eubacteria and archaebacteria (upto key phyla).
- Bacterial ultrastructure: shape, size, arrangement, cell membrane, cell wall, nucleoid, plasmid, cytoplasm, ribosomes, flagellum, glycocalyx, endospore, special features in archaeal ultrastructure

Unit II

- Bacterial locomotion, nutrition, types of media, pure culture techniques, maintenance of pure cultures
- Bacterial reproduction, bacterial growth curve, brief idea about batch, fed batch and continuous cultivation
- Sterilization and disinfection techniques

Unit III

- Concept of acellular agents: virus, viroid, satellites and prions, enumeration and cultivation of virus
- Structure of virus, classification according to Baltimore, General strategies of viral life cycle, significance of vectors in viral infection

- Concept of lytic and lysogenic life cycles using examples of T4 and lambda bacteriophage

References

- Jacquelyn G. Black. Microbiology-Principles and explorations 8 th edition: Publisher John Wiley & Sons 2012.
- J.M. Willey, L.M. Sherwod and C.J. Wolverton. Prescott, Harley and Klein's Microbiology, McGraw Hill International Edition, 11th Edition.
- Brock, Biology of Microorganisms, Pearson International Edition. 15th edition
- M.J. Pelczar Jr., E.C.S.Chan, N.K. Krieg. Microbiology/ Tata McGraw Hill. 5th edition
- R.Y. Stannier, J.L.Ingraham, M.L.Wheelis and P.R. Painter. Genereal Microbiology. Fifth Edition.Macmillan Press Ltd.
- Atlas RM. Principles of Microbiology. 2ndedition. 1997

Course Outcome: After completion of the course the student shall be able to

CO1: Explain the development of microbiology along with the milestones
CO2: Understand the ultrastructure of prokaryotic cell and its basic physiology
CO3: Generate concepts of basic virology

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS-204
SUBJECT NAME: LIFESCIENCES LABORATORY COURSE-II

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

Course Objective: The course aims at generating hands on training towards identification of different flowering plants and chordates along with isolation of prokaryotes and their study using temporary slides.

1. Study of different plants yielding economically important products.
2. Study of vegetative and floral characters of locally available flowers of different families (atleast 6)
3. Preparation of herbarium
4. Study of specimens of Pisces, Amphibia, Reptilia, Aves and Mammalia (*Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis,* Any six common birds from different orders*, Sorex,* Bat*, Funambulus, Loris*
5. Preparation of nutrient medium
6. Isolation of bacteria from soil/water

7. Study of streak techniques\
8. Study of bacterial morphology using simple staining and Gram staining techniques
9. Study of bacterial growth curve using turbidometric method.
10. Demonstration of plaque formation.
11. Study about animal and microbial repositories of India

Course Outcome: After completion of the course, the student will be to

CO1: Identify the families of different plants
CO2: Distinguish between different chordates taxa using specimen study
CO3: Acquire skills for isolation and study of bacteria

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS-205
SUBJECT NAME: MUSHROOM PRODUCTION

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

Course Objective: The course aims towards imparting skills to students in production of mushrooms and maintenance of the inoculum

1. Orientation to a mushroom farm
2. Identification of different types of mushroom
3. Storage /Transportation of spawn
4. Different parts of a typical mushroom & variations in mushroom morphology.
5. Preparation of culture media: Potato Dextrose medium, Richards medium.
6. Preparation of spawn: Grain spawn, Straw spawn, Sawdust spawn.
7. Preparation of mother spawn
8. Production of planting spawn
9. Preparation of compost and known compost formulations.
10. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves.
11. Cultivation of White button mushroom.
12. Cultivation of Paddy straw mushroom.
13. Cultivation of Oyster mushroom.
14. Cultivation of Milky mushroom.
15. Diseases of Mushrooms
16. Quality testing of compost, Casing and casing material

Course Outcome: After the completion of the course the student will be able to

CO1: Generate the substrate for mushroom cultivation

CO2: Maintain the microbial inoculant and process it

CO3: Grow different varieties of mushroom and harvest them

B.Sc LIFE SCIENCES SEMESTER III
CODE: NBLS-301
SUBJECT NAME: PLANT ANATOMY AND EMBRYOLOGY

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

UNIT I

Plant Cells, Tissues and Tissue systems: Introduction and scope of Plant Anatomy; General structure of plant cells - nature of cell wall. Tissue and tissue systems - Meristematic and permanent tissues. Plant secretary cells/tissues. Concept of tissue systems - Ground, Dermal and Vascular tissues.
Classification of meristems: Based on location (apical, intercalary and lateral), Origin (primary and secondary meristem) and function (protoderm, procambium and ground). Apical meristems: Generalised structure of shoot and root apex, theories on organization of Shoot and Root Apical Meristem.
Applications of anatomy in Plant systematics, forensics and Pharmacognosy.

UNIT II

Primary and Secondary anatomy of Angiosperms: Primary structure of root and stem - Dicot (Tridax/Sunflower), monocot (Maize), Nodal anatomy; Anatomy of leaf - Dicot (Tridax/Sunflower), Monocot (Maize). Normal Secondary growth in stem and root (Tridax/Sunflower). Anomalous secondary growth in *Aristolochia* and *Boerhaavia* (dicot stem), *Dracaena* (monocot stem). Wood - Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses, Periderm, rhytidome and lenticels.
Adaptive, Protective and secretory Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes, stomata (classification); Anatomical adaptations of xerophytes and hydrophytes; hydathodes, cavities, lithocysts and laticifers.

UNIT-III

Differentiation and Morphogenesis in Plants: Introduction to the concepts of differentiation and morphogenesis. Concept of totipotency and de-differentiation.
Differentiation and cell polarity in Unicellular (*Acetabularia*) and multicellular systems (*Arabidiopsis*).
Shoot Apical meristem: Origin, structure and function. Cytohistological zonation and Ultrastructure of meristems.
Organogenesis: Differentiation of root, stem, leaf and axillary buds; bud dormancy.
Leaf development: Mechanism of leaf primordium initiation, development and Phyllotaxis, Diversity in size, shape and arrangement of leaves

Root apical meristem: Origin, structure and function. Root cap, quiescent centre and origin of lateral roots. Flower development: Flower initiation and development, Genetic control of flower development - ABC model of flower development. Senescence in plants – a general account.

Suggested readings:

1. Bhojwani Sant Saran, 2014. Current Trends in the Embryology of Angiosperms**,** Woong-Young Soh, Springer Netherlands.
2. Bhojwani, S.S., Bhatnagar, S.P. and P. K. Dantu, P.K. (2015). The Embryology of Angiosperms. Vikas Publishing House Pvt Ltd, New Delhi.
3. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
4. Johri, B.M (2015). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Pandey, B.P. (2012). Plant Anatomy. S. Chand & Company Ltd., New Delhi
6. Singh, V., Pande, P.C. and Jain, D.K. (2012-13). Structure, Development and Reproduction in Angiosperms. Rastogi Publications, Meerut.
7. Esau, K (2006). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi Esau, K. Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
8. Raghavan, V (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER III
CODE: NBLS-302
SUBJECT NAME: COMPARATIVE ANATOMY OF CHORDATES

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

Unit I

General features and classification of epithelial and connective tissues; Structure, functions and derivatives of integument (Scale, claw, nail, hair, feather and dentition).
Skeletal system: Form, function, body size and skeletal elements of the body, Comparative account of jaw suspensorium. Development of skull.

Unit II

Digestive system: Dentition, Stomach, Digestive Glands, Anatomy of gut in relation to feeding habits- herbivores, carnivores and omnivores, Comparative physiology of digestion and absorption;

Respiratory system: Characters of respiratory tissue, Internal and External Respiration, Comparative physiology of respiratory systems with special emphasis on respiratory organs

Unit III

General plan of circulation in various groups: General plan of circulation in reptiles, birds and mammals, Evolution of heart, aortic arches and Portal systems.

Evolution of Urinogenital system in vertebrates: Structure and functions of different types of kidneys, Urino-genital ducts, Flight adaptation in birds,

Nervous system: Comparative anatomy of the brain in relation to its functions,

Suggested readings

- Schatten, H. and Constantinescu, G.M. eds., 2017. *Animal models and human reproduction*. John Wiley & Sons.
- Plant, T.M. and Zeleznik, A.J. eds., 2014. *Knobil and Neill's physiology of reproduction*. Academic Press.
- Schatten, H. ed., 2017. *Human Reproduction: Updates and New Horizons*. John Wiley & Sons.
- Martini, F.H., Nath, J.L., Bartholomew, E.F. and Ober, W., 2015. Fundamentals of anatomy and physiology. *Pentice Hall: New Jersey*
- Tortora, G.J. and Derrickson, B.H., 2018. *Principles of anatomy and physiology*. John Wiley & Sons.

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS-303
SUBJECT NAME: INTRODUCTION TO BIOTECHNIQUES

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

Unit I

Microscopy: Basics of microscopy-Magnification, Numerical aperture, Limit of Resolution; Light Microscopy; Bright field microscopy; Principle and applications of Electron Microscopy (SEM, TEM and AFM); Confocal microscopy; Cryo-electron microscopy.

Principle and applications of flow-cytometry; Light, Flurochromes; Fluorescence and Stokes shift; Absorbance, emission and spectra viewers.

Unit II

Centrifugation: Principle of centrifugation; Relative centrifugal force; types of rotors; Types of centrifuge- Benchtop Continuous flow, Gas centrifuge, Hematocrit; Micro-centrifugation; Ultracentrifugation, Analytical centrifugation.

Spectrophotometric techniques: beer lamberts law; photometry, UV/VIS spectrophotometry, infrared spectroscopy; Raman spectroscopy.

Unit III

Chromatography: Principles and applications of High-performance liquid chromatography and Gas chromatography–mass spectrometry; Ion exchange chromatography, Gel filtration chromatography, Hydrophobic interaction chromatography.

Electrophoresis and their types: Native, SDS PAGE; 2 Dimensional gel electrophoresis.

References

1. Wilson and Walker's Principles and Techniques of Biochemistry and MolecularBiology, Andreas Hofmann and Samuel Clokie (8th Edition).
2. Molecular Biology and Biotechniques: the fundamental approach- Aga Syed Sameer (2nd Edition).
3. Biotechniques- Theory and Practice, S.V.S Rana, Rastogi Publication (1st Edition).

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS-304
SUBJECT NAME: LIFESCIENCES LABORATORY COURSE-III

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

Course Objectives:

1. Study of meristems (Permanent slides/ Photographs).
2. Study of Simple Tissues (Parenchyma, Collenchyma and Sclerenchyma) and Complex Tissues (xylem and phloem).
3. Maceration technique to study elements of xylem and phloem,

4. Study of primary structure of dicot root, stem and leaf (Sunflower) and monocot root, stem and leaf (Maize) with temporary sections and permanent slides
5. Study of Normal secondary growth structure in dicot stem and root (Sunflower) and Anomalous secondary growth: *Aristolochia, Boerhaavia* (dicot stem) *Dracaena* (monocot stem)
6. Study of trichomes (any three types) and stomata (any three types) with the help of locally available plant materials.
7. To prepare a longitudinal section of shoot apical meristem from given plant material
8. To prepare a temporary mount of a leaf peel to examine different types of stomata.
9. To study adaptive anatomy: preparation of temporary slides of Nerium leaf (Xerophyte) and Hydrilla stem (Hydrophyte).
10. Study of secretory tissues: cavities, lithocysts and laticifers
11. Examination of histological sections from permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems
12. Study of permanent slides of squamous epithelium, striated muscle fibres and nerve cells.
13. Introduction to handling and maintenance of centrifuge, autoclave, spectrophotometers, microscopes
14. Study of different types of skulls, pectoral and pelvic girdles.
15. To prepare slides of fish scales and identify
16. To study Beer-Lambert's Law by preparing standard curve of BSA.
17. Demonstration of SDS/ agarose gel electrophoresis.
18. Separation of amino acids/ sugars/ bases by thin layer chromatography/paper chromatography

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER III
CODE: NBLS-305
SUBJECT NAME: BIOSAFETY AND LABORATORY VALIDATION

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

1. To demonstrate the segregation of the laboratory waste one the basis of containment level.
2. To demonstrate the use of personnel protective equipment's (PPE)s
3. To demonstrate the use of biosafety cabinets and fume hoods
4. To perform the laboratory discard autoclave cycles
5. To prepare the solutions of the disinfectants and sterilizing agents
6. To perform the efficacy analysis of sterilizing agents & disinfectants

7. To perform the fumigation in laboratory using chemical agents
8. To perform the cleaning and disinfection of laboratory glassware
9. To perform phenol coefficient test to determine the efficacy of the substances
10. To perform the environmental monitoring using solid agar surface
11. To perform the air quality monitoring using air samplers
12. To perform the validation of the autoclave using chemical and biological indicator
13. To perform the validation of the hot air oven using biological indicator
14. To perform the preparation of the standard operating procedures (SOPs) for a given experiment

B.Sc LIFE SCIENCES SEMESTER IV
CODE: NBLS-401
SUBJECT NAME: PLANT PHYSIOLOGY

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

Unit 1

Plant water relationship: Water Potential and its components, water absorption by roots, pathway of water movement, root pressure, guttation. Ascent of sap – cohesion-tension theory. Transpiration and factors affecting transpiration, mechanism of stomatal movement.

Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, mineral deficiency symptoms, roles of essential elements, chelating agents (phytosiderophores).

Unit 2

Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption; simple (fick's law) and facilitated diffusion, active absorption, role of ATP, proton ATPase pump and ion flux, uniport, co-transport (symport, antiport), role of mycorhhizae.

Translocation in the phloem : Experimental evidence of phloem as the site of sugar translocation. Phloem sap composition, Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 3:

Plant growth regulators: Discovery, chemical nature, biosynthesis, signaling pathway and roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids, and Jasmonic acid. Stress plant physiology: Introduction, Plant responses to abiotic and biotic stresses, hormones in defense against abiotic and biotic stresses.

Physiology of flowering: Photoperiodism, florigen concept, CO-FT Model of flowering stimulus, ABCDE model of flowering, vernalization, seed dormancy.

Sensory photobiology: Photomorphogenesis, Discovery, structure, mechanism of action of photoreceptors - phytochrome, cryptochromes and phototropins in plant growth and development.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U. S.A. 4th edition.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development.
3. Kochhar, S.L., Gujral, S.K. (2017). Plant Physiology: Theory and Applications. New Delhi, Delhi: Foundation Books, Cambridge University Press India Pvt, Ltd.
4. Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer Nature, Singapore Pvt. Ltd. Sinauer Associates Inc. USA. 6th edition.
5. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER IV
CODE: NBLS-402
SUBJECT NAME: ANIMAL PHYSIOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

Unit I

Blood and Cardiovascular system - Composition of blood, structure and functions of its constituents, Blood coagulation and anticoagulants, Hemostasis, Hemoglobin and its polymorphism, Concept of arteries, veins and capillaries, Blood Groups, Structure of Heart, Cardiac cycle.

Digestion - Physiology of digestion in the alimentary canal, Absorption of carbohydrates, proteins, lipids.

Unit II

Respiration- inhalation and exhalation, internal intercostal muscles, external intercostal muscles, roles of accessory muscles in forceful inspiration and expiration, respiratory volumes and capacities, transport of oxygen and carbon dioxide in blood.

Reproduction and Endocrine System - Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction, hormonal control of menstrual cycle, Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal glands.

Unit III

Excretion- Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism, Glomerular Filtration rate, Renin-angiotensin aldosterone system, Muscle physiology- Sarcomere structure, Molecular basis of Muscle contraction, Rigor mortis.

Nervous system- Introduction to nervous system, Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and unmyelinated nerve fibers, Different types of Nerve fibers, Synapse and neurotransmitters, Sensory physiology- Structure of eye and mechanism of vision.

Suggested Readings

● Sembulingam K (2019). Essentials of Medical Physiology, Jaypee Brothers Medical Publication.

● Guyton, A.C. and Hall, J.E (2015). Textbook of Medical Physiology. Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.

● Barret Kim (2019). Ganong's review of medical Physiology, McGraw Hill Publication

● Tortora, G.J. and Derrickson, B.H (2018). Principles of Anatomy and Physiology. John Wiley &Sons, Inc.

● Verma P S, Tyagi (2017). Animal Physiology. S Chand Publication

● Widmeyer, E.P., Raff, H. and Strang, K.T (2019). Vander's Human Physiology. McGraw Hill.

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER IV
CODE: NBLS-403
SUBJECT NAME: IMMUNOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

Unit I

Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system. Hematopoiesis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system.

Antigen–antibody interactions: Antibody affinity, antibody avidity, Antibodies Structure, classes of immunoglobulins and function of antibodies

Unit II

Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Complement system: Components and pathways, Introduction to concepts of immunological tolerance, autoimmunity, Hypersensitivity, and Transplantation immunology.

Unit III

Hybridoma technology: Production of monoclonal antibodies, Antibody engineering and use of monoclonal and other synthesized antibodies.

Immunological techniques: Precipitin curve, Immuno diffusion, one and two dimensional, single radial immuno diffusion, Ouchterlony immuno diffusion
Immuno-electrophoresis: Rocket immuno-electrophoresis, Graber and William technique.
Agglutination: Direct and Indirect, Widal test, VDRL test
Radioimmunoassay: ELISA – Principle, Methodology and applications. Immuno-fluorescence: Direct, indirect and Sandwich

Recommended Books:

1 Punt J, Stranford SA, Jones PP, and Judith AO (8th Edition, 2019) Kuby immunology. WH Freeman.
2. Abbas AK, Lichtman AH, and Pillai S (9th edition, 2016) Cellular and Molecular Immunology. Saunders.
3. Male DK, Brostoff J, Roth D, and Ivan R (8th Edition , 2012) Immunology. Gower Medical Publishing London.
4. Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Peter J. Delves, (13th edition, 2017), Roitt's Essential Immunology, Wiley-Blackwell.
5. William E. Paul (7th edition, 2012), Fundamental Immunology, Lippincott Williams & Wilkins Publishers

Course Outcomes

B.Sc LIFE SCIENCES SEMESTER IV
CODE: NBLS-404
SUBJECT NAME: LIFESCIENCES LABORATORY COURSE-IV

Credits	L	P		
3	0	6	Sessional	30
			Theory Exam	70
			Total:	100

Course Objectives:

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces of leaves).
6. To study the effect of light on seed germination.
7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation.
8. To study the induction of amylase activity in germinating barley grains.
9. To study suction due to transpiration (Demonstration).
10. Fruit ripening/Rooting from cuttings (Demonstration).
11. Bolting experiment/Avena coleptile bioassay (demonstration).
12. Identification of various immune cells by morphology – Leishman staining, Giemsa staining
13. Haemeagglutination tests for identification of human blood groups.
14. Collection of serum from animal and separation of antiserum from blood
15. To study antigen-antibody interaction: Ouchterlony method
16. Heamagglutination Reactions- Blood Grouping – Rh Typing, Coomb's test
17. ELISA test to study antigen-antibody reaction of the given sample
18. Demonstration of immunofluorescence technique
19. Determination of antibody content by Lowry method
20. Purification of IgG from bovine serum

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER V
CODE: NBLS-501
SUBJECT NAME: PLANT PATHOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Unit-I

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology.
History of Plant Pathology with special reference to Indian work. Terms and key concepts in Plant Pathology, Koch's Postulates, Disease Triangle, Classifications of plant diseases. Important plant pathogenic organisms.
Disease cycle - Host parasite interaction, recognition concept and infection, symptomatology, Disease development, role of enzymes, toxins and growth regulators in disease development, Defense strategies - structural and biochemical mechanisms (preexisting and induced),

Unit-II

Bacterial diseases: general symptoms and types of bacterial diseases. Study of disease cycles: soft rot of carrot, Brown rot of potato, *Citrus* canker
Viral diseases: general symptoms, survival and transmission of plant viruses, Role of vectors in disease transmission. Study of disease cycles: bhindi yellow mosaic virus, potato virus, cucumber mosaic virus
Fungal diseases- general symptoms and disease cycle Study of disease cycles: white rust, early and late blights of potato, powdery mildew on wheat
Brief introduction to key diseases caused by - Mycoplasma, Nematodes and insects.

Unit-III

Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases.
Concepts of pathogen immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.
Disease resistance and molecular approach for disease management.

Suggested Readings

- Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
- Heitefuss R & Williams PH. 1976. Physiological Plant Pathology. Springer Verlag, Berlin, New York.
- Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.
- Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
- Fry WE. 1982. Principles of Plant Disease Management. Academic Press, New York.

Course Outcomes

B.Sc LIFE SCIENCES SEMESTER V
CODE: NBLS-502
SUBJECT NAME: GENETICS

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

Unit 1

Introduction to Genetics- Concept of alleles, Genes, Homologous, non-homologous chromosomes and homoeologous chromosomes; Mendelian genetics and its principles, Numericals based on mendelian genetics along with probability; Chromosome theory of inheritance, Human genetic disorders, Polygenic inheritance with examples, Sex linked genes, Sex limited gene, Sex influenced genes.

Unit 2

Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles; Epistatic interactions (Dominant, recessive, duplicate dominant, duplicate recessive); sex linked inheritance with numericals, Extra- chromosomal inheritance, Pedigree analysis with numericals; Linkage, Crossing Over and Chromosomal Mapping, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Centromere mapping by Tetrad analysis

Unit 3

Microbial genetics- Gene transfer mechanism- Transformation, Conjugation, Transduction; Mutations- Types and Molecular basis of mutation, mutation induced by chemicals and radiations; Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy; Transposable elements (IS, Composite, Ac/Ds, Tn3, LINES, SINES), Dosage compensation, Barr bodies, Polytene chromosome, lamp brush chromosome; Hardy Weinberg Law and its numericals.

Suggested Readings

● Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2006). Principles of Genetics. Wiley India.
● Singh B.D. (2009). Fundamental of Genetics, Kalyani Publisher
● Lewis Ricky, (2020). Human Genetics: Concepts and application, McGraw Hill publication

● Klug W. S, Cummings M.R, Spencer C.A, Palladino M.A, Killian D. (2019). Concepts of Genetics. Benjamin Cummings.
● Snustad, D.P. Simmons, M.J. (2014). Principles of Genetics. John Wiley and Sons

Course outcome :

B.Sc LIFE SCIENCES SEMESTER V
CODE: NBLS-503
SUBJECT NAME: BIOCHEMISTRY AND METABOLISM

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

Unit I

Structure, physical and chemical properties of water molecule, pH, Buffers, biological buffer systems (phosphate and bicarbonate buffer system)

Carbohydrates: classification, functions and properties (Aldoses and ketoses, mutarotation , anomers, epimers and enantiomers) of carbohydrates, Heteropolysaccharides (glycosoaminoglycans), Homo polysaccharides (starch, glycogen)

Common structural features, classification and properties of amino acids; Classification and structure of proteins (Primary, secondary, tertiary & quaternary)

Unit II

Classification, structures and properties of lipids: simple lipids (Fatty acids & waxes), compound lipids (Phospholipids and glycolipids) and derived lipids (Sterols)

Nucleosides and Nucleotides; Nucleic acid structure – Watson-Crick model of DNA. Structure, Function and different types of RNA

Unit III

Metabolism: Catabolic and Anabolic pathways

Energy currency ATP, Carbohydrate metabolism: Glycolysis, citric acid cycle, and pentose phosphate pathway

Fatty acid metabolism: Beta oxidation of fatty acids

Recommended Books:

1. John Tymoczko Jeremy M. Berg Lubert Stryer Gregory Gatto, (9th edition, 2019) Biochemistry, W.H.Freeman & Co Ltd
2. Robert K. Murray, Victor W. Rodwell, David Bender, Kathleen M. Botham, P. Anthony Weil, Peter J. Kennelly, (28th edition, 2009) Harper's Illustrated Biochemistry, McGraw Hill Professional, , New York, USA
3. D. Voet, and J.G. Voet (4th Edition, 2010) Biochemistry, Wiley, Hoboken.

4. David L. Nelson, Michael Cox (7th edition, 2017). Lehninger's Principal of Biochemistry, WH Freeman
5. C. Grisham, R. Garrett (6th edition, 2016) Biochemistry, Brooks/Cole.

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER V
CODE: NBLS-504
SUBJECT NAME: EVOLUTIONARY BIOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

Unit I

Evolutionary Concept, Evidences and sources of Evolution

Concept: Pre-Darwinian ideas, Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era – Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo-Darwinism.

Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes.

Evidences: Paleobiological – Concept of Stratigraphy and geological timescale; fossil study, Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogeny of horse as a model.

Sources: Types of variations – Continuous and discontinuous; heritable and non-heritable. Causes, classification and contribution to evolution – Gene mutation. Concept of micro- and macro-evolution – A brief comparison.

Unit II

Natural selection as a guiding force – Its attributes and action. Basic characteristics of natural selection. Stabilizing, directional, and disruptive selection, Group selection, sexual selection, kin selection, and sociobiology. Colouration, camouflage and mimicry. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force – Its attributes and action. Basic characteristics of drift; selection vs. drift, Bottleneck effect. Founder principle. Population genetics – Gene pool; gene/allele frequency (with and without selection); genotypic frequency; phenotypic frequency.. Models of population growth, Variation in natural populations, Hardy-Weinberg equilibrium, Gene flow, Genetic drift, migration, Non-random breeding, Calculation based on Selection Coefficient and Fitness).

Unit III

Speciation: Concept of species as a real entity, Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation – Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation – Isolating mechanisms. Ecogeographic rules: Subspecies concepts ; Clines and hybrid zones. Extinction: Mass-scale extinctions – Causes and events. Human Ancestry and evolution. Study of Phylogenetic Trees. Phenetics and cladistics, Phyletic patterns and biogeography

Suggested readings

1. Ridley, M. (2004) Evolution. III Edn. Blackwell
2. Hall, B. K. and Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett
3. Zimmer, C. and Emlen, D. J. (2013) Evolution: Making Sense of Life. Roberts & Co.
4. Futuyma, D. (1998) Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
5. Barton, Briggs, Eisen, Goldstein and Patel. (2007) Evolution. Cold Spring Harbor Laboratory Press

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER V
CODE: NBLS-504
SUBJECT NAME: LIFESCIENCES LABORATORY COURSE-III

Credits	L	P		
3	0	6	Sessional	30
			Theory Exam	70
			Total:	100

Course Objective:

1. Isolation of fungi by warcup method
2. Isolation of *Rhizobium* from root nodules
3. Study of plant diseases using slides, specimens and pictures.
4. Preparation of temporary slides of meiosis
5. Preparation of buccal cavity smear
6. Numericals based on pedigree analysis, mapping, recombination
7. Preparation of normal and molar solutions.
8. Preparation of buffers, phosphate and acetate buffers.
9. Qualitative tests for carbohydrates.
10. Qualitative tests for amino acids
11. Estimation of vitamin C
12. Estimation of protein by Lowry method
13. Estimation of cholesterol.
14. Estimation of reducing sugars
15. Preparation of standard curve of RNA by orcinol method.
16. Calculations of genotypic, phenotypic and allelic frequencies from the data provided

17. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-601
SUBJECT NAME: ECOLOGY AND ENVIRONMENTAL BIOLOGY

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

Unit 1

Introduction and scope of ecology and environmental biology.

Definitions: ecology, landscape, habitat, ecozones, biospheres, ecosystems.; Concepts of ecosystem stability, resistance and resilience, autecology and synecology

Ecological levels of organization, Influence of climatic factors and altitude on ecosystems.

Population ecology: r and k selection; population characteristics, survivorship curves, population growth (exponential and logistic), limits to population growth.

Unit II

Community characters (General account of analytical and synthetic characters); Ecotone;edge effect; Succession: processes, types (Lithosere, Hydrosere, Xerosere, Psammosere) and models.

Types of ecosystems, components, trophic organisation; food chain & food webs, ecological efficiencies; ecological pyramids. models of energy flow; production and productivity

Brief outline of biogeochemical cycles (Carbon and Nitrogen). Different types of biotic interactions.

Unit III

Types of resources, definitions and levels of biodiversity, biodiversity hotspots, threats to biodiversity, conservation of biodiversity: in-situ and ex-situ.

Environmental pollution (air, water, soil and noise), types of pollution, causes, effects and control.

Climate change, green house effect, global warming, ozone layer depletion and acid rain.

Recommended Books

- Kormondy, E.J. (1996). Concepts of Ecology. New Delhi, India: PHI Learning Pvt. Ltd. 4th edition.
- Odum, E.P. (2005). Fundamentals of Ecology. New Delhi, India: Cengage Learning India Pvt. Ltd., 5th edition.
- Sharma, P.D. (2010). Ecology and Environment. Meerut, India: Rastogi Publications. 8th edition.
- Singh, J.S., Singh, S.P., Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. New Delhi, India: S. Chand.
- Environmental Biotechnology: S. V.S Rana, Rastogi Publications

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-602
SUBJECT NAME: CELL BIOLOGY

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

1. To introduce the concept of structure and function of biological cells and its living and non-living parts.
2. To develop an understanding of the subject by studying, designing and analyzing different experiments in this most rapidly progressing areas of life sciences, especially the cell components and their molecular mechanism of activities.

Unit-I

Prokaryotic and Eukaryotic cells, Plasma membrane composition and structure.
Transport across membranes – simple diffusion, facilitated diffusion through carrier proteins and channel proteins, active transport. Energetics of transport.
Non gated Ion channels Voltage gated ion channels, membrane potential.
Cell cycle and its regulation, Cell Death& Cell Renewal: Mechanism of apoptosis, Intrinsic and extrinsic pathways. Role of apoptosis in human diseases;
Cancer: Relationship of the cell cycle to cancer, Genes and Cancer, Telomere shortening

Unit -II

Ultra-structure of nucleus, nuclear membrane,
Chromosome structure and its Packaging, histone proteins. Role of nuclear matrix in chromosome organization and function; Heterochromatin and Euchromatin.
The Transport of Molecules into and out of the Nucleus, Mitochondria, Chloroplasts, Peroxisomes, and The endoplasmic reticulum.

Structure of Endoplasmic reticulum and Golgi complex. Role of E R and Golgi complex in protein glycosylation, secretary pathways, Transport from the Trans Golgi Network to Lysosomes protein trafficking, exocytosis, endocytosis, coated vesicles in cellular transport processes.
Lysosomes and cellular digestion. Role of plant vacuole and peroxisomes. Structure of mitochondria and chloroplast

Unit-III

The Nature of the Cytoskeleton, microtubules, microfilaments, intermediary filaments.
Myosin and actin-binding proteins. Cilia, flagella and cell movement,
Cell-cell recognition and adhesion, cell – cell junction, integrins, extracellular matrix of animal cells, Plant cell wall.
Signal transduction through messengers and receptors. Chemical signals and cellular receptors; G- Protein linked receptors,
Kinase associated receptors, Structural Features of Trans-membrane Receptors,
Hormone Receptor Interaction, Two-component signaling, Second messengers.

Suggested Readings:

1. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts
2. and J.D. Watson. Garland Publishing Inc., New York
3. Cell and Molecular Biology by De Robertis
4. The Cell: A molecular approach by Geoffrey Cooper, 8th ed, OUP USA Publishers
5. Cell and molecular biology by Gerald Karp and James G Patton, 7th ed, John Wiley & Sons

Course Outcomes:

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-603
SUBJECT NAME: MOLECULAR BIOLOGY

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

Unit I

Nucleic acids: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey& Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

Replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); Mechanism of replication in prokaryotes and eukaryotes, Enzymes involved in DNA replication.

Central dogma and genetic code: The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

Unit II

Transcription (Prokaryotes and Eukaryotes): Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types.

Mechanism of Transcription in prokaryotes and eukaryotes

Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing; Ribozymes, exon shuffling; RNA editing and mRNA transport.

Unit III.

Translation: Translation in Prokaryotes and eukaryotes; Ribosome structure and assembly, mRNA;Charging of tRNA, aminoacyl tRNA synthetases; Fidelity of translation; Inhibitors of protein synthesis; post-translational modifications of proteins.

Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulation in prokaryotes and Eukaryotes

Regulation of gene expression in prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes

Suggested Reads:

1. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts
2. and J.D. Watson. Garland Publishing Inc., New York
3. Cell and Molecular Biology by De Robertis
4. The Cell: A molecular approach by Geoffrey Cooper, 8th ed, OUP USA Publishers
5. Cell and molecular biology by Gerald Karp and James G Patton, 7th ed, John Wiley & Sons

Course Outcome

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-E601
SUBJECT NAME: REPRODUCTIVE BIOLOGY OF FLOWERING PLANTS

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives:

UNIT I

Introduction and scope of reproductive biology, contributions of embryologists - G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison.

Microsporangium: Development and structure of mature anther; Anther wall layers; Tapetum -types, structure and functions; sporogenous tissue.

Microsporogenesis - Microspore mother cells, microspore tetrads and its types; Pollinia.

Microgametogenesis – Formation of vegetative and generative cells, structure of male gametophyte. Pollen embryo sac (Nemec phenomenon).

UNIT II

Megasporangium – Structure of typical Angiosperm ovule.Types of ovules- Anatropous, Orthotropous, Amphitropous, Campylotropous, Circinotropous.

Megagametogenesis –Female gametophyte embryosac- monosporic - *Polygonum* type, bisporic – *Allium* type, tetrasporic - *Fritillaria* type. Structure of mature embryosac.

Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization

Self-incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination;

UNIT III

Endosperm: Types, development, structure and functions.

Embryogenesis: Six types of embryogeny; General pattern of development of Dicot (*Capsella bursa-pastoris)* and Monocot (*Najas)* embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. Seed - Structure, importance and dispersal mechanisms

Polyembryony and apomixes: Introduction; Classification; Causes and applications.

Germline transformation: Pollen grain and ovules through pollen tube pathway method/ Agrobacterium/ electrofusion/ floral dip/biolistic.

Suggested Readings

1. Bhojwani, S.S., Bhatnagar, S.P. and P. K. Dantu, P.K. (2015). The Embryology of

Angiosperms. Vikas Publishing House Pvt Ltd, New Delhi.
2. Bhojwani Sant Saran, 2014. Current Trends in the Embryology of Angiosperms**,** Woong Young Soh, Springer Netherlands
3.Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
4. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
5. Johri, B.M. l (2015). Embryology of Angiosperms, Springer-Verlag, Netherlands.
6. Singh, V., Pande, P.C. and Jain, D.K. (2012-13). Structure, Development and Reproduction in Angiosperms. Rastogi Publications, Meerut.

Course outcomes:

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-E602
SUBJECT NAME: DEVELOPMENTAL BIOLOGY OF ANIMALS

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives:

Unit 1

Introduction, Historical perspective and basic concepts: Phases of development, cell-cell interaction, pattern formation, differentiation and growth, differential gene expression, cytoplasmic determinants and asymmetric cell division

Early Embryonic Development : Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes

Unit 2

Fertilization (External and Internal)

Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques);

Early development of frog and chick up to gastrulation; Embryonic induction and organizers Late and Post Embryonic development: Fate of Germ Layers; Formation of neural tube, Extra-embryonic membranes in birds

Unit 3

Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Metamorphosis: Changes, hormonal regulations in amphibians and insects;

Regeneration: Modes of regeneration, epimorphosis, morphallaxis regeneration,

Ageing: Concepts and Theories

Embryonic stem cells and their applications

References

1. Michael J.F. Barresi and Scott F. Gilbert, (2020). Developmental Biology, Sinauer Associates Inc., Massachusetts, USA. 12th Edition
2. Wolpert, L., Beddington, R., Brockes, J., Jessell, T., & Lawrence, P. (2019). Principles of Development Oxford University Press. New York. 6th Edition
3. Analysis of Biological Development, Kalthoff, (2000), McGraw-Hill Science, New Delhi, INDIA. 2 nd Edition
4. Slack, J. M. (2012). Essential developmental biology. John Wiley & Sons. 3rd Edition
5. Tortora, G.J. &; Grabowski, S. (2020) Principles of Anatomy & Physiology. XI Edition John Wiley & sons, 16th Edition

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-604
SUBJECT NAME: LABORATORY COURSE-VI

Credits	**L**	**P**	**Sessional**	**30**
3	**0**	**6**	**Theory Exam**	**70**
			Total:	**100**

Course Objectives:

1. Measurement of soil pH and temperature.
2. To determine moisture percentage, bulk density and water holding capacity of soil.
3. To detect presence of carbonate, nitrate and deficiency of replaceable bases.
4. Determination of minimal quadrat size and number for the study of herbaceous vegetation in the campus, by species area curve method (species to be listed).
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
6. Study of cell cycle by mitosis
7. Extraction of genomic DNA by CTAB method
8. Extraction of plasmid DNA
9. Estimation of DNA by spectrophotometric method
10. Measuring the size of stomata/pollen grains using stage micrometer and oculometer
11. Separation of chloroplast by density gradient centrifugation.

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS-605
SUBJECT NAME: BIOSTATISTICS

Credits	L	T		
4	2	2	Sessional	25
			Theory Exam	75
			Total:	100

Course Objectives: The course focuses on developing concepts about types of experimental biological data, processing and analysis to further formulate hypothesis in experiments.

UNIT I

Types of data, Collection and Graphical representation of data, Measures of central tendency: Mean, Median, Mode, Quartile, and Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Coefficient of Variation, Correlation and Regression.

UNIT II

Probability and its applications: Laws of Addition and Multiplication, Compound Probability, Bayes theorem. Probability distributions: Binomial, Poisson and Normal distributions and their applications.

UNIT III

Testing of hypothesis: Parameter and Statistic, Sampling distribution and Standard error, Null and Alternative hypotheses, Simple and composite hypotheses, Two types of errors, Level of significance and Power of the test, One tailed and two tailed tests.

UNIT IV

Tests of significance: t and Z tests for mean and proportion for one and two samples, Chi square test of goodness of fit and independence. F test, Analysis of variance for one way and two-way classification, Elementary ideas of Designs of Experiments; Important statistical softwares and their applications

References:

1. Daniel Wayne W. (2007) Biostatistics: A Foundation for Analysis in Health Sciences. 10th Edition, Wiley Sciences.

2. Pagano Marcello and Gauvreau Kimberlee (2000). Principles of Biostatistics, 2nd Edition. CRC Press
3. Zar JH (1999) Biostatistical analysis. Pearson Education Inc.
4. Sokal RR, Rohlf FJ and Rohlf JF (1995). Biometry. macmillan

Course Outcomes:

CO 1- Understand the concept and scope of statistics in biological data generation, collection, and sampling.

CO 2- Develop skills for data analysis and development to attain statistically significant inferences.

CO 3- Apply the acquired skill in data interpretation, record keeping, and scientific document generation.

Minor Subject Syllabus

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS/MIC-101
SUBJECT NAME: Conceptual Organic Chemistry-I

Credits	L	P		
2	2	0	Sessional	25
			Theory Exam	75
			Total:	100

Course objective To predict and explain patterns in shape, structure, bonding, hybridization, formal charge, stability, acidity, basicity, solubility, and reactivity for hydrocarbons, halocarbons, alkenes, dienes, and arenes, by understanding and applying concepts of organic chemical structure and bonding and stability.

Unit I

Stereochemistry: Writing of Fischer projection, Newman and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformations: Restricted rotation about single bonds, Various conformations of ethane, butane, ethane-1,2-diol and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism, Cis-Trans and E/ Z notation along with CIP rules for geometrical isomers. Optical Isomerism: Optical activity, specific and molar rotation, chirality, enantiomerism, diastereo-isomerism, racemic mixtures and their resolution by salt formation method. Relative and absolute configuration: D / L nomenclature system for configuration of carbohydrates (difference between d/l and D/L notations). Threo and Erythro designation. R-and S- configuration (upto two chiral centres).

Unit II

Addition Reactions: Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercuration-demercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes. Aldehydes and ketones: (formaldehyde, acetaldehyde, benzaldehyde, acetone) Addition of sodium bisulphite, hydrogen cyanide and alcohols. Addition- elimination reactions with ammonia and its derivatives Name reactions: Aldol, cross Aldol, Claisen, Cannizzaro, cross Cannizzaro

Suggested Readings

● Nasipuri, D. (2020) Stereochemistry of Organic Compounds, New Age International Publishers

● Kalsi, P.S. (2015) Stereochemistry, Conformation and Mechanism. John Wiley and Sons.

● Morrison, R.T. and Boyd., R. N. (2010) Organic Chemistry, Pearson Education

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS/MIC-201
SUBJECT NAME: Conceptual Organic Chemistry-II

Credits	L	P		
2	2	0	Sessional	25
			Theory Exam	75
			Total:	100

Course objective: To understand the basic and stereochemical aspects of substitution and elimination reactions.

Unit-I

Substitution Reactions: Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkyl benzenes. Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group).Alcohols, amines and phenols: Substitution of active hydrogen, replacement of hydroxyl group in alcohols. Electrophilic Substitution Reactions (aromatic compounds): General mechanism of electrophilic substitution reactions (nitration, halogenation, sulphonation, Friedel Crafts alkylation and acylation), directive influence of substituents.

Unit-II

Elimination Reactions: Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination).

Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Alcohols: Oxidation with potassium permanganate, potassium dichromate, catalytic dehydrogenationand Oppenauer oxidation. Oxidation of 1,2–diols with periodic acid and lead tetraacetate. Aldehydes: Oxidation with potassium permanganate, chromic acid and Tollens's reagent Ketones: Oxidation withpotassium permanganate, sodium hypoiodite (iodoform reaction) and Baeyer–Villiger oxidation. Reductions -Aldehydes and Ketones: Catalytic hydrogenation, reduction with sodium borohydride, lithium aluminium hydride, Clemmensen, Wolff-Kishner. Carboxylic acids and their derivatives: Lithium aluminium hydride, sodium-ethanol and Rosenmund reduction. Nitro compounds: Acidic, alkaline and neutral reducing agents, lithium aluminium hydride and electrolytic reduction.

Suggested Readings

- Bahl, A. and Bahl. B.S. (2012) Advanced Organic Chemistry, S. Chand
- Finar, I.L. Organic Chemistry, E. L. B. S.
- Morrison, R.T. and Boyd., R. N. (2010) Organic Chemistry, Pearson Education
- Solomon's, T.W.G. (2017) Organic Chemistry. John Wiley and Sons
- Sykes, P. (2003) A Guide Book to Mechanism in Organic Chemistry.

B.Sc LIFE SCIENCES SEMESTER III
CODE: NBLS/MIC-301
SUBJECT NAME: Inorganic Chemistry-I

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

COURSE OBJECTIVE
The objective of the course is to make the students understand the basic concept of atom and atomic structure, periodic properties of elements and chemical bonding.

Unit-I

Atomic Structure: Recapitulation of Bohr's theory, its limitations and atomic spectrum of hydrogen atom. de Broglie equation, Heisenberg's Uncertainty Principle and its significance.

Schrödinger's wave equation, Significance of ψ and ψ^2. Quantum numbers and their significance. Radial and angular distribution curves. Shapes of s, p, d and f orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations.

Unit-II

Periodicity of Elements: Brief discussion of the following properties of the elements, with reference to *s* & *p*-block and the trends shown:

1. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
2. Atomic and ionic radii.
3. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods.
4. Electron gain entahlpy and trends in groups and periods.
5. Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

Unit-III

Chemical Bonding:

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Haber cycle and its application

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5, SF_6, ClF_3

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators

Referred Books:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970

- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Course Outcomes: After the completion of the course, students will be able to,

- Learn basic concept of atom and its structure in detail.
- Arrangement of electrons in atom.
- Concept of s, p, d and f orbitals and their shape using.
- Understand nature of chemical bonding and concept of molecular orbitals.

B.Sc LIFE SCIENCES SEMESTER IV
CODE: NBLS/MIC-401
SUBJECT NAME: Physical Chemistry - I

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

COURSE OBJECTIVE

The objective of the course is to make the students understand the different states of matter and various laws governing the properties of solid, liquid and gaseous state. Emphasis will also be on the basic concept of ionic equilibrium and its applications.

Unit-I

Gaseous state: Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of ζ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit-II

Liquid state: Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Unit-III

Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

Unit-IV

Ionic equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. **(20 Lectures)**

Course Outcomes: After the completion of the course, students will be able to,

- Learn the states of matter in detail.
- Laws governing the solid, liquid and gaseous state.
- Have a deep understanding methods to study the solid, liquid and gaseous state.
- Concept of ionic equilibria and its applications.

Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

B.Sc LIFE SCIENCES SEMESTER V
CODE: NBLS/MIC-501
SUBJECT NAME: Physical Chemistry - II

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

COURSE OBJECTIVE

The objective of the course is to have an understanding concept of thermodynamics in chemistry, system of variable composition, chemical equilibrium, solutions and colligative properties.

Unit-I

Chemical Thermodynamics: Intensive and extensive variables; state and path functions; isolated, closed and open systems.

First law: Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Thermochemistry: Heats of reactions: standard states; enthalpy of formation and enthalpy of combustion and its applications; effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity

Unit-II

Chemical Equilibrium: Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration (Le Chatelier Principle, Quantitatively)). Free energy of mixing and spontaneity. equilibrium between ideal gases and a pure condensed phase.

Unit-III

Solutions and Colligative Properties: Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount

of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Course Outcomes: After the completion of the course, students will be able to,

- Understand the basic concept of chemical thermodynamics and the laws governing.
- Learn the basics of systems of variable compositions.
- Learn the concept of chemical equilibrium.
- Learn solution and colligative properties.

Reference Books

• Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
• Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
• Rastogi, R.P and Mishra, R.R. An introduction to chemical Thermodynamics,1995.
• Kapoor, K.L., A text book of physical chemistry, vol 2, McGraw Hill education
• Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010). • Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

B.Sc LIFE SCIENCES SEMESTER VI
CODE: NBLS/MIC-601
SUBJECT NAME: Inorganic Chemistry-II

Credits	L	P		
4	4	0	Sessional	25
			Theory Exam	75
			Total:	100

COURSE OBJECTIVE

The objective of the course is to make the students understand the basic concept of s & p block elements and the concept of metallurgy.

Unit-I

Chemistry of *s* Block Elements:

(i) General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group.
(ii) Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
(iii) Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.

Unit-II

Chemistry of *p* Block Elements:

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group.
Structure, bonding and properties: acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following:

- Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group 16 and Group 17.
- Oxides: oxides of phosphorus, sulphur and chlorine

Unit-III

Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

Unit-IV

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams) Different between the first, second and third transition series.

Referred Books:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
- Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth- Heinemann. 1997.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 3rd Ed.(adapted)*, Pearson, 2009
- Shriver, D.F., Atkins P.W and Langford, C.H., *Inorganic Chemistry 2nd Ed*., Oxford University Press, 1994

Course Outcomes: After the completion of the course, students will be able to,

- Understand general principles of metallurgy.
- Understand general characteristics and chemical properties of s & p block elements.

- Learn chemical and physical properties of hydrides, oxides, oxo and halides of various groups.
- Understand preparation, properties, structures of borazines, silicates, silicons, phosphonitrilic halides, interhalogens and pseudohalogen compounds and clatherate compounds of nobel gases.

Multidisciplinary Courses (MDC)

B.Sc LIFE SCIENCES SEMESTER I
CODE: NBLS/MDC-101
SUBJECT NAME: Computer Network & Internet Technology

Credits	L	P		
3	3	0	Sessional	25
			Theory Exam	75
			Total:	100

COURSE OBJECTIVE

- To understand basic computer network technology, different types of network topologies and to differentiate among various communication models.
- To familiarize the students with the basic concepts of internet, its history and ways to connect to internet and various fundamental features of world wide web like HTTP, TCP,IP protocols etc.
- To provide a detailed understanding of search engines and also familiarize him with the fundamental language of internet i.e. HTML

UNIT -I

Computer Networks: Uses of Computer Network, Network Hardware, Network Software, Goals and Applications of Computer networks, Structure of Computer Network: Point-to-point structure, Broadcasting structure.

UNIT -II

Types of Networks, Topologies. Reference Models: OSI Reference Model, TCP/IP reference Model, Comparison of OSI and TCP Reference Model. Data Communication: Transmission media, Wireless communication, and the Telephone system, Introduction to cellular radio and communication satellite, Data Rate of Channel, Electromagnetic spectrum.

UNIT-III

World Wide Web : Introduction, Miscellaneous Web Browser details, searching the www: Directories search engines and meta search engines, search fundamentals, search strategies, working of the search engines, Telnet and FTP, E Mail, Chat Servers, net meeting, video conferencing.

UNIT-IV

Hypertext markup language: The anatomy of an HTML document: Marking up for structure and style: basic page markup, absolute and relative links, ordered and unordered lists,

COURSE OUTCOMES: After the completion of the course, the student will be :

- Acquainted with the concepts of Computer Networks, Its topologies and various
- communication Models. Able to use internet terminologies like searching fundamentals and its types on internet,
- Telnet, Email, Chat Servers,FTP and Net Meeting etc. in order to solve problems. Able to develop a web page by
- using various tags and concepts of Hyper Text Markup Language.

REFERENCE BOOKS

1. Computer Networks (3rd edition), Tanenbaum Andrew S., International edition, 1996.

2. Forouzan, Data Communications and Networking, TMH, 4 th Edition, 2006.

3. William Stallings, Data and Computer Communications, PHI, 7 th Edition, 2003

4. Fundamentals of the Internet and the World Wide Web, Raymond Greenlaw and Ellen Hepp 2001, TMH

5. Internet &World Wide Programming, Deitel, Deitel& Nieto, 2000, Pearson Education

6. Data Communications, Computer Networks and Open Systems (4th edition), Halsall Fred,2000, Addison Wesley, Low Price Edition.

B.Sc LIFE SCIENCES SEMESTER II
CODE: NBLS/MDC-201
SUBJECT NAME: Information Security

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

COURSE OBJECTIVE

- **Learn the fundamentals of Information Security**
- **To understand various types of cryptographic techniques and ciphers**
- **To gain an insight of various security threats in network and email in particular**

- **To become familiar with the security aspects of Firewall**

UNIT I: Information Security Basics Introduction to Information Security: Attacks, Vulnerability, Security Goals, Security Services and mechanisms. Classification of Attacks, Introduction to "What is Infosphere", Difference between Information Security, Computer Security and Cyber Security.

Unit II: Conventional Cryptographic Techniques Conventional substitution and transposition ciphers, One-time Pad, Block cipher and Stream Cipher; Symmetric and Asymmetric Cryptographic Techniques: DES, RSA algorithms, Authentication and Digital Signatures: Use of Cryptography for authentication, Secure Hash function, Key management – Kerberos.

Unit III: Security in Networks Threats in networks, Network Security Controls – Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security – PGP,S/MIME.

COURSE OUTCOMES After the successful completion of the course, the student will be able to :

- Understand the basics of Information Security
- Become acquainted with various types of cryptographic techniques and ciphers
- Have an insight of various security threats in network and email in particular.

REFERENCE BOOKS 1. William Stalling, Cryptography and Network Security, 3rd Edition,PHI New Delhi,2018.
2. William Stalling, Network Security Essentials, 2nd Edition,PHI New Delhi,2017.
3. Charles P. Pfleeger, Security in computing, 4th Edition Pearson,New Delhi,2018.

B.Sc LIFE SCIENCES SEMESTER II
CODE: MDC-32-01
SUBJECT NAME: Entrepreneurship

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Outcomes: After completion of the course, the students will be able to:

1. Understand the dynamics of entrepreneurship to develop proper perspective of current entrepreneurial practices.

2. Develop a clear understanding about business opportunity and selection.
3. Develop a clear understanding about business plan formulation.
4. Suggest institutional support available to new venture.

UNIT I

Entrepreneur and Entrepreneurship:

Concept of Entrepreneur, Manager, Entrepreneur traits of an entrepreneur, Concept of Manager, Roles and Responsibilities of Manager, Concept of Entrepreneur, Need and Importance of Entrepreneurship, Relationship between Entrepreneur and Entrepreneurship. Problem of Unemployment and opportunities of Entrepreneurial in India.

UNIT II

Challenges for Women Entrepreneurship in India, Business opportunity Identification: Opportunity Search: Divergent Thinking Mode: Meaning, Objectives; Environmental scanning for business opportunity Identification, Opportunity Selection: Convergent Thinking Mode: Meaning, Objectives, Sources of new ideas, methods of idea generations.

UNIT III

Business Plan: Meaning and, Objectives of Business Plan; Elements of Business Plan; Business Planning Process – Self Audit, Evaluation of Business Environment, setting objectives, Forecasting Market Conditions, stating actions and resources required, Feasibility Analysis.

UNIT IV

Institutional Support to New Venture (Students are expected to study the assistance scheme of following institutions) District Industries Centre (DIC), Small Industries Development Bank of India (SIDBI), National Small Industries Corporation (NSIC), Entrepreneurship Development Program (EDP); objectives, curriculum.

SUGGESTED READINGS:

1. Desai Vasant: - Managment of Small Scale Industries – Himalaya Publishing House.
2. Taneja Satish and Gupta: - Entrepreneurship Development- New Venture Creation – Galgotia Publishing Company, New Delhi.
3. Jain P.C: Handbook for new Entrepreneurs Entrepreneurship

B.Sc LIFE SCIENCES SEMESTER III
CODE: NBLS/MDC-301
SUBJECT NAME: Fundamentals of Database Systems

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

COURSE OUTCOMES:

The students will be able to

CO1: Explore the basic concepts, applications and architecture of database systems

CO2: Master the basics of ER diagram

CO3: Know relational database algebra expressions and construct queries using SQL

CO4: Analyze sound design principles for logical design of databases, normalization

UNIT-I Database: Introduction to database, relational data model, DBMS architecture, data independence, DBA, database users, end users, front end tools.

UNIT-II Modeling: Entity types, entity set, attribute and key, relationships, relation types, E- R diagrams, database design using ER diagrams.

UNIT-III Relational Data Model: Relational model concepts, relational constraints, primary and foreign key, normalization: 1NF, 2NF, 3NF.

REFERENCE BOOKS

1. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3 rd edition, Addision-Wesley, Low Priced Edition,2000.

2. An Introduction to Database Systems by C.J. Date, 7 th edition, Addison-Wesley, Low Priced Edition, 2000.

3. Database Management and Design by G.W. Hansen and J.V. Hansen, 2 nd edition, Prentice-Hall of India, Eastern Economy Edition,1999.

4. Database Management Systems by A.K. Majumdar and P. Bhattacharyya, 5 th edition,Tata McGraw-Hill Publishing. , 1999.

5. P. Rob, C. Coronel, Database System Concepts by, Cengage Learning India, 2008.

6. R. Elmsasri,S. Navathe Fundamentals of Database Systems, Pearson Education, Fifth Edition, 2007. 9. MySQL : Reference Manual.

B.Sc LIFE SCIENCES SEMESTER III
CODE: NBLS/MDC-302
SUBJECT NAME: Intellectual Property Rights

Credits	**L**	**P**	**Sessional**	**25**
3	**3**	**0**	**Theory Exam**	**75**
			Total:	**100**

Course Objectives: To understand the principles and use of intellectual property rights.
Course Outcomes: At the end of the course, the student shall be able to:
CO1. Understand the basic concept of IPR, different types of IP with examples.
CO2. Recognise a patentable process or material and file an international/national patent for it through proper channel.
CO3. Different aspects of trademark and trade secrets and procedures to protect them

Unit I:
Introduction to Intellectual Property Rights (IPR) and their need. Origin and development of IPR in India.
Categorization of IPR. Introduction to types of IPR with their use.
Role of WIPO and WTO in development of IPR.

Significant treaties impacting IPR development: TRIPS, Budapest treaty, PCT, Berne Convention, Madrid treaty, Trademark Law treaty

Unit II

Definition of patent. Types of patents. Characteristics of patentable matter. Legal process of patent granting in India, types of patent applications, Drafting, searching and filing of patents. Rights of patent owners. Commercial utilization of patents. Compulsory licensing.

Definition of copyrights. Rights and protection covered by copyrights. Law of copyright: Fundamentals of copyright law, originality of material, rights of reproduction, right to perform the work publicity, copyright ownership issue, obtaining copy right registration, notice of copy right, international copy right law, infringement of copyright under copyright Act

Unit III

Trademarks and their significance. Types of trademarks. Process of registration of trademarks in India. Protection given by trademarks.

Tradesecrets and sui generis system of IPR. Nature of protectable matter covered. Liabilities and nature of legal protection available.

Geographical Indicators and their significance. Process of registration of GI in India. Benefits of legal protection.

Recommended Books

- Fundamentals of Intellectual Property Rights for students, industrialist and patent lawyers. By B. Ramakrishna and H.S. Anil Kumar. Notion Press.
- Intellectual Property Rights by N.Pandey and K.Dharni. PHI Publications
- IPR, Biosafety and Bioethics by D.Goel and S.Parasha. Pearson Publication