COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

ZOOLOGY

STUDENT COPY

Choice Based Credit System(CBCS)

First & Second Semester Examination – 2018-19

Third & Fourth Semester Examination – 2019-20

Fifth & Sixth Semester Examination – 2020-21

GOVERNMENT AUTONOMOUS COLLEGE,
PHULBANI, KANDHAMAL

SYLLABI FOR CBCS COURSE

Sem	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill based Enhancement Compulsory Course (SECC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	AECC-1			GE-1 (Minor-1)
	CORE-II				
II	CORE-III	AECC-2			GE-1 (Minor-2)
	CORE -IV				
III	CORE-V		SECC-2		GE-2 (Minor-1)
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		SECC-1		GE-2 (Minor-2)
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-1	
	CORE-XII			DSE-2	
VI	CORE-XIII			DSE-3	
	CORE-XIV			DSE-4 (Project)	

SECC-1 : To be offered by English Department.
SECC-2 : To be offered by Mathematics Department.
GE : Minor-1 and Minor-2 is to be decided by the college Based on Subject.

QUESTION PATTERN FOR MID SEM

Mid Semester Examination	Full Marks	No. of Short Answer type Questions (2 marks each) (Compulsory)	No. of Long Answer type Questions (8 marks each)	No. of Long Answer type Questions (12 marks each)
Practical Subject	20	6	1	*
Non-Practical Subject	20	4	*	1

QUESTION PATTERN FOR END SEM

End Semester Examination	Full Marks	GROUP – A					GROUP - B									
		No. of Short Answer type Questions (2 marks each) (Compulsory)					No. of Long Answer type Questions (8 marks each)					No. of Long Answer type Questions (12 marks each)				
Units -->		I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Non-Practical Subject	80	10					*	*	*	*	*	1	1	1	1	1
Practical Subject	50	5					1	1	1	1	1	*	*	*	*	*

- There is no alternative questions (choice) in Group-A questions (Short Answer type questions). All questions are compulsory.
- There is internal alternative questions (choice) in each number in Group-B questions (Long Answer type questions). Examinee has to answer one questions out of two alternative questions from each number.
- There is little deviation in question pattern of AECC (Eng Communication) & SECC-I & II. Details regarding question pattern of concerned subject is given at appropriate place.)
- The duration of Mid Sem exam of each paper is 1 hour irrespective of Full marks.
- The duration of End Sem exam of each paper is 3 hours for 80 marks/50 marks.

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons.) (Zoology Hons.)				
Yr.	Sl.No.	Course Structure	Code	Credit Points
FIRST YEAR		**SEMESTER-I**		
	1	Diversity and Evolution of Non-Chordata (Protista to Pseudocoelomates)	C-1.1	4+2
	2	Perspectives in Ecology	C-1.2	4+2
	3	Chemistry (Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons)	GE-1.3	4+2
	4	MIL Communication – Odia / English Communication	AECC-1.4	6
			TOTAL -	**24**
		SEMESTER-II		
	5	Diversity and Evolution of Non-Chordata (Coelomate to Nonchordates)	C-2.1	4+2
	6	Life Sustaining Systems	C-2.2	4+2
	7	Botany (Plant Diversity)	GE-2.3	4+2
	8	Environmental Studies	AECC-2.4	6
			TOTAL -	**24**
SECOND YEAR		**SEMESTER-III**		
	9	Diversity and Distribution of Chordata	C-3.1	4+2
	10	Controlling and Coordinating System	C-3.2	4+2
	11	Comparative Anatomy of Vertebrates	C-3.3	4+2
	12	Chemistry (Chemical Energetics, Equilibria & Functional Organic Chemistry-I)	GE-3.4	4+2
	13	Quantitative and Logical Thinking	SECC-3.5	6
			TOTAL -	**30**
		SEMESTER-IV		
	14	Biochemistry of Metabolic Processes	C-4.1	4+2
	15	Cell Biology	C-4.2	4+2
	16	Principles of Genetics	C-4.3	4+2
	17	Botany (Angiosperms and Developmental Botany)	GE-4.4	4+2
	18	Communicative English	SECC-4.5	6
			TOTAL -	**30**
FINAL YEAR		**SEMESTER-V**		
	19	Developmental Biology	C-5.1	4+2
	20	Molecular Biology	C-5.2	4+2
	21	Animal Behaviour	DSE-5.3	4+2
	22	Economic Zoology	DSE-5.4	4+2
			TOTAL -	**24**
		SEMESTER-VI		
	23	Immunology	C-6.1	4+2
	24	Evolutionary Biology	C-6.2	4+2
	25	Microbiology	DSE-6.3	4+2
	26	Project Work	DSE-6.4	6
			TOTAL -	**24**
			GRAND TOTAL -	**156**

Notes:

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- SECC- Skill based Enhancement Compulsory Course
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours

SEMESTER-I

C-1.1: DIVERSITY AND EVOLUTION OF NON-CHORDATA (PROTISTA TO PSEUDOCOELOMATES)

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Phylum Protozoa, Parazoa and Metazoa

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax, Trypanosoma gambiense* and *Entamoeba histolytica;* Locomotion and reproduction in Protozoa; Evolution of Parazoa and Metazoa.

UNIT-II : Phylum Porifera and Ctenophora

General characteristics and classification up to classes; Canal system in sponges; General characteristics and evolutionary significance.

UNIT-III : Phylum Cnidaria

General characteristics and classification up to classes; Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs.

UNIT-IV : Phylum Platyhelminthes

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Fasciola hepatica* and *Taenia solium;* Parasitic adaptations.

UNIT-V : Phylum Nematohelminthes

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Ascaris lumbricoides* and *Wuchereria bancrofti;* Parasitic adaptations.

Note: Classification to be followed from "Barnes RD (1982) Invertebrate Zoology. 5th Edition."

PRACTICAL

End Sem Practical – 30/3 hrs

Phylum Protozoa

1. Morphology of *Paramecium,* Binary fission and Conjugation in *Paramecium.*
2. Life stages of *Plasmodium vivax, Trypanosma gambiense* and *Entamoeba histolytica* (Slides/Micro-photographs).
3. Examination of pond water for protists.

Phylum Porifera

4. Study of *Sycon* (including T.S. and L.S.), *Hyalonema,* and *Euplectella.*
5. Temporary mounts of spicules, gemmules and spongin fibres.

Phylum Cnidaria

6. Study of *Obelia, Physalia, Millepora, Aurelia,* Ephyra larva*, Tubipora, Corallium, Alcyonium, Gorgonia* and *Metridium* (including T.S. and L.S.).

Phylum Ctenophora

7. Any one specimen/slide.

Phylum Platyhelminthes

8. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/ microphotographs).

Phylum Nemathelminthes

9. Study of adult *Ascaris lumbricoides, Wuchereria bancrofti* and their life stages (Slides/ microphotographs).

Note: Classification to be followed from "Barnes RD (1982) Invertebrate Zoology. 5th Edition."

Suggested Readings :

1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002) The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science, USA.
5. Barrington EJW (1979) Invertebrate Structure and Functions. 2nd Edition. ELBS and Nelson.
6. Boradale LA and Potts EA (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand, New Delhi.
8. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

C-1.2: PERSPECTIVES IN ECOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Introduction to Ecology

Relevance of studying ecology; History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors; Detailed study of temperature and light as physical factors.

UNIT-II : Population

Unitary and modular populations; Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, r and K strategies, Population regulation - density-dependent and independent factors; Population interactions, Gause's Principle with laboratory and field examples; Lotka-Volterra equation for competition and Predation, functional and numerical responses.

UNIT-III : Community

Community characteristics: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example and Theories pertaining to climax community.

UNIT-IV : Ecosystem

Types of ecosystem; Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Nutrient and biogeochemical cycle, Nitrogen cycle and Sulphur cycle.

UNIT-V : Conservation of Biodiversity

Types of biodiversity, its significance, loss of biodiversity; Conservation strategies (in situ and ex situ); Role of ZSI, WWF, IUCN; Wildlife (Protection) Act, 1972.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO2.
4. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.

Suggested Readings:

1. Colinvaux PA (1993) *Ecology*. II Edition. John Wiley and Sons, Inc., USA.
2. Dash MC (1993) Fundamentals of Ecology. McGraw Hill Book Company, New Delhi.
3. Joshi N and Joshi PC (2012) Ecology and Environment. 1st Edition. Himalaya Publishing House, New Delhi.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Odum EP (2008) *Fundamentals of Ecology*. Indian Edition. Brooks/Cole.
6. Ricklefs, R.E., (2000). *Ecology*. 5th Edition. Chiron Press.
7. Robert Leo Smith Ecology and field biology Harper and Row.
8. Singh JS, Gupta SR and Singh SP (2014) Ecology, Environmental Science and Conservation. S. Chand, New Delhi.

GE- 1.3 : ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: INORGANIC CHEMISTRY-1

UNIT-I : Atomic Structure (14 Periods)

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ 2 , Schrödinger equation for hydrogen atom. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT-II : Chemical Bonding and Molecular Structure-I (16 Lectures)

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character

UNIT-III: **Chemical Bonding and Molecular Structure-II** Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements

Concept of resonance and resonating structures in various inorganic and organic compounds

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ , Comparison of VB and MO approaches

SECTION B : ORGANIC CHEMISTRY-I

UNIT- IV : Fundamentals of Organic Chemistry (8 Lectures)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry (10 Lectures)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT- V : Aliphatic Hydrocarbons (12 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, Ozonolysis and oxidation with hot alk. $KMnO_4$.

Reference Books :

1. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
2. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.

6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.
8. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
10. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydroxide present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
6. Estimation of Na_2CO_3 & $NaHCO_3$ present in a mixture.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books :

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

AECC-1.4 : ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା- ଓଡ଼ିଆ (କଳା ଓ ବିଜ୍ଞାନ ବିଭାଗ ପାଇଁ)

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3hrs

ୟୁନିଟ୍-୧ : ବିଜ୍ଞାପନ କଳା ଓ ସାହିତ୍ୟ / ବିଜ୍ଞାପନର ଆବଶ୍ୟକତା ଓ ଉପକାରିତା

ୟୁନିଟ୍-୨ : ଗଳ୍ପ- କୃଷ୍ଣଚୂଡ଼ା- ସୁରେନ୍ଦ୍ର ମହାନ୍ତି
ପାଟଦେଈ- ବୀଣାପାଣି ମହାନ୍ତି
ବୁଢ଼ାଶଙ୍ଖାରୀ- ଲକ୍ଷ୍ମୀକାନ୍ତ ମହାପାତ୍ର

ୟୁନିଟ୍-୩ : କବିତା- ଶ୍ରୀରାଧା- ରମାକାନ୍ତ ରଥ
ପ୍ରତିମା ନାୟକ- ସଚ୍ଚି ରାଉତରାୟ
ଦୁର୍ଯ୍ୟୋଧନ- ସୀତାକାନ୍ତ ମହାପାତ୍ର

ୟୁନିଟ୍-୪ : ପ୍ରବନ୍ଧ- ଗାଡ଼ି ଛାଡ଼ିଦେଲା – ଚନ୍ଦ୍ରଶେଖର ରଥ
ଆମେରିକାରେ ଲୋକଚରିତ୍ର – ଗୋଲୋକ ବିହାରୀ ଧଳ
ସ୍ୱାଧୀନ ଚିନ୍ତା – ବିଶ୍ୱନାଥ କର

ୟୁନିଟ୍-୫ : କାରକ ଓ ବିଭକ୍ତି

ପୁସ୍ତକ :

୧. ଯୋଗାଯୋଗର ଭାଷା, ଫ୍ରେଣ୍ଡସ୍ ପ୍ରକାଶନ, କଟକ
୨. ଗଳ୍ପ, କବିତା ଓ ପ୍ରବନ୍ଧ - ସଂକଳିତ ପୁସ୍ତକ, କଲେଜ ଛକ, ଫୁଲବାଣୀ

AECC-1.4 : ENGLISH COMMUNICATION

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3hrs

UNIT-I : Introduction

1. What is communication?
2. Types of communication
   - Horizontal
   - Vertical
   - Interpersonal
   - Grapevine

UNIT-II : Language of Communication

1. Verbal : spoken and written
2. Non-verbal
   - Proxemics
   - Kinesics
   - Haptics
   - Chronemics
   - Paralinguistics
3. Barriers to communication
4. Communicative English

UNIT-III : Reading Comprehension (Prose & Poetry)

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas and information
- Read "between the lines" to understand underlying meanings
- Connect information to what they already know

UNIT-IV : Writing

- Expanding an Idea
- Note Making
- Information Transfer
- Writing a Memo
- Writing Formal Email
- Writing a Business Letter
- Letters to the Editor
- CV & Resume Writing
- Covering Letter
- Report Writing
- News Story
- Interviewing for newspaper

(The above mentioned writing activities are covered in the prescribed text book Vistas and Visions)

UNIT-V : Language functions in listening and conversation

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually
3. Group Discussion
4. Interview
5. Dialogue

(Practice to be given using the set pieces from the prescribed textbook)

Grammar and Usage :

1. Phrasal verbs
2. Collocation
3. Using Modals
4. Use of Prepositions
5. Common Errors in English Usage

(The above mentioned grammar items are covered in the prescribed text book Vistas and Visions)

Book Prescribed :

1. *Vistas and Visions: An Anthology of Prose and Poetry.* (Ed.) Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. OBS

Texts to be studied

Prose

1. Pleasures of Ignorance
2. Life style English
3. Playing the English Gentleman
4. Ecology and Community
5. My Lost Dollar

Poetry

1. Last Sonnet
2. The Darkling Thrush
3. The Felling of Banyan Tree
4. Meting Poets

All grammar and writing activities in the textbook *Vistas and Visions*

Pattern of Examination :

Mid-Semester Examination :

Using texts (500-600 words), students will be tested for

- Vocabulary : synonyms, antonyms, words used as different parts of speech = 10 marks
- Word order ; subject-predicate; subject-verb agreement = 10 marks

End-Semester Examination :

Using texts (600-700 words), students will be tested for

- Use of vocabulary in context 2 marks X 5 bits = 10 marks
- Use of grammar in context
- Use of cohesive and transitional devices in one paragraph 2 marks X 10 bits = 20 marks
- Writing two paragraphs (expository/descriptive/narrative/ Argumentative) using topic sentences 10 marks X 2 qns = 20 marks
- Correcting in-text citation from given input 2 marks X 5 bits = 10 marks
- Preparing a correct version of Works Cited page from given input 2 marks X 5 bits = 10 marks

Suggested Readings:

1. *Fluency in English – Part II,* OUP, 2006
2. *Business English,* Pearson, 2008
3. *Communicative English* -E. Suresh Kumar and P. Sreehari
4. *Break Free : Unlock the Powerful Communicator in You*. Rajesh, V. Rupa, 2015
5. *Soft Skills* Shalini Verma, 2009
6. *Language, Literature and Creativity, Orient BlackSwan, 2013*
7. *Language through Literature.* (forthcoming) ed. Gauri Mishra, Dr. Ranajan Kaul, Dr. Brati Biswas

SEMESTER-II

C-2.1: DIVERSITY AND EVOLUTION OF NON-CHORDATA (COELOMATE TO NONCHORDATES)

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Phylum Annelida

General characteristics and classification up to classes; Evolution of Coelom; Metamerism and Excretion in Annelida.

UNIT-II : Phylum Arthropoda

General characteristics and classification up to classes; Vision in Arthropoda; Respiration in Arthropoda; Moulting in insects, Metamorphosis in insects; Social life in insects (bees and termites) and Larval forms in Crustacea.

UNIT-III : Phylum Onychophora

General characteristics, evolutionary significance and affinities of *Peripatus.*

UNIT-IV : Phylum Mollusca

General characteristics and classification up to classes; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves and Evolutionary significance of trochophore larva.

UNIT-V : Phylum Echinodermata

General characteristics and classification up to classes; Water-vascular system in Asteroidea; Larval forms in Echinodermata and Evolutionary significance (Affinities with Chordates).

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, 5th Edition, Holt Saunders International Edition."

PRACTICAL

End Sem Practical – 30/3 hrs

Phylum Annelida

1. Study of *Aphrodite, Nereis, Heteronereis, Sabella, Terebella, Serpula, Chaetopterus, Pheretima and Hirudinaria.*
2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
3. T.S. through crop of leech.

Phylum Arthropoda

4. Study of *Limulus*, *Palamnaeus, Palaemon, Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, honeybee, silk moth, wasp and dragon fly.

Phylum Onychophora

5. Any one specimen/slide.

Phylum Mollusca

6. Study of *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Mytilus, Loligo, Sepia,Octopus* and *Nautilus* and *Cypraea* (cowrie).

Phylum Echinodermata

7. Study of echinoderm larvae.
8. Study of *Pentaceros, Asterias, Ophiura, Clypeaster, Echinus, Echinocardium, Cucumaria* and *Antedon.*

Note: Classification to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, 5th Edition, Holt Saunders International Edition".

Suggested Readings :

1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002) The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science, USA.
5. Barrington EJW (1979) *Invertebrate Structure and Functions*. 2nd Edition. ELBS and Nelson.
6. Boradale LA and Potts EA (1961) *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand, New Delhi.
8. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

C-2.2: LIFE SUSTAINING SYSTEMS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Digestive System

Structural organization, histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Role of gastrointestinal hormones on the secretion and control of enzymes of gastrointestinal tract.

UNIT-II : Respiratory System

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volume and capacity; Transport of oxygen in the blood; Oxygen- hemoglobin and myoglobin, dissociation curve and the factors influencing it; Carbon monoxide poisoning; Carbon dioxide transport in the blood; buffering action of blood and haemoglobin and Control of respiration.

UNIT-III : Excretory System

Structure of kidney and its histological details; Renal blood supply; Mechanism of urine formation and its regulation and Regulation of acid-base balance.

UNIT-IV : Blood

Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis and Coagulation of blood and Disorders of blood.

UNIT-V : Heart

Structure of heart; Coronary circulation; Structure of conducting and working of myocardial fibers; Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart; Nervous and chemical regulation of heart rate; Blood pressure and its regulation and Electrocardiogram.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Enumeration of red blood cells using haemocytometer.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Preparation of haemin and haemochromogen crystals.
4. Recording of blood pressure using a Sphygmomanometer.
5. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung and kidney.

Suggested Readings:

1. Arey LB (1974) Human Histology. 4th Edition. W.B. Saunders, USA.
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata.
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
6. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. & Wilkins, USA.

GE-2.3 : PLANT DIVERSITY

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I :

Algae: General characteristics, classification proposed by Fritsch. Occurrence, structure, reproduction and life cycle of:

(i) Cyanophyta-Nostoc (ii) Chlorophyta –Chlamydomonas and Chara
(iii) Xanthophyta-Vaucheria (iv) Phaeophyta-Ectocarpus

Range of thallus organization in algae. Origin and evolution of sex in algae. Economic importance of algae.

UNIT-II :

Fungi & Lichen: Fungi-General Characteristics, Classification Proposed By Anisworth. Occurrence, Structure, Reproduction And Life Cycle of:

(i) Mastigomycotina: Phytophthora : Symptoms And Disease Control Of Late Blight Of Potato.
(ii) Ascomycotina: Saccharomyces, Penicillium
(iii) Basidiomycotina: Puccinia, Agaricus. Symptoms And Disease Control of Rust of Wheat.

Economic Importance of Fungi.

Lichen- structure, reproduction and economic importance.

UNIT-III :

Bryophyta: General Characteristics, Morphology, Anatomy and Reproduction of :

(i) Hepaticopsida: Marchantia (ii) Anthocerotopsida: Anthoceros
(iii) Bryopsida : Sphagnum

Economic importance of bryophytes.

UNIT-IV : Pteridophyta:

General Characteristics, Morphology, Anatomy and Reproduction and life cycle of :

(i) Psilophytopsida: Rhynia (ii) Lycopsida: Selaginella
(iii) Sphenopsida: Equisetum (iv) Pteropsida: Marsilea

Stelar system and evolution of stele in pteridophytes. Heterospory and seed habit in pteridophytes.

UNIT-V :

Gymnosperms and Paleobotany:

General Characteristics. Distribution, Morphology, Anatomy, Reproduction and Life Cycle of :

(i) Cycadophyta: Cycas (ii) Coniferophyta: Pinus

(iii) Gnetophyta: Gnetum

Economic importance.

Fossil and Fossilization Process : Fossilization process, morphology, anatomy of lepedodendrom, lyginopteris and cycadeoidea.

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva Voce- 5 & Lab. Record- 10

1. Study of the morphology and anatomy of the various genera belonging to Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms belonging to the syllabus.
2. Study of different types of plant diseases caused by pathogens belonging to different classes of fungi, T.S of infected parts (Leaf & stem)
3. Study of growth forms of lichens (Crustose, Foliose and fruiticose)

Suggested Books :

1. Smith G.M. Cryptogamic Botany- Vol. I & Vol. II
2. Singh V., Pandey P.C. and Jain D.K. A. Textbook of Botany.
3. Mitra J.N. and Choudhury S.K. Moulik Studies in Botany Vol. I.
4. Nath Rabindra, Kalyani Modern College Botany Vol. I & II.

AECC-2.4 : ENVIRONMENTAL STUDIES

Full Marks –100
Mid Sem – 20/1 hr
End Sem– 80/3hrs

UNIT-I :

Concept of environment : Ecology; Ecosystem; types and components of the ecosystem. Ecological adaptations of plants and animals

UNIT-II :

Functional aspects of ecosystem : Trophic level, food chain, food web, energy flow in the ecosystem, ecological pyramids, Biogeochemical cycles: Water cycle and Nitrogen cycle

UNIT-III :

Environmental Pollution : Source, causes and concept of air, water, noise, soil, pollution, Sewage & Sewage treatment, green house effect, Acid rain, Ozone layer depletion

UNIT-IV :

Conservation of Natural Resources : Resources, renewable & non renewable resources; soil, soil erosion and its conservation; Forest, deforestation; afforestation, conservation of Forest

UNIT-V :

Biodiversity and its Conservation : Introduction, Definition : genetic species and ecosystem diversity, value of biodiversity; consumptive use, productive use, social, ethical and aesthetic values, Biodiversity at global, national and local level, conservation of Biodiversity:- In situ and Ex-situ conservation, Bio-Geographic classification of India

Suggested Readings :

1. Shukla, R.S and Chandel, P.S : Plant Ecology and soil science, S. Chand & Company Ltd, New Delhi
2. Sharma, P.D. : Ecology and Environment, Rastogi Publication, Meerut.
3. Singh, J.S. Singh, S.P and Gupta, R.S (2006). Environmental Science, Kalyani Publishers, New Delhi

SEMESTER-III

C-3.1: DIVERSITY AND DISTRIBUTION OF CHORDATA

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Protochordata and Origin of Chordates

General characters of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata; Dipleurula concept and the Echinoderm theory of origin of chordates.

UNIT-II : Introduction to Vertebrata and Agnatha

Advanced features of vertebrates over Protochordata; General characters and classification of cyclostomes up to class; Structural peculiarities and affinities of *Petromyzon* and *Myxine.*

UNIT-III : Pisces and Amphibia

General characters of Chondrichthyes and Osteichthyes and classification up to order; Migration; Osmoregulation and Parental care in fishes; Scales in fishes; Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characters and classification up to order and Parental care in Amphibians.

UNIT-IV : Reptilia and Aves

General characters and classification up to order; Skull in Reptilia; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes; General characters and classification up to order; Principles and aerodynamics of flight, Flight adaptations; *Archaeopteryx*- a connecting link and Migration in birds.

UNIT-V : Mammals and Zoogeography

General characters and classification up to order; Affinities of Prototheria and Metatheria; Dentition in mammals; Adaptive radiation with reference to locomotory appendages; Zoogeographical realms; Theories pertaining to distribution of animals and Distribution of vertebrates in different realms.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Protochordata

1. *Balanoglossus, Herdmania, Branchiostoma* and Colonial Urochordata.
2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of spicules of *Herdmania*.

2. Agnatha

5. *Petromyzon* and *Myxine.*

3. Fishes

6. *Sphyrna, Pristis, Trygon, Torpedo, Chimaera, Notopterus, Mystus, Heteropneustes, Hippocampus, Exocoetus, Echeneis, Anguilla, Tetrodon,Diodon, Anabas* and Flat fish.

4. Amphibia

7. *Ichthyophis/Ureotyphlus, Necturus, Duttaphrynus, Polypedates, Hyla, Alytes* and *Salamandra.*

5. Reptiles

8. *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco, Ophiosaurus, Bungarus, Vipera, Naja, Hydrophis, Zamenis* and *Crocodylus.*
9. Key for Identification of poisonous and non-poisonous snakes.

6. Aves

10. Study of six common birds from different orders.
11. Types of beaks and claws.
12. Types of feathers.

7. Mammalia

13. *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes* and *Hemiechenis.*

Suggested Readings:

1. Agarwal VK (2011) Zoology for degree students. S. Chand, New Delhi.
2. Arora MP (2006) Chordata-1. 1st Edition. Himalaya Publishing House, New Delhi.
3. Hall BK and Hallgrimsson B (2008) *Strickberger's Evolution*. 4th Edition. Jones and Bartlett Publishers Inc., USA.
4. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Young JZ (2004) *The Life of Vertebrates*. 3rd Edition. Oxford University Press, USA.

C-3.2: CONTROLLING AND COORDINATING SYSTEM

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Tissues and Glands, Bone and cartilage

Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue; Types of glands and their functions; Structure and types of bones and cartilages; Ossification, bone growth and resorption.

UNIT-II : Nervous System

Structure of neuron, resting membrane potential; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapsis, Synaptic transmission; Neuromuscular junction; Reflex action and its types, Reflex arc and Physiology of hearing and vision.

UNIT-III : Muscle

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation and tetanus.

UNIT-IV : Reproductive System

Histology of male and female reproductive systems; Puberty; Physiology of reproduction of male and female; Methods of contraception (depicted through flow chart).

UNIT-V : Endocrine System

Functional Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, thymus, pancreas, adrenals; Hormones secreted by them and their mechanism of action; Gonadal hormones; Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland), principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system and Placental hormones.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells.
3. Examination of sections of mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.

Suggested Readings:

1. Arey LB (1974) Human Histology. 4th Edition. W.B. Saunders, USA.
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata.
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
6. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. and Wilkins, USA.

C-3.3: COMPARATIVE ANATOMY OF VERTEBRATES

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Integumentary System and Skeletal System

Structure, functions and derivatives of integument; Axial and appendicular skeletons; Jaw suspensorium in vertebrates.

UNIT-II : Digestive and Respiratory System

Alimentary canal and associated glands; Skin, gills, lungs and air sacs and Accessory respiratory organs in fishes.

UNIT-III : Circulatory System

General plan of circulation; Evolution of heart and aortic arches.

UNIT-IV : Urinogenital System

Succession of kidney; Evolution of urinogenital ducts and Types of mammalian uteri.

UNIT-V : Nervous System and Sense Organs

Comparative account of brain; Autonomic nervous system; Spinal Nerves; Spinal cord; Cranial nerves in Mammals; Classification of receptors; visual receptors, chemo-receptors and mechanoreceptors.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.
2. Disarticulated skeleton of Frog, *Varanus,* Fowl and Rabbit.
3. Carapace and plastron of turtle or tortoise.

4. Mammalian skulls (One herbivorous and one carnivorous animal).

Suggested Readings:

1. Hilderbrand M and Gaslow GE. Analysis of Vertebrate Structure. John Wiley and Sons., USA.
2. Kardong KV (2005) Vertebrates' Comparative Anatomy, Function and Evolution. 4th Edition. McGraw-Hill Higher Education, New York.
3. Kent GC and Carr RK (2000) Comparative Anatomy of the Vertebrates. 9th Edition. The McGraw-Hill Companies, New York.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Weichert CK and William Presch (1970) Elements of Chordate Anatomy. Tata McGraw Hill, New York.

GE- 3.4 : CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: PHYSICAL CHEMISTRY-1

UNIT-I : Chemical Energetics (10 Lectures)

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium: (8 Lectures)

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o , Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

UNIT- II : Ionic Equilibria: (12 Lectures)

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. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

SECTION B: ORGANIC CHEMISTRY-2

UNIT- III : (8 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides (8 Lectures)

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

UNIT- IV : (14 Lectures)

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1^0 , 2^0 and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

UNIT-V: Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books :

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J.C. Kotz, P.M. Treichel & J.R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Physical Chemistry : Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone
4. Identification of simple organic compounds containing C, H, O & C, H, N & their confirmation using melting & boiling point only.

Reference Books :

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960)
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co

GE-3.5: QUANTITATIVE AND LOGICAL THINKING

Full Marks – 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

I. QUANTITATIVE APTITUDE & DATA INTERPRETATION

UNIT – I :

Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and Cube roots, Surds and Indices, Problems on Numbers, Divisibility

Steps of Long Division Method for Finding Square Roots:

UNIT – II :

Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture

UNIT – III :

Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them

UNIT – IV :

Concept of Angles, Different Polygons like triangles, rectangle, square, right angled triangle, Pythagorean Theorem, Perimeter and Area of Triangles, Rectangles, Circles

UNIT – V :

Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability

II. LOGICAL REASONING

UNIT – I :

Analogy basing on kinds of relationships, Simple Analogy; Pattern and Series of Numbers, Letters, Figures. Coding-Decoding of Numbers, Letters, Symbols (Figures), Blood relations

UNIT – II :

Logical Statements– Two premise argument, More than two premise argument using connectives

UNIT – III :

Venn Diagrams, Mirror Images, Problems on Cubes and Dices

SEMESTER-IV

C-4.1: BIOCHEMISTRY OF METABOLIC PROCESSES

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Biomolecules

Structures and properties of important mono-, di- and polysaccharides; Fatty acids, triglycerides and steroids; and amino acids and proteins.

UNIT-II : Carbohydrate Metabolism

Glycolysis; Citric acid cycle; pentose phosphate pathway; Gluconeogenesis; Shuttle systems (Malate-aspartate shuttle, Glycerol 3-phosphate shuttle); Glycogenolysis; Glycogenesis.

UNIT-III : Lipid Metabolism

β-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid and Ketogenesis and its regulation.

UNIT-IV : Protein Metabolism

Catabolism of amino acids: Transamination, Deamination; Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

UNIT-V : Enzymes and Oxidative Phosphorylation

Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action; Allosteric enzymes; Oxidative phosphorylation in mitochondria; Respiratory chain, ATP synthase, Inhibitors and Uncouplers.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
2. Colour tests of functional groups in protein solutions.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH on the action of salivary amylase.
5. Effect of temperature on the action of salivary amylase.
6. Estimation of total protein in given solutions by Lowry's method.

Suggested Readings:

1. Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry. 6th Edition, W.H. Freeman and Co., New York.
2. Cox MM and Nelson DL (2008) Lehninger Principles of Biochemistry. 5th Edition. W.H. Freeman and Co., New York.
3. Devesena T (2014) Enzymology. 2nd Edition. Oxford University Press, UK.
4. Hames BD and Hooper NM (2000) Instant Notes in Biochemistry. 2nd Edition. BIOS Scientific Publishers Ltd., U.K.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Well PA (2009) Harper's Illustrated Biochemistry. 28th Edition. International Edition. The McGraw-Hill Companies Inc., New York.

C-4.2: CELL BIOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells; Mycoplasma; Virus, Viroids, Virions and Prions; Various models of plasma membrane; Transport across membranes; Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.

UNIT-II : Endomembrane System, Mitochondria and Peroxisomes

The Endoplasmic Reticulum; Golgi apparatus; Mechanism of vesicular transport; Lysosomes; Structure and function of mitochondria: Chemi-osmotic hypothesis; Semiautonomous nature of mitochondria; Endosymbiotic hypothesis and Peroxisomes.

UNIT-III : Cytoskeleton and Nucleus

Structure and functions of intermediate filament, microtubules and microfilaments; Ultra structure of nucleus; Nuclear envelope: Structure of nuclear pore complex; Chromosomal DNA and its packaging; Structure and function of Nucleolus.

UNIT-IV : Cell Cycle and Cell Signaling

Cell cycle, Regulation of cell cycle; Signaling molecules and their receptors.

UNIT-V : Apoptosis and Cancer

Extrinsic (Death Receptor) Pathway and Intrinsic (Mitochondrial) Pathway; Growth and development of tumors and Metastasis.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Gram's staining technique for visualization of prokaryotic cells.
2. Study various stages of mitosis from permanent slides.
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides).
5. Cytochemical demonstration (Preparation of permanent slides).
   i. DNA by Feulgen reaction.
   ii. Mucopolysaccharides by PAS reaction.
   iii. Proteins by Mercurobromophenol blue.
   iv. DNA and RNA by Methyl Green Pyronin.

   (In practical examination, 05 marks should be of permanent slide submission; one mark each for DNA, PAS, Proteins, MGP and Barr body slide.)

Suggested Readings:

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni G P (2009) The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008) Molecular Biology of the Cell. 5th Edition. Garland publishing Inc., New York.
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc., USA.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

C-4.3: PRINCIPLES OF GENETICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Mendelian Genetics and its Extension

Principles of inheritance; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance.

UNIT-II : Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over; Cytological basis of crossing over; Molecular mechanisms of crossing over; Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Interference and coincidence and Somatic cell hybridization.

UNIT-III : Mutations

Gene mutations; Chromosomal mutations: Deletion, duplication, inversion, translocation; Aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached *X* method and DNA repair mechanisms.

UNIT-IV : Sex Determination and Quantitative Genetics

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex limited characters; Polygenic inheritance and Transgressive variation.

UNIT-V : Extra-chromosomal Inheritance

Criteria for extra-chromosomal inheritance; Antibiotic resistance in *Chlamydomonas*; Mitochondrial mutations and Maternal effects.

PRACTICAL

End Sem Practical – 30/3 hrs

1. To study the Mendelian laws and gene interactions and their verification by Chisquare analyses using seeds/beads/*Drosophila*.
2. Identification of various mutants of *Drosophila*.
3. To calculate allelic frequencies by Hardy-Weinberg Law.
4. Linkage maps based on data from crosses of *Drosophila*.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.
7. Preparation of polytene chromosomes from larva of *Chironomous*/*Drosophila*.
8. To study mutagenicity in *Salmonella/E. coli* by Ames test.

Suggested Readings:

1. Gardner EJ, Simmons MJ, Snustad DP (2008) Principles of Genetics. 8th Edition. Wiley India.
2. Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB. Introduction to Genetic Analysis. 9th Edition. W. H. Freeman and Co., New York.
3. Klug WS, Cummings MR, Spencer CA and Palladino MA (2012) Concepts of Genetics. 10th Edition. Pearson Edsucation, Inc., USA.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Russell PJ (2009) Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings, USA.
6. Verma PS and Agarwal VK (2010) Genetics. 9th Edition. S. Chand, New Delhi.

GE-4.4 : ANGIOSPERMS AND DEVELOPMENTAL BOTANY

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I :

Taxonomy of Angiosperms: Taxonomic categories, concept of species, Nomenclature, Elementary idea about ICN, classification of flowering plants proposed by (i) Bentham and Hooker (2) Engler & Prantle. General Account and floral character of the following families: Magnoliaceae, Lamiaceae, Apocyanaceae, Musaceae. Poaceae.

UNIT-II :

Embryology of Angiosperms and Plant breeding: Male gametophytes & Microsporogenesis, female gametophytes and megasporogenesis. Process of fertilization, structure and development of different types of endosperms, structure and development of monocot and dicot embryo. General account of plant breeding, pure line and mass selection.

UNIT-III :

Anatomy and Tissue culture: Meristematic and permanent tissue, Epidermal, Fundamental, conductive tissue systems. Secondary growth in dicot stem and root. Adaptive and non–adaptive anomalous secondary growth in stem: Bignonia Bougainvillea, Amaranthus and Boerhaavia. Concept of totipotency, principles and procedure of plant tissue culture

UNIT-IV :

Economic Botany: Origin and diversification of domesticated plants. General account of botany, cultivation and economic importance of Rice, Jute, Sugarcane, Green gram, Coconut. General account of the following medicinal and timber yielding plants; Azadirachta, Ocimum, Aloe, Rawolfia, Shorea, Tectona

UNIT-V :

Plant Physiology: Osmosis, plasmolysis, concept of water potential, transpiration, water absorption, ascent of sap. Enzyme & enzyme action. Photosynthesis, translocation of photosynthates. Biological nitrogen fixation phytohormones (Auxins, Gibberellins, Cytokininis)

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva Voce- 5 & Lab. Record- 10

1. Study of flowering plants belonging to the dicot families in the syllabus.
2. Study of flowering plants belonging to the monocot families in the syllabus.
3. Study of embryological slides related to the syllabus.
4. Study of anomalous secondary growth of different plant species included in the syllabus (*Bignonia, Bougainvillea, Amaranthus and Boerrhaevia*).
5. Study of economically important plants included in the syllabus.
6. Determination of osmotic pressure by plasmolytic method.
7. Determination of diffusion pressure deficit (DPD) of storage tissue.
8. To measure the ratio between transpiration and absorption by T/A apparatus.
9. Measurement of rate of photosynthesis by using Willmott's Bubbler under different light qualities and CO_2 concentration.
10. Microscopic observation of opening and closing of stomata.

Books Recommended :

1. Heywood V.H Current concepts in plant Taxonomy.
2. Jeffery C, An Introduction to plant Taxonomy. Cambridge Press, Cambridge.
3. Sambamurty A.V.S.S. Taxonomy of Angiosperms.
4. Subramaniyam N.S Modern Plant Taxonomy.
5. Singh V. & Jain D.K. Taxonomy of Angiosperms – Rastogi Publications.
6. Bhojwani S.S. & Bhatnagar S.P. Embryology of Angiosperms.
7. Singh V., Pande P.C. & Jain D.K. Embryology of Angiosperms.
8. Maheswari P. An Introduction to Embryology of Angiosperms.
9. Pandey B.P. Plant Anatomy.
10. Vasistha P.C. A. Text Book of Plant Anatomy.
11. Singh B.D. Applications of Biotechnology.
12. Pandey B.P. Economic Botany.
13. Kochhar S.L. Economic Botany in Tropics-, Macmillan & Company, New Delhi India.
14. Srivastava H.N. Plant Physiology.
15. Verma V. Plant Physiology.

SECC-4.5 : COMMUNICATIVE ENGLISH

(Enriching Linguistic Knowledge & Communication Proficiency)

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3hrs

UNIT-I : BUSINESS COMMUNICATION AND GRAMMAR

Why English Communication is Essential and How to Improve the Skill?

Introduction to Voice and Accent, Why do we have such different accents?, Accent Training-Consequences, Voice and accent in the Enterprise Industry, Globally Comprehensible Accent, Introduction to Phonetics, International Phonetic Alphabet

Consonant Sounds

Vowels

Diphthongs

A Few Phonic Rules

Word Stress: Syllables

Intonation : Intonation and Stress

Pacing and Chunking : Common Patterns of Pacing, Importance of Chunking

Fluency

Indianisms : Errors relating to Grammar, Vocabulary

UNIT-II : GRAMMAR

English: Spoken Versus Written Communication

Nouns : Kinds of Nouns, Activity 3: Noun Ping-pong, Nouns-Number, Noun-Gender, Countable and Uncountable Nouns

Pronouns : Reflexive Pronouns, Relative Pronouns, Demonstrative Pronouns, Interrogative Pronouns, Indefinite pronouns, Activity 4: Sentence Auction

Adjectives : Activity 5 : Picture perfect, Positioning of adjectives, Comparative Degrees of Adjectives, Order of Adjectives

Adverbs : Kinds of Adverb, Degree of Comparison, Word Order with Adverbs, Activity 6: Relay Race

Prepositions : Activity 7: Treasure Hunt, Activity 8: Route Map, Prepositions with Adjectives, Nouns and Verbs

Conjunctions : Coordinating conjunctions, Subordinating Conjunctions, Correlative Conjunctions, Connecting Adverbs, Activity 9: The Socks Story

Verbs : Verb Classification, List of irregular verbs, Activity 10: Word Search

Subject and verb agreement, Activity 11: Tossed Word Salad, Activity 12: The Sentence Pageant Determiners and Modifiers : Kinds of determiners, The Definite and the Indefinite Article, Definite Article: The, Activity 13: Proof Reading

Tenses : Reference Table, Present Tense, Activity 14: Instruction Manual, Activity 15: Commentary, Past Tense, Activity 16:The Chain List, Activity 17: Transcription, Future Tense, Activity 18: This Week for You, Activity 19: Verb Grand Prix

Punctuation : Forms of Punctuation

UNIT-III : READING COMPREHENSION

Reading – A 7 Step Process, Techniques to enhance students' reading skills, Types of reading skills, Skimming, Scanning, Extensive reading, Intensive reading, Three levels of Reading, Improving your reading speed, Reading Comprehension Practice Exercises

SEMESTER-V

C-5.1: DEVELOPMENTAL BIOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Introduction

History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of induction; Cell-Cell interaction; Pattern formation; Differentiation and growth; Differential gene expression; Cytoplasmic determinants and asymmetric cell division.

UNIT-II : Early Embryonic Development

Gametogenesis (Spermatogenesis, Oogenesis); Types of eggs; Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation; Fate maps; Embryonic induction and organizers.

UNIT-III : Late Embryonic Development

Fate of germ layers; Extra-embryonic membranes in birds; Implantation of embryo in humans and Placenta (Structure, types and functions of placenta).

UNIT-IV : Post Embryonic Development

Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration (epimorphosis, morphallaxis and compensatory regeneration); Ageing: Concepts and models.

UNIT-V : Implications of Developmental Biology

Teratogenesis: Teratogenic agents and their effects on embryonic development; *in vitro* Fertilization; Stem cell culture and Amniocentesis.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation(Hamilton and Hamburger stages).
3. Study of developmental stages (above mentioned) by raising chick embryo in the laboratory.
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
5. Study of different types of placenta.
6. Project report on *Drosophila* culture/chick embryo development.

Suggested Readings:

1. Balinsky BI and Fabian BC (1981) An Introduction to Embryology. 5th Edition. International Thompson Computer Press.
2. Gilbert SF (2010) Developmental Biology. 9th Edition. Sinauer Associates, Inc., USA.
3. Kalthoff (2008) Analysis of Biological Development. 2nd Edition. McGraw-Hill, New York.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E and Smith J (2002) Principles of Development. 1st Edition, Oxford University Press, New York.

C-5.2: MOLECULAR BIOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Nucleic Acids and DNA Replication

Salient features of DNA double helix; Watson and Crick model of DNA; DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases; Cot curves; Structure of RNA, tRNA and DNA and RNA associated proteins; DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication; Role of proteins and enzymes in replication; Licensing factors; Semi-conservative, bidirectional and semi-discontinuous replication; RNA priming; Replication of circular and linear *ds*-DNA and replication of telomeres.

UNIT-II : Transcription

RNA polymerase and transcription Unit; Mechanism of transcription in prokaryotes and Eukaryotes; Synthesis of rRNA and mRNA; Transcription factors and regulation of transcription.

UNIT-III : Translation

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

UNIT-IV : Post Transcriptional Modifications and Processing of Eukaryotic RNA

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

UNIT-V : Gene Regulation and Regulatory RNAs

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing, Genetic imprinting; Ribo-switches, RNA interference, miRNA and siRNA.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Study of DNA replication using Photographs or slides and special cases, e.g., Polyteny using permanent slides of polytene chromosomes.
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
3. Estimation of the growth kinetics of *E. coli* by turbidity method.
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
7. Quantitative estimation of RNA using Orcinol reaction.

Suggested Readings:

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2008) Molecular Biology of the Cell, 4th Edition. Garland publishing Inc., New York.
3. Cooper GM and Hausman RE (2007) The Cell: A Molecular Approach**.** 4th Edition, ASM Press, USA.
4. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley and Sons. Inc., USA.
6. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

DSE-5.3: ANIMAL BEHAVIOUR & BIOSTATISTICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Introduction and Mechanisms of Behaviour

Origin and history of Ethology; Brief profiles of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate behavior; Objective of behaviour, Behaviour as a basis of evolution; Behaviour as a discipline of science; Innate behaviour, Instinct, Stimulus filtering, Sign stimuli and Code breakers.

UNIT-II : Patterns of Behaviour

Reflexes: Types of reflexes, reflex path, characteristics of reflexes (latency, after discharge, summation, fatigue, inhibition) and its comparison with complex behavior.

Orientation: Primary and secondary orientation; kinesis-orthokinesis, klinokinesis; taxistropotaxis and klinotaxis and menotaxis (light compass orientation) and mnemotaxis.

Learning: Associative learning, classical and operant conditioning, Habituation and Imprinting.

UNIT-III : Social Behaviour

Insects' society; Honey bee: Society organization, polyethism, foraging, round dance, waggle dance, Experiments to prove distance and direction component of dance, learning ability in honey bee, formation of new hive/queen; Reciprocal altruism, Hamilton's rule and inclusive fitness with suitable examples.

UNIT-IV : Biological Clocks

Circadian rhythm, Tidal rhythm, Lunar rhythm, Advantages of biological clocks, Jet lag and Entrainment.

UNIT-V :

Sample, population, Histogram, frequency polygon and frequency curves, pie chart, Mean, Median, Mode, Standard deviation, Chi-square test and students 't' test

PRACTICAL

End Sem Practical – 30/3 hrs

1. To study different types of animal behaviour such as habituation, social life, courtship behaviour in insects, and parental care from short videos/movies and prepare a short report.
2. To study nests and nesting habits of the birds and social insects.
3. To study the behavioural responses of wood lice to dry condition.
4. To study behavioural responses of wood lice in response to humid condition.
5. To study geotaxis behaviour in earthworm.
6. To study the phototaxis behaviour in insect larvae.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

Suggested Readings:

1. David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
2. John A (2001) Animal Behaviour. 7th Edition. Sinauer Associate Inc., USA.
3. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, USA.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Paul WS and John A (2013) Exploring Animal Behaviour. 6th Edition. Sinauer Associate Inc., Massachusetts, USA.

DSE-5.4: ECONOMIC ZOOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Bee-keeping and Bee Economy (Apiculture)

Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Diseases of honey bee, American and European Foulbrood, and their management; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee; Visit to an apiculture institute and honey processing Units.

UNIT-II : Silk and Silk Production (Sericulture)

Different types of silk and silkworms in India; Rearing of *Bombyx mori,* Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons; Silkworm diseases: Pebrine, Flacherie, Grasserie, Muscardine and Aspergillosis, and their management; Silkworm pests and parasites: Uzi fly, Dermestid beetles and their management; Silk reeling techniques and Quality assessment of silk fibre.

UNIT-III : Aquaculture I

Brood stock management; Induced breeding of fish; Management of hatchery of fish; Management of nursery, rearing and stocking ponds; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish; Fishery by-products.

UNIT-IV : Aquaculture II

Prawn farming; Culture of crab; Pearl culture and Culture of air breathing fishes.

UNIT-V : Dairy and Poultry Farming

Introduction; Indigenous and exotic breeds; Rearing, housing, feed and rationing; Commercial importance of dairy and poultry farming; Varietal improvement techniques; Diseases and their management; Dairy or poultry farm management and business plan; Visit to any dairy farm or Poultry farm.

** Submission of report on anyone field visits mentioned above.*

PRACTICAL

End Sem Practical – 30/3 hrs

1. Study of different types of bees (Queens, Drones and Worker bees).
2. Study of different types of silk moths.
3. Study of different types of pearls.
4. Study of different types of fish diseases.
5. Identification of different types of scales in fishes.
6. Study of different types of fins.

7. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
8. Identification of various types of natural silks.

Suggested Readings:

1. Dhyan Singh Bisht, Apiculture, ICAR Publication.
2. Dunham RA (2004) Aquaculture and Fisheries Biotechnology – Genetic Approaches. CABI publications, U.K.
3. Hafez ESE (1962) Reproduction in Farm Animals. Lea and Fabiger Publishers.
4. Knobil E and Neill JD (2006) The Physiology of Reproduction. Vol. 2. Elsevier Publishers, USA.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
7. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
8. Srivastava CBL (1999) Fishery Science and Indian Fisheries. Kitab Mahal publications, India.

SEMESTER-VI

C-6.1: IMMUNOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Immune System and Immunity

Historical perspective of Immunology, Early theories of Immunology, Haematopoiesis, Cells and organs of the Immune system; Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity and Immune dysfunctions.

UNIT-II : Antigens

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T - Cell epitopes.

UNIT-III : Immunoglobulins

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies and Hybridoma technology.

UNIT-IV : Major Histocompatibility Complex and Complement System

Structure and functions of endogenous and exogenous pathway of antigen presentation; Components and pathways of complement activation.

UNIT-V : Cytokines, Hypersensitivity and Vaccines

Properties and functions of cytokines; Cytokine-based therapies; Gell and Coombs' classification and Brief description of various types of hypersensitivities; Types of vaccines: Recombinant vaccines and DNA vaccines.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Demonstration of lymphoid organs.
2. Ouchterlony's double immuno-diffusion method.
3. Determination of ABO blood group.
4. Preparation of single cell suspension of splenocytes from chick spleen, cell counting and viability test.
5. ELISA/ dot Elisa (using kit).
6. Principles, experimental set up and applications of immuno-electrophoresis, RIA, F.

Suggested Readings:

1. Abbas KA and Lechtman HA (2003) Cellular and Molecular Immunology. 5th Edition. Saunders Publication, Philadelphia.
2. David M, Jonathan B, David RB and Ivan R (2006) Immunology. 7th Edition. Elsevier Publication, USA.
3. Kindt TJ, Goldsby RA, Osborne BA and Kuby J (2006) Immunology. 6th Edition. W.H. Freeman and Company, New York.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

C-6.2: EVOLUTIONARY BIOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : History of Life, theories of Evolution and Extinction

Chemogeny, Biogeny, RNA World, Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.

UNIT-II : Evidences of Evolution

Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.

UNIT-III : Processes of Evolutionary Change

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

UNIT-IV : Principles of population genetics

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressure and Gene flow and Shifts in gene frequencies with selection.

UNIT-V : Species Concept and Evolution above species level

Biological concept of species (Advantages and Limitations); Sibling species, Polymorphic species, Polytypic species, Ring species; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (Darwin's Finches); Convergence, Divergence and Parallelism.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Study of fossil evidences from plaster cast models and pictures.
2. Study of homology and analogy from suitable specimens/ pictures.
3. Demonstration of changing allele frequencies with and without selection.
4. Construction of cladogram based on morphological characteristics.
5. Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip).
6. Interpretation of phylogenetic trees.

Suggested Readings:

1. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH (2007) Evolution. Cold Spring Harbour Laboratory Press.
2. Campbell NA and Reece JB (2011) Biology. 9th Edition. Pearson Education Inc., New York.
3. Douglas JF (1997) Evolutionary Biology. Sinauer Associates, USA.
4. Hall BK and Hallgrimsson B (2008) Evolution. 4th Edition. Jones and Bartlett Publishers, USA.
5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
6. Pevsner J (2009) Bioinformatics and Functional Genomics. 2nd Edition. Wiley-Blackwell, USA.
7. Ridley M (2004) Evolution. 3rd Edition. Blackwell Publishing, USA.

DSE-6.3: MICROBIOLOGY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I :

History of Microbiology; Microbial World – Characterization, Classification and identification of microbes.

UNIT-II :

Prokaryotes: General morphology and classification of bacteria, their characters and economic importance; Gram-positive and Gram-negative bacteria.

UNIT-III :

Eukaryotes: General morphology of Protista and Fungi – classification and economic importance.

UNIT-IV :

Viruses: structure, genome, replication cycle; Epidemiology of infectious diseases with reference of human hosts – Bacterial (Tuberculosis), Viral (Hepatitis), Protozoan (Amoebiasis) and Fungal (any one) disease.

UNIT-V :

Microbe interactions-Immune Responses-Antibiotics and other chemotherapeutic agents; Applied microbiology in the fields of food, agriculture, industry and environment.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Cleaning of glasswares, sterilisation principle and methods - moist heat - dry heat and filtration methods.
2. Media preparation: Liquid media, Solid media, Agar slants, Agar plates. Basal, enriched, selective media preparation - quality control of media, growth supporting properties, sterility check of media.
3. Pure culture techniques: Streak plate, pour plate and decimal dilution.
4. Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description and demonstration of pigment production.
5. Staining techniques: Smear preparation, simple staining, Gram's staining, Acid fast staining and staining for metachromatic granules.
6. Morphology of microorganisms.
7. Antibiotic sensitivity testing: Disc diffusion test - Quality control with standard strains
8. Physiology characteristics: IMViC test, H_2S, Oxidase, catalase, urease test, Carbohydrate fermentation, Maintenance of pure culture, Paraffin method, Stab culture and maintenance of mold culture.

Suggested Readings:

1. Ahsan J and Sinha SP (2010) A Hand book on Economic Zoology. S Chand, New Delhi.
2. Arora DR and Arora B (2001) Medical Parasitology. 2nd Edition. CBS Publications and Distributers.
3. Atwal AS (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
4. Dubey RC and Maheshwari DK (2013) A Textbook of Microbiology. S. Chand, New Delhi.
5. Dunham RA (2004) Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications.
6. Pelczar MJ, Chan ECS and Krieg NR (1993) Microbiology. 5th Edition, Tata McGraw Hill Publishing Co.Ltd.
7. Pradhan, S (1983) Insect Pests of Crops. National Book Trust of India, New Delhi.
8. Shukla, G.S. and Upadhya, V.B. (2013) Economic Zoology. 5th Edition, Rastogi Publications, Meerut.

DSE-6.4: PROJECT WORK

Full Marks - 100
End Sem Project – 100

Topics to be announced by the HOD.

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