COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

ZOOLOGY HONOURS

Choice Based Credit System(CBCS)

First & Second Semester Examination – 2019-20

Third & Fourth Semester Examination – 2020-21

Fifth & Sixth Semester Examination – 2021-22

GOVERNMENT AUTONOMOUS COLLEGE,
PHULBANI, KANDHAMAL

SYLLABI FOR CBCS COURSE

Sem	CORE COURESE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	AECC-I			GE-IA
	CORE-II				
II	CORE-III	AECC-II			GE-1B
	CORE -IV				
III	CORE-V		SEC-II		GE-2A
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		SEC-I		GE-2B
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-I	
	CORE-XII			DSE-II	
VI	CORE-XIII			DSE-III	
	CORE-XIV			DSE-IV / Project	

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons) (Zoology Honours)				
Yr.	Sl.No.	**Course Structure**	**Code**	**Credit Points**
FIRST YEAR		**SEMESTER-I**		
	1	Non-chordates I : Protista to Pseudocoelomates	C-1.1	4+2
	2	Principles of Ecology	C-1.2	4+2
	3	Chemistry	GE-1.3	4+2
	4	EVS	AECC-1.4	6
		SEMESTER-II		
	5	Non-chordates II : Coelomates	C-2.1	4+2
	6	Cell Biology	C-2.2	4+2
	7	Botany	GE-2.3	4+2
	8	MIL Communication – Odia / MIL (AE)	AECC-2.4	6
SECOND YEAR		**SEMESTER-III**		
	9	Diversity of Chordates	C-3.1	4+2
	10	Physiology : Controlling and Coordinating systems	C-3.2	4+2
	11	Fundamentals of Biochemistry	C-3.3	4+2
	12	Chemistry	GE-3.4	6
	13	Quantitative & Logical Thinking	SECC-II-3.5	6
		SEMESTER-IV		
	14	Comparative Anatomy of Vertebrates	C-4.1	4+2
	15	Physiology : Life sustaining Systems	C-4.2	4+2
	16	Biochemistry of Metabolic Process	C-4.3	4+2
	17	Botany	GE-4.4	4+2
	18	Communicative English	SECC-I-4.5	6
FINAL YEAR		**SEMESTER-V**		
	19	Molecular Biology	C-5.1	4+2
	20	Principles of Genetics	C-5.2	4+2
	21	Animal Behaviour and Chronobiology	DSE-5.3	4+2
	22	Economic Zoology	DSE-5.4	4+2
		SEMESTER-VI		
	23	Developmental Biology	C-6.1	4+2
	24	Evolutionary Biology	C-6.2	4+2
	25	Immunology	DSE-6.3	4+2
	26	Project Work / Fish and Fisheries	DSE-6.4	6 / 4+2

Notes:

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

SEMESTER-I

C-1.1 : NON-CHORDATES I: PROTISTA TO PSEUDOCOELOMATES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Protista, Parazoa, Metazoa and Porifera

General characteristics and Classification up to classes. Study of *Euglena*, *Amoeba*. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*. Locomotion and Reproduction in Protista.General characteristics and Classification up to classes, Canal system and spicules in sponges.

UNIT – II: Cnidaria & Ctenophora

General characteristics and Classification up to classes, Metagenesis in *Obelia*, Polymorphism in Cnidaria, Corals and coral reefs. General characteristics and Evolutionary significance of Ctenophora.

UNIT – III: Platyhelminthes

General characteristics and Classification up to classes. Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium.*

UNIT – IV: Nemathelminthes

General characteristics and Classification up to classes. Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*. Parasitic adaptations in helminthes.

Note: Classification to be followed from "Barnes, R.D. (1982). Invertebrate Zoology, V Edition"

PRACTICAL

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*.
2. Examination of pond water collected from different places for diversity in protista.
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*.
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*.
5. One specimen/slide of any ctenophore.
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs).
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs).
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Note: Classification to be followed from "Ruppert and Barnes (2006) Invertebrate Zoology, 8th edition, Holt Saunders International Edition"

Text Books :

1. Kotpal RL; Modern Textbook of Zoology – Invertebrates; Rastogi Publications - Meerut; 2016 edition
2. Richard Busca, W. Moore, Stephen M. Shuster. Invertebrates; OUP USA; 3rd edition (19 January 2016)

Suggested Readings :

- Richard Fox , Robert D. Barnes, Edward E. Ruppert, Invertebrate Zoology: A
- Functional Evolutionary Approach, Brooks/Cole; 7th edition 2003
- Barrington, E.J.W.Invertebrate Structure and Functions. II Edition, E.L.B.S. and
- Nelson.
- Hyman, L.H. Invertebrate Series (Recent edition)
- Verma P. S. A Manual of Practical Zoology: Invertebrates. S Chand Publication
- Parker JJ and WA Haswel Textbook of Zoology. Vol I and II

C-1.2 : PRINCIPLES OF ECOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Ecosystem and Applied Ecology

Ecology: Autecology and synecology, Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids Nutrient and biogeochemical cycle with one example of Nitrogen cycle. Ecology in Wildlife Conservation and Management. Laws of limiting factors, Study of physical factors- (Light, temperature).

UNIT – II: Population

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.

UNIT – III: Community

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example. Theories pertaining to climax community.

UNIT – IV: Biometry

Biological data, graphical representation of data (frequency polygon and histogram), sampling techniques, measures of central tendency (Mean, median and mode), Measures of dispersion (range, quartile deviation, mean deviation and standard deviation), Hypothesis and hypothesis testing (Chi-square test, t- test)

PRACTICAL

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: Phytoplankton and zooplankton collection, preservation and mounting, Measurement of temperature, turbidity/penetration of light, determination of pH, Dissolved Oxygen content (Winkler's method), BOD, COD, Free CO2, Hardness, TDS.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.
5. Chi-square analysis using seeds/beads/*Drosophila*.
6. Problems on standard deviation.
7. Graphical representation of data (Frequency polygon and Histogram).

Text Book

1. Odum, E.P. and Barrett, G.W., (2018). Fundamentals of Ecology, 5th Edition
2. Smith and Smith, Elements of Ecology, Global Edition; Pearson Education India; ninth edition (14 May 2015)
3. Myra Samuels, J. Witmer,A. Schaffner, Statistics for the life sciences, Prentice Halls, Boston, 4th edition, 2012

Suggested Readings :

- Kormondy, (2017). Concepts of Ecology, Updated 4/e, Pearson
- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Ricklefs, R.E., (2000). Ecology. 5th Edition. Chiron Press
- Dash M.C., Fundamentals of Ecology. Mc GrawHill
- Smith TM and Smith RL, Elements of Ecology, 8th Edition,Pearson education INC, USA
- Miller, G.T. and Spoolman, S.E. (2017) Environmental Science, 14th Edition. Cengage Publication, New Delhi.
- Baneerjee Pranab Kumar, Introduction to biostatistics, S Chand & Company; 3rd Rev. Edn. 2006 edition
- Chainy GBN, Mishra G, Mohanty PK, 2016, Basic Biostatistics, Kalyani Publisher 3rd edition

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

SECTION A: INORGANIC CHEMISTRY-I

UNIT-I : Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrodinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Quantum numbers and their significance, shapes of s, p and d atomic orbitals, nodal planes.

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 orbital, Anomalous electronic configurations.

UNIT-II : Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics, energy considerations. Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules and its applications.

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 (N_2, O_2) and heteronuclear diatomic molecules (CO, NO). Comparison of VB and MO approaches.

SECTION B: ORGANIC CHEMISTRY-I

UNIT- III : Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive effect, Electrometric 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: Huckel's rule.

Stereochemistry

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

UNIT-IV : Aliphatic Hydrocarbons

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

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

Alkenes: (Up to 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.

Alkynes: (Up to 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.

Recommended Text Books :

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5th Edn., 2008.
2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd Ed., 2017.
3. Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford University Press, 5th Edn.
4. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry – Principles of structure and reactivity, Pearson Education, 4th Ed. 2002.
5. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Bhal Arun & Bhal B S., Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
7. Kalsi, P. S. Stereochemistry Conformation and Mechanism; 8th Edn, New Age International, 2015.

Reference books :

- Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
- Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.
- Mallick, Madan and Tuli, S. Chand Selected Topic in Inorganic Chemistry, 17thEdn. 2010.
- Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications.

PRACTICAL

SECTION A: INORGANIC CHEMISTRY

Volumetric Analysis

a. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
b. Estimation of oxalic acid by titrating it with $KMnO_4$.
c. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
d. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
e. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

SECTION B: ORGANIC CHEMISTRY

a. Detection of extra elements (N, S, Cl) in organic compounds (containing up to two extra elements)
b. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
    i. 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.

ii. Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

AECC-1.4 : ENVIRONMENTAL STUDIES

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

UNIT – I

The Environment: The Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecology, Ecosystem, Biogeochemical Cycle (Carbon Cycle, Nitrogen Cycle), Environment Pollution: Air Pollution, Water Pollution, Soil Pollution, Radiation Pollution

UNIT – II

Population Ecology: Individuals, Species, Pollution, Community, Control Methods of Population, Urbanization and its effects on Society, Communicable Diseases and its Transmission, Non-Communicable Diseases

UNIT – III

Environmental Movements in India: Grass root Environmental movements in India, Role of women, Environmental Movements in Odisha, State Pollution Control Board, Central Pollution Control Board

UNIT – IV

Natural Resources: Conservation of Natural Resources, Management and Conservation of Wildlife, Soil Erosion and Conservation, Environmental Laws: Water Act, 1974, Air Act, 1981, The Wildlife (Protection) Act, 1972, Environment Protection, 1986, Natural Disasters and their Management

Suggested Readings :

- Dash MC and Mishra PC, Man and Environment, McMillan, London.
- Mishra PC and Das MC, Environment and Society, McMillan, London.
- Odeem EP, Fundamentals of Ecology, Natraj Publication.
- Mishra DD, Fundamental Concept in Environmental Studies, S. Chand, New Delhi.
- Asthana DK and Asthana Meera, A Text book of Environmental Studies, S. Chand, New Delhi.
- Bharucah Erach, Textbook for Environmental Studies, Universities Press India Pvt. Ltd., Hyderabad.

SEMESTER-II

C-2.1 : NON- CHORDATES II: COELOMATES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Coelomates and Annelids

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Excretion in Annelida.

UNIT – II: Arthropoda and Onychophora

General characteristics and Classification up to classes. Vision and Respiration in Arthropoda. Metamorphosis in Insects. Social life in bees and termites. Onychophora: General characteristics and Evolutionary significance.

UNIT – III: Mollusca

General characteristics and Classification up to classes. Respiration in Mollusca. Torsion and detorsion in Gastropoda. Evolutionary significance of trochophore larva.

UNIT – IV: Echinodermata

General characteristics and Classification up to classes. Water-vascular system in Asteroidea, Larval forms in Echinodermata, Affinities with Chordates.

Note: Classification to be followed from "Ruppert and Barnes (2006) Invertebrate Zoology, 8th edition, Holt Saunders International Edition"

PRACTICAL

1. Study of following specimens:
2. Annelids - *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria*
3. Arthropods – *Tachypleus,Carcinoscorpious, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina*, Cancer, *Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees
4. Onychophora –*Peripatus*
5. Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus*
6. Echinodermates - *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon*
7. Study of digestive system, nephridia of earthworm (Virtual).
8. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
9. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta.*
10. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Text Books :

1. Kotpal RL (2014) Text book of Zoology, Invertebrate, Rastogi Publication
2. Jordan and Verma PS (2009) Invertebrate Zoology. S Chand publication.

Suggested Readings :

❖ Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
❖ Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
❖ Verma P S. (2010) A Manual of Practical Zoology: Non-chordates. S Chand Publication

C-2.2 : CELL BIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Overview of cells and plasma membrane

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membrane structure. Transport across membranes: Active and Passive transport, Facilitated transport. Cell junctions: Tight junctions, Desmosomes, Gap junctions.

UNIT – II: Cytoskeleton & Endomembrane System

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments; Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes.

UNIT – III: Mitochondria and Peroxisomes

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis; Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis. Peroxisomes.

UNIT – IV: Nucleus, Cell Division and Cell signalling

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome); Mitosis, Meiosis, Cell cycle and its regulation; GPCR and Role of second messenger (cAMP)

PRACTICAL

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
   i. DNA by Feulgen reaction
   ii. DNA and RNA by MGP
   iii. Mucopolysaccharides by PAS reaction
   iv. Proteins by Mercuric bromophenol blue/Fast Green
5. Demonstration of osmosis (RBC/ Egg etc.).

Text Books :

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. S Harisha (2007) Biotechnology procedures and experiments handbook., Infinity Science Press, Hingham

Suggested Readings :

❖ Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). MolecularBiology of the Cell, V Edition, Garland publishing Inc., New York and London.
❖ Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
❖ Suvarna S, Lyton C, Bancroft JD (2013) Theory and practice of histological techniques, Churchill Livingstone, Elsevier, UK
❖ Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

GE-2.3 : PLANT PHYSIOLOGY AND METABOLISM

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

i. Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.
ii. Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.
iii. Translocation in phloem.: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

UNIT-II

i. Photosynthesis: Photosynthetic Pigments (*Chl* a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation.
ii. Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative Phosphorylation.

UNIT-III

i. Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.
ii. Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

UNIT-IV

i. Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.
ii. Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on hotomorphogenesis; Vernalization.

PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.

Text Books:

1. A. C. Sahu (2018). Plant Physiology and Metabolism. Kalyani Publishers, New Delhi.

Reference Books:

❖ Taiz, L., Zeiger, E., MOller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
❖ Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
❖ Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
❖ H. S. Srivatava. Plant Physiology, Rastogi Publications, New Delhi

AECC – 2.4 : MIL COMMUNICATIONS – ODIA
(ଯୋଗାଯୋଗ ଅନୁବିଧି, ରୀତି ଓ ମାଧ୍ୟମ)

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

୧ମ ଏକକ / ୟୁନିଟ୍ – ୧ :

ଯୋଗାଯୋଗର ପରିଭାଷା, ଅନୁବିଧି, ପରିସର ଓ ପ୍ରକାରଭେଦ

୨ୟ ଏକକ / ୟୁନିଟ୍ – ୨ :

ସାକ୍ଷାତକାର, ଭାଷଣ କଳା

୩ୟ ଏକକ / ୟୁନିଟ୍ – ୩ :

ସମ୍ବାଦର ପରିଭାଷା, ପରିସର ଓ ସମ୍ବାଦ ପ୍ରସ୍ତୁତି

୪ର୍ଥ ଏକକ / ୟୁନିଟ୍ – ୪ :

ଓଡ଼ିଆ ଭାଷାର ବର୍ଣ୍ଣମାଳା, ବର୍ଣ୍ଣାଶୁଦ୍ଧିର ନିରାକରଣ । (ବନାନ ତ୍ରୁଟି - ସାଦୃଶ୍ୟଜନିତ ଅଶୁଦ୍ଧି, ଲିଙ୍ଗଗତ ଅଶୁଦ୍ଧି, ସନ୍ଧିଗତ ଅଶୁଦ୍ଧି, ସମାସଗତ ଅଶୁଦ୍ଧି, ବଚନ ଓ ବିଭକ୍ତିଗତ ଅଶୁଦ୍ଧି, ବାକ୍ୟ ବିଧିଜନିତ ଅଶୁଦ୍ଧି, ସମାର୍ଥବୋଧକ ଶବ୍ଦାଶୁଦ୍ଧି, ପ୍ରତ୍ୟୟ ଜନିତ ଅଶୁଦ୍ଧି, ଶବ୍ଦ ସଂଯୋଗାତ୍ମକ ଓ ସ୍ୱରସଙ୍ଗତି ଜନିତ ଅଶୁଦ୍ଧି)

ସହାୟକ ଗ୍ରନ୍ଥସୂଚୀ :

୧. ଯୋଗାଯୋଗ ମୂଳକ ମାତୃଭାଷା (ଓଡ଼ିଆ) - ସାମଲ ବିରଞ୍ଚି ନାରାୟଣ, ସତ୍ୟନାରାୟଣ ବୁକ ଷ୍ଟୋର, କଟକ

୨. ସଂଯୋଗ ଅନୁବିଧି - ସନ୍ତୋଷ କୁମାର ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ

୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ - କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ, ସତ୍ୟନାରାୟଣ ବୁକ୍ ଷ୍ଟୋର,କଟକ

୪. ପ୍ରାୟୋଗିକ ଓଡ଼ିଆ ଭାଷା – ଓଡ଼ିଶା ରାଜ୍ୟପାଠ୍ୟ ପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ୱର

୫. ସମ୍ବାଦ ଓ ସାମ୍ବାଦିକତା – ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡ଼ିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ୱର

୬. ନିର୍ଭୁଲ ଲେଖାର ମୂଳସୂତ୍ର - ନୀଳାଦ୍ରିଭୂଷଣ ହରିଚନ୍ଦନ, ପି.ସି.ଆର ପବ୍ଲିକେସନ, ଭୁବନେଶ୍ୱର

୭. ସର୍ବସାର ବ୍ୟାକରଣ - ନାରାୟଣ ମହାପାତ୍ର ଓ ଶ୍ରୀଧର ଦାସ, ନିୟୁ ଷ୍ଟୁଡେଣ୍ଟସ୍ ଷ୍ଟୋର, କଟକ

ମୂଲ୍ୟ ବିଭାଜନ ପଦ୍ଧତି : (ସବୁଥିରୁ ବିକଳ୍ପ ପଢ଼ିବ)

(କ) ପତ୍ରର ମୋଟ ନମ୍ବର – ୧୦୦

(ଖ) ଅନ୍ତଃପରୀକ୍ଷା – ୨୦ ଓ ମୁଖ୍ୟ ପରୀକ୍ଷା – ୮୦

(ଗ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକ(ୟୁନିଟ୍)ରୁ ବିକଳ୍ପସହ ଦୁଇଟି ଲେଖାଏଁ ମୋଟ ୮ଟି ୧୫ନମ୍ବର ବିଶିଷ୍ଟ ଦୀର୍ଘ ପ୍ରଶ୍ନ ପଡିବ । ବିଦ୍ୟାର୍ଥୀଙ୍କୁ ୪ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ । (୧୫ x ୪ = ୬୦)

(ଘ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକରୁ ୧୨ଟି ଅତିସଂକ୍ଷିପ୍ତ ପ୍ରଶ୍ନ ପଡ଼ିବ । ସେଥିରୁ ୧୦ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ । (୧୦ x ୨ = ୨୦)

AECC-2.4 : MIL (ALTERNATIVE ENGLISH)

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

Introduction:
The paper is focused upon developing one fundamental skills of Language learning; reading which needs a thorough rethink and revision. In order to build a strong base for acquisition of the communication skills, suitable reading content is selected from diverse areas in prose form. This would boost the learner's competence in expressive and comprehension skills. The well researched language exercises in the form of usage, vocabulary and grammar is the other area that should attract the teacher and learner to work out for giving decent shape to the mastery of English language.

UNIT - I: Short Story
a. Jim Corbett-The Fight between Leopards
b. Dash Benhur- The Bicycle
c. Dinanath Pathy- George V High School
d. Alexander Baron- The Man who knew too much
e. Will F Jenkins- Uneasy Homecoming

UNIT - II: Prose
a. Mahatma Gandhi- The way to Equal Distribution
b. S Radhakrishnan- A Call to Youth
c. C V Raman-Water- The Elixir of Life
d. Harold Nicolson- An Educated Person
e. Claire Needell Hollander- No Learning without Feeling

UNIT - III:
Comprehension of a passage and answering the questions

UNIT - IV:
Language exercises-test of vocabulary, usage and grammar

Text Books:
1. All Stories and Prose pieces

Reference Books:
- *The Widening Arc: A Selection of Prose and Stories*, Ed. A R Parhi, S Deepika, P Jani, Kitab Bhavan, Bhubaneswar.
- *A Communicative Grammar of English*, Geoffrey Leech.
- *A University Grammar of English*, Randolph Quirk and Sidney Greenbaum
- *Developing Reading Skills*. F. Grellet. Cambridge: Cambridge University Press, 1981.

SEMESTER-III

C-3.1 : DIVERSITY AND DISTRIBUTION OF CHORDATES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Protochordates and Origin of Chordates
Protochordata: General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata.
General characteristics and outline classification Chordata. Dipleurula concept and the Echinoderm theory of origin of chordates.

UNIT – II: Agnantha, Pisces & Amphibia
General characteristics of Agnatha: General characteristics and classification of cyclostomes up to class Chondrichthyes and Osteichthyes: classification up to order, Migration, Parental care in fishes, Accessory respiratory organs in pisces, Evolutionary significance of Dipnoi.
Amphibian: Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characteristics and classification up to order. Parental care in Amphibia.

UNIT – III: Reptilia & Aves

General characteristics and classification up to order in reptiles; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes. General characteristics and classification up to order in Aves *Archaeopteryx* - a connecting link; Flight adaptations and Migration in birds.

UNIT – IV: Mammals & Zoogeography

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages. Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms.

PRACTICAL

1. Protochordata: *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial Urochordata, Sections of *Balanoglossus* through proboscis and branchio-genital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slides of Herdmania spicules.
2. Agnatha: *Petromyzon* and *Myxine*.
3. Fishes*: Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon/ Diodon*, *Anabas*, Flat fish.
4. Amphibia*: Ichthyophis/Ureotyphlus*, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamander*.
5. Reptilia: *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus*. Key for Identification of poisonous and non-poisonous snakes
6. Aves: Study of six common birds from different orders. Types of beaks and claws. Study of feathers.
7. Mammalia: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus*, Loris, *Herpestes*, *Erinaceous*.
8. Power point presentation on study of any two animals from two different classes by students. Submission of album of local species.

Text Books :

1. Kotpal RL; Modern Textbook of Zoology –Vertebrates; Rastogi Publications - Meerut; 2016 edition
2. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
3. Tiwari SK (2006) Fundamentals of World Zoogeography, Sarup & Sons

Suggested Readings :

- Pough H. Vertebrate life, VIII Edition, 2007 Pearson International.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Hickman CP, Roberts LS, Keen S, Larson A, I'AnsonH, Isenhour DJIntegrated Principle of Zoology, 14th edition, 2008, McGrawHill publication
- Verma PS and Srivastava PC. (2011) Advanced Practical Zoology. S Chand Publication.

C-3.2 : PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Tissues & Tissue system

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue. Structure and types of bones and cartilages, Ossification, bone growth and resorption.

UNIT – II: Muscle & Nervous System

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction. Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.

UNIT – III: Reproductive System

Histology of testis and ovary; Physiology of male and female reproduction; Hypothalamus-Pituitary & Gonadal axis. Puberty, Ovarian Cycle, Methods of contraception in male and female, Placental hormones.

UNIT – IV: Endocrine System

Histology of endocrine glands – Hypothalamus (Neuroendocrine gland) pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones and mechanism of hormone action, (steroidal and non-steroidal hormones).

PRACTICAL

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Study of permanent slides- Squamous epithelium, Striated muscle fibres and nerve cells.

3. Study of permanent slides-Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.
4. Microtomy: Preparation of permanent slides/photographs/computer models of any five types of mammalian (Goat/rat,etc) tissues

Text Books :

1. Marieb EN and Hoehn K, Human Physiology,(2013), 9th edition, Pearson Education, USA.
2. Endocrinology, Hadley ME and Levine JE (2009), Pearson Education India; 6 edition
3. Textbook of Medical Physiology, Guyton & Hall, Elsevier, 12th edition, 2016

Suggested Readings :

❖ Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition., Lippincott W. & Wilkins
❖ Martini F H, Nath J L and Bartholomew E F.(2015) Fundamentals of Anatomy and Physiology. Pearson Education Publication,
❖ Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B.Saunders Company.
❖ Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.

C-3.3 : FUNDAMENTALS OF BIOCHEMISTRY AND MICROBIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Carbohydrates & Lipids

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates; Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

UNIT – II: Proteins

Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids.

Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Renaturation, Denaturation; Introduction to simple and conjugate proteins

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants.

UNIT – III: Nucleic Acids

Structure : Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves : Base pairing, Denaturation and Renaturation of DNA, Types of DNA and RNA, Complementarity of DNA, Hpyo-Hyperchromaticity of DNA.

UNIT – IV: Enzymes

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

PRACTICAL

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase./Urease/acid or alkaline phosphatase
5. Demonstration of proteins separation by SDS-PAGE.
6. Identification of different bacteria and viruses through slide/photographs

Text Books :

1. Satyanarayan and Chakrapani , (2017) Biochemistry, Elsevier; Fifth edition
2. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
3. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto, Biochemistry, 8th edition, 2015.
4. Victor W., Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony,Harper's Illustrated Biochemistry, 31st edition.
5. Tortora GJ, Funke BR and Case CL (2016) Microbiology: An introduction, Pearson India Education Services Pvt.Ltd.11th edition

Suggested Readings :

- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Publication.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Devasena T. (2010). Enzymology Oxford University Press; 1 edition
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- Pelezar Jr.MJ, Chan E.C.S. and Krieg NR (2001) Microbiology, Mc-Graw Hill Education

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

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

SECTION A: PHYSICAL CHEMISTRY-I

UNIT-I : Chemical Energetics

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.

Chemical Equilibrium

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

UNIT- II : 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. 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-II

UNIT- III :

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) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Up to 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.

Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

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: KNH_2/NH_3 (or $NaNH_2/NH_3$).

UNIT- IV : Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols: Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and 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: (Up to 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. Reimer Tiemann Reaction, Gattermann -Koch Reaction,

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

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

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co, 47th Edn., 2017.
3. K. L. Kapoor, Text Book of Physical Chemistry, Mac Grow Hill, 3rd Edn. 2017.
4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Arun Bahl & B S Bahl, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

Reference Books:

❖ Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.
❖ Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

PRACTICAL

Section A: Physical Chemistry

Thermochemistry (any three)

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:
   - Sodium acetate-acetic acid
   - 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 determination of melting.
2. Preparations, recrystallisation, determination of melting point and calculation of quantitative yields of the followings:
   a. Bromination of Phenol/Aniline
   b. Benzoylation of amines/phenols
   c. Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

❖ A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
❖ Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
❖ Khosla, B.D.; Garg, V.C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
❖ Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

SECC-II-3.5 : QUANTITATIVE AND LOGICAL THINKING

Full Marks – 100
Mid Sem – 20/1hr
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

Books Prescribed :

1. Quantitative And Logical Thinking – Odisha State Higher Education Council, Bhubaneswar

SEMESTER-IV

C-4.1 : COMPARATIVE ANATOMY OF VERTEBRATES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Integumentary & Skeletal System

Structure, functions and derivatives of integument (Scale, claw, nail, hair, feather and dentition). Axial and appendicular skeleton, Jaw suspensorium, Visceral arches.

UNIT – II: Digestive & Respiratory System

Alimentary canal and associated glands; Respiration through skin, gills, lungs and air sacs; Accessory respiratory organs.

UNIT – III: Circulatory and Urinogenital system

General plan of circulation, evolution of heart and aortic arches; Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

UNIT – IV: Nervous System & Sense Organs

Comparative account of brain;Nervous system, Spinal cord, Cranial nerves in mammals. Classification of receptors: Brief account of visual and auditory receptors in man. Chemo and mechano receptors

PRACTICAL

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit.
3. Carapace and plastron of turtle /tortoise (Photographs, charts etc).
4. Mammalian skulls: One herbivorous and one carnivorous animal.
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted).
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted).

Text Books :

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies 3. R. K. Saxena and Sumitra Saxena (2016). Comparative Anatomy of Vertebrates 2nd edition.

Suggested Readings :

❖ Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate tructure, John Wiley and Sons
❖ Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House

C-4.2 : PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Physiology of Digestion

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in gastrointestinal tract.

UNIT – II: Physiology of Respiration

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration.

UNIT – III: Renal Physiology and Blood

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance. Components of blood and their functions; Structure and functions of haemoglobin haemostasis: Haemopoiesis, Blood clotting system, Blood groups: Rh factor, ABO and MN.

UNIT – IV: Physiology of Heart

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

PRACTICAL

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

Text Books :

1. Marieb E.N. and Hoehn K.N. (2009) Human Physiology. Pearson Education Publication , 9th edition
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
3. Guyton & Hall, (2016) Textbook of Medical Physiology. Elsevier, 12th edition,

Suggested Readings :

- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.
- Moyes C.D., Schulte PM (2016), Principles of physiology, 2nd edition, Pearson education, 3rd.
- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.

C-4.3 : BIOCHEMISTRY OF METABOLIC PROCESSES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Overview of Metabolism

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms.

UNIT – II: Carbohydrate Metabolism

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

UNIT – III: Lipid and protein Metabolism

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

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

UNIT – IV: Oxidative Phosphorylation

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

PRACTICAL

1. Estimation of total protein in given solutions
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin/ Lipase.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
5. Dry Lab (Virtual): To trace the labelled C atoms of Acetyl-CoA till they evolve as CO2 in the TCA cycle.

Text Books :

1. Satyanarayan and Chakrapani , (2017) Biochemistry, Elsevier; Fifth edition.
2. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

Suggested Readings :

- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007).Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

GE-4.4 : PLANT ECOLOGY AND TAXONOMY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT-I

i. Ecological factors: Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes
ii. Plant communities : Characters; Ecotone and edge effect; Succession; Processes and types

UNIT-II

i. Ecosystem : Structure; Biotic and abiotic components, energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous
ii. Phytogeography: Principal biogeographical zones, Endemism.

UNIT-III

i. Introduction to plant taxonomy: Identification, Classification, Nomenclature.
ii. Identification : Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

UNIT-IV

i. Taxonomic hierarchy: Ranks, categories and taxonomic groups
ii. Botanical nomenclature: Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.
iii. Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Hutchinson (upto series).
iv. Taxonomic description of the families : Malvaceae, Fabaceae, Asteraceae and Poaceae, Apocynaceae, Lamiaceae and Musaceae.

PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.

2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
5. (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta)*, Root parasite
6. (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
8. Study of vegetative and floral characters of the families as in theory syllabus (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).
9. Mounting of properly dried and pressed specimen of any ten wild plant's with herbarium label (to be submitted in the record book).

Text Books:

1. Sharma, P.D. (2017). Fundamentals of Ecology. Rastogi Publications, Meerut, India.

Reference Books:

- Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
- Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
- Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
- Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
- Sahu, A. C. (2017). Plant Ecology and Phytogeography, Kalyani Publishers, New Delhi.
- Das, M. C. and Das, S. P. (2009). Fundamental of Ecology. Tata McGrow Hill, New Delhi.
- Shukla, R.S. and Chandel, P.S. (2016). A text book of Plant Ecology. S Chand Publication, New Delhi
- Mohanty, C. R. (2017). Text Book of Plant Systematics, Kalynai Publisher, New Delhi.

SECC-I-4.5 : COMMUNICATIVE ENGLISH

(Enriching Linguistic Knowledge & Communication Proficiency)

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

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

Text Books:

1. Communicative English – Odisha State Higher Education Council, Bhubaneswar

SEMESTER-V

C-5.1 : MOLECULAR BIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Nucleic Acids, DNA Replication & Repair

Salient features of DNA and RNA, Watson and Crick model of DNA.,Nucleic acids cot curves, denaturation and renaturation of DNA, DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear ds-DNA, replication of telomeres, Pyrimidine dimerization and mismatch repair.

UNIT – II: Transcription & Translation

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors and regulation of transcription.

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 tRNAsynthetases 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 – III: 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, Processing of tRNA.

UNIT – IV: Gene Regulation & 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, silencer elements; Gene silencing, RNA interference, miRNA, siRNA.

PRACTICAL

1. Study of Polytene chromosomes from *Chironomous / Drosophila* larvae
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. Quantitative estimation of Salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260nm measurement)
6. Quantitative estimation of RNA using Orcinol reaction
7. Study and interpretation of electron micrographs/ photograph showing
   (a) DNA replication, (b) Transcription and (c) Split genes.

Text Books :

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. Lewin B. (2013). Gene XI, Jones and Bartlett.
3. De Robertis E.D.P. (2017) Cell and Molecular Biology 8Ed.
4. Arnold Berk , Chris A. Kaiser, Harvey Lodish , Angelika Amon , Hidde Ploegh, Anthony Bretscher, Monty Krieger Kelsey C. Martin(2016) Molecular Cell Biology. 8th edition.

Suggested Readings :

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology ofthe Cell, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach**,** V Edition, ASM Press and Sinauer Associates.
- McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.

C-5.2 : PRINCIPLES OF GENETICS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Mendelian Genetics, Linkage, Crossing Over and Chromosomal Mapping

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance. Polygenic inheritance with suitable examples; simple numericals based on it.

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

UNIT – II: Mutations

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

UNIT – III: Sex Determination & Extra-chromosomal Inheritance

Chromosomal mechanisms of sex determination in *Drosophila* and Man; Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects.

UNIT – IV: Recombination in Bacteria and Viruses & Transposable Genetic Elements

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage.

Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, Transposons in human.

PRACTICAL

1. Study of Mendelian laws and gene interactions.
2. Linkage maps based on data from conjugation, transformation and transduction.
3. Linkage maps based on data from *Drosophila* crosses.
4. Study of human karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.

Text Books :

1. Benjamin Pierce, (2015) Genetics- A Conceptual Approach, 5th edition, WH Freeman publication
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition.

Suggested Readings :

- Benjamin Cummings. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
- Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

DSE-5.3 : ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Animal 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

Stereotyped Behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

UNIT – III: Social and Sexual Behaviour

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

UNIT – IV: Chronobiology

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks, Relevance of biological clocks, Types and characteristics of biological rhythms: Short- and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

PRACTICAL

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice in dry and humid condition.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Study and actogram construction of locomotor activity of suitable animal models.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioral activities of animals and prepare a short report.

Text Books :

1. John A (2009) Animal Behaviour.9th edition, Sinauer Associate Inc., USA.
2. Vinod Kumar (2002) Biological Rhythms: Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Suggested Readings :

❖ AK Pati. Chronobiology: The Dimension of Time in Biology and Medicine. PINSA (Bilogical Sciences). Part B 67 (6). 323-372, Dec., 2001.
❖ David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
❖ Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, USA.
❖ Paul WS and John A (2013) Exploring Animal Behaviour. 6th Edition. Sinauer Associate Inc., Massachusetts, USA.
❖ Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Chronobiology Biological Timekeeping: J, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

DSE-5.4 : ECONOMIC ZOOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

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; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee.

UNIT – II: Silk and Silk Production (Sericulture)

Different types of silk and silk worms 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

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. Prawn farming; Culture of crab; Pearl culture.

UNIT – IV: 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.

PRACTICAL

1. Submission of report on anyone field visits related to Aquaculture/Apiculture/ Sericulture/Poultry/ Dairy farm.
2. Study of different types of bees (Queens, Drones and Worker bees).
3. Study of different types of silk moths.
4. Study of different types of pearls.
5. Study of different types of fish diseases.
6. Identification of different types of scales in fishes.
7. Study of different types of fins.
8. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
9. Identification of various types of natural silks.

Text Books :

1. Sarkar, Kundu and Chaki. (2014) Introduction to Economic Zoology. NCBA Publisher.
2. T.V.R. Pillay (Author), M.N. Kutty (2011) Aquaculture: Principles and Practices, Wiley India Pvt Ltd; Second edition

Suggested Readings :

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

SEMESTER-VI

C-6.1 : DEVELOPMENTAL BIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Introduction to Developmental Biology, Gametogenesis & Fertilization

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. Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy.

UNIT – II: Early Embryonic Development

Cleavage: 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.

UNIT – III: Late Embryonic Development

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

UNIT – IV: Post Embryonic Development & Implications of Developmental Biology

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories. Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis.

PRACTICAL

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 the developmental stages and life cycle of *Drosophila* from stock culture.
4. Study of different sections of placenta (photomicropgraph/ slides).
5. Project report on *Drosophila* culture/chick embryo development.
6. Study of developmental stages by raising chick embryo in the laboratory

Text Books :

1. Lewis Wolpert (2010). Principles of Development. II Edition, Oxford University Press.
2. Gilbert, S. F. (2017). Developmental Biology, XI Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

Suggested Readings :

❖ Carlson, R. F. Patten's Foundations of Embryology.
❖ Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
❖ Verma PS and Agrawal VK, Chordata Embryology (2010) (S Chand Publication).

C-6.2 : EVOLUTIONARY BIOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Theories, Evidences of Evolution and Extinction

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism.Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Sources of variations: Heritable variations and their role in evolution. Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

UNIT – II: Process of Evolutionary changes

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection). Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies.

UNIT – III: Species concept and Speciation

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Parapatric. Adaptive radiation / macroevolution (exemplified by Galapagos finches);

UNIT – IV: Concept of Origin and Evolution of man

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin. Phylogenetic trees, Multiple sequence alignment, construction and interpretation of phylogenetic trees.

PRACTICAL

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis

4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

Text Books :

1. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
2. Rastogi B.B., (2018). Organic Evolution, MedTech; 3rdedition

Suggested Readings :

❖ B.K. and Hallgrimson, B. (2008). Evolution IV Edition. Jones and Barlett Publishers.
❖ Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates. Snustad. S Principles of Genetics.
❖ Ridley,M (2004) Evolution III Edition Blackwell publishing Hall.

DSE-6.3 : IMMUNOLOGY

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Innate and Adaptive Immunity

Historical perspective of Immunology, Early theories of Immunology, 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, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

UNIT – II: Antigens and Immunoglobulins

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen antibody interactions, Immunoassays (ELISA- Direct, Indirect, Competitive, Sandwich and RIA)

UNIT – III: Major Histocompatibility Complex, Cytokines and Complement system

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation; Cytokines -Properties and functions of cytokines, Therapeutics Cytokines Complement System - Components and pathways of complement activation.

UNIT – IV: Hypersensitivity and Vaccines

Gell and Coombs' classification and brief description of various types of hypersensitivities Vaccines -various types of vaccines, Advances in vaccine production.

PRACTICAL

1. Study of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of White blood cells.
4. ABO blood group determination.
5. Total WBC counting.
6. Demonstration of ELISA.
7. Demonstration of Bone marrow smears to study Immune cells.

Text Books :

1. Abbas K. Abul and Lechtman H. Andrew (2017) Cellular and Molecular Immunology. V Edition. Saunders Publication.
2. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2017). Immunology, VI Edition. W.H. Freeman and Company.

Suggested Readings :

❖ Peter J. Delves and Seamus J. Martin (2017) Roitt's Essential Immunology, Wiley-Blackwell; 13th edition

DSE-6.4 : FISH AND FISHERIES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

UNIT – I: Systematics, Morphology and Physiology

Systematic classification of native/exotic fishes (upto classes), Types of fins and their modification; Locomotion in fishes; Hydrodynamics; Types of scales, Use of scales in classification and determination of age of fish; Gills and gas exchange; Swim bladder; Reproductive strategies (Special reference to Indian fishes); Electric organs; Bioluminescence; Mechanoreceptors; Schooling; Migration

UNIT – II: Fisheries

Inland fisheries; Marine fisheries; Environmental factors influencing the seasonal variation in fish; Fishing crafts and Gears; Depletion of Fisheries resources; Fisheries laws and regulations.

UNIT – III: Aquaculture

Sustainable aquaculture; Extensive, semi-intensive and intensive culture of fish; Polyculture; Composite fish culture; brood stock management; Induced breeding of fish; Management of fin fish hatcheries; Preparation and maintenance of fish aquarium. Factors affecting aquaculture.

UNIT – IV: Fish Pathology and Transgenesis

Fish diseases: bacterial, viral and parasites; Preservation, diagnosis and treatment, Processing of harvested fish, Fishery byproducts; Transgenic fish, zebrafish as a model organism in research.

PRACTICAL

1. Study of *Petromyzon, Myxine, Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas*
2. Study of different types of scales (Through permanent slides and photographs)
3. Study of crafts and gears used in fisheries.
4. Water quality criteria for aquaculture: assessment of pH, conductivity, total solids and total dissolve solids.
5. Study of air breathing organs in *Channa, Heteropneustes, Anabas and Clarias*.
6. Demonstration of induced breeding in fishes (Virtual).
7. Demonstration of parental care in fishes (Virtual).
8. Project report on a visit to any fish farm/ pisciculture unit/ zebra fish rearing lab

Text Books :

1. Q Bone and R Moore (2008), Biology of fishes, Taylor and Francis group, CRC Press, UK
2. S.S. Khanna and H.R. Singh (2014) A textbook of fish biology and fisheries, Narendra Publishing House, 3rd edition.

Suggested Readings :

- D H Evans and J D Claiborne, The Physiology of fishes, Taylor and Francis group, CRC, UK
- R J Mogdans and B G Kapoor, The senses of fish: Adaptations for the reception of natural stimuli, Springer, Natherland
- C B L Srivastava, Fish biology, Narendra Publishing House
- J R Norman, A History of fishes, Hill and Wang Publishers.

OR

DSE-6.4 : PROJECT WORK

Full Marks – 100
End Sem – 100

Each student has to undertake a project work under the guidance of a teacher and submit the project report in the form of a thesis. There will be a presentation of the project work before an external examiner.

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