St. FRANCIS COLLEGE FOR WOMEN, BEGUMPET HYDERABAD-500016
(An Autonomous College Affiliated to Osmania University)
DEPARTMENT OF CHEMISTRY

DISCIPLINE SPECIFIC CORE II **CHEMISTRY II** **B.Sc. I - SEMESTER- II 60 h**
Module 1: Inorganic Chemistry Chemistry of d-Block elements Chemistry of f-Block elements
Module 2: Organic Chemistry Halogen Compounds Hydroxy Compounds and Ethers Carbonyl Compounds
Module 3: Physical Chemistry Electrochemistry
Module 4: General Chemistry Chemical Bonding Stereoisomerism Colligative Properties

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SEMESTER - II
CHEMISTRY - II

1. Course Description

Programme: B.Sc.
Course Code: U26/CHE/DSC/201
Course type: DSC - 2
No. of credits: 4

Max. Hours: 60
Max. Marks: 100
Hours per week: 4

2. Course Objectives

- To enable students to critically understand the electronic structure, periodic trends, magnetic and spectral properties, complex formation, and applications of d- and f-block elements.
- To develop a clear understanding of the structure, reactivity, preparation methods, and reaction mechanisms of halogen compounds, alcohols, ethers, and carbonyl compounds.
- To provide a comprehensive understanding of electrochemical principles, including electrode potentials, electrochemical cells, and their practical applications.
- To impart fundamental knowledge of chemical bonding theories, stereochemical concepts, and colligative properties to explain the structure and behavior of chemical substances.

3. Course Outcomes

On completion of the course the student will be able to

- Explain and predict the chemical behavior of d- and f-block elements based on electronic structure and bonding principles.
- Analyze reactions and predict products of halogen, alcohol, ether, and carbonyl compounds.
- Calculate electrode potentials, analyze electrochemical cells, and apply electrochemical concepts to practical systems such as batteries and corrosion.
- Students will be able to apply bonding theories, distinguish stereoisomers, and solve numerical problems related to colligative properties.

4. Course Content

MODULE I: INORGANIC CHEMISTRY 15 h (1h/week)

Chemistry of d-block elements 7h

Characteristics of d-block elements with special reference to electronic configuration, variable oxidation states, color properties, d-d spectral transitions, ability to form complexes, magnetic properties, calculation of magnetic moment-spin only formula & catalytic properties. Comparative treatment of second and third transition series with their 3d analogues.

Chemistry of f-block elements 8h

Chemistry of Lanthanides: Position in periodic table, electronic structure, oxidation state, ionic and atomic radii/ionic radii- lanthanide contraction- cause and consequences, anomalous behavior of post lanthanides-complexation-type of donor ligands preferred. Magnetic properties- paramagnetism, color and spectra, f-f transitions-occurrence and separation-ion exchange method, solvent extraction.

Chemistry of actinides: General features-electronic configuration, oxidation state, actinide contraction, color and complex formation. Comparison with lanthanides.

IKS: Case studies on The Iron Pillar of Delhi – Metallurgical Excellence and Monazite Sands of Kerala – Source of Rare Earths and Thorium.

MODULE II: ORGANIC CHEMISTRY 15 h (1h/week)

Halogen compounds 4 h

Classification: alkyl (primary, secondary, tertiary), aryl, aralkyl,. Chemical reactivity - reduction, formation of RMgX, Nucleophilic substitution reactions – classification into S_N1 and S_N2. Mechanism and energy profile diagrams of S_N1 and S_N2 reactions. Stereochemistry of S_N2 (Walden Inversion) 2-bromobutane, S_N1 (Racemization) 1-bromo-1-phenylpropane.

Hydroxy compounds and ethers 5 h

Alcohols: Preparation: 1°, 2° and 3° alcohols using Grignard reagent, Reduction of Carbonyl compounds, carboxylic acids and esters. Physical properties: H-bonding, Boiling point and Solubility. Reactions with Sodium, $HX/ZnCl_2$ (Lucas reagent), oxidation with conc. HNO_3 and Oppenauer oxidation (Mechanism).

Phenols: Preparation: (i) from diazonium salts of anilines and (ii) from benzene sulphonic acids. Properties: Acidic nature, formation of phenoxide and reaction with R-X, electrophilic substitution; halogenations, Riemer Tiemann reaction (Mechanism), Gattermann-Koch reaction, Schotten Baumann reaction.

Ethers: Nomenclature, preparation by Williamson synthesis. Chemical properties – inert nature, action of conc. H_2SO_4.

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Carbonyl compounds 6h

Preparation of aldehydes & ketones from acid chlorides, nitriles and carboxylic acids. Special methods of preparing aromatic aldehydes and ketones by Oxidation of arenes. Physical properties – absence of Hydrogen bonding. Reactivity of the carbonyl groups in aldehydes and ketones. Chemical reactivity: Addition of (a) $NaHSO_3$ (b) HCN (c) RMgX (d) 2,4-DNP (Schiff base). Addition of H_2O to form hydrate, addition of alcohols - hemi acetal and acetal formation. Cannizzaro reaction. Oxidation reactions – $KMnO_4$ oxidation, reduction – catalytic hydrogenation, mechanism of Clemmensen reduction, Meerwein-Ponndorf-Verley reduction.

MODULE III: PHYSICAL CHEMISTRY 15 h (1h/week)

Electrochemistry 15h

Revision of conductance, specific conductance, equivalent conductance and factors influencing conductance of electrolytes. Ionic mobility, definition and significance of transport number. Kohlrausch's law – its applications: determination of degree of dissociation and acid dissociation constant (K_a) of weak acids, solubility product determination and conductometric titrations. Ostwald's dilution law - its uses and limitations. Debye- Hückel -Onsager's equation for strong electrolytes (elementary treatment only).

Types of electrodes with examples - Types of reversible electrodes - the gas electrode, metal metal ion, metal-insoluble salt, redox electrodes and ion-selective electrode. Reversible and irreversible cells; Nernst equation – EMF of a cell; representation of a cell-problems; electrode potentials-electrochemical series and its significance. Determination of pH – using quinhydrone and glass electrodes. Potentiometric titrations.

MODULE IV: GENERAL CHEMISTRY 15 h (1h/week)

Chemical Bonding 5h

Molecular orbital theory: Shapes and sign convention of atomic orbitals. Modes of bonds. Criteria for orbital overlap. LCAO concept. π and σ overlapping. Concept of Types of molecular orbitals: bonding, antibonding and non-bonding. MOED of homonuclear diatomic molecules - H_2, N_2, O_2, O_2^-, O_2^{2-}, F_2 (unhybridized diagrams only) and heteronuclear diatomics - CO,. CN^-, NO, NO^+ and HF, their bond order, stability and magnetic properties.

Stereoisomerism 5h

Optical activity: Definition, wave nature of light, plane polarized light, optical rotation and specific rotation, chiral centers. Chiral molecules: definition and criteria - absence of plane, center and Sn axis of symmetry – asymmetric and dissymmetric molecules. Examples of asymmetric molecules (Glyceraldehyde, Lactic acid, Alanine) and dissymmetric molecules (trans- 1,2-Dichlorocyclopropane). Molecules with constitutionally symmetrical chiral carbons (Tartaric acid) Molecules with constitutionally unsymmetrical chiral carbons (2,3-Dibromopentane). D, L configuration – examples. R, S – configuration: Cahn-Ingold-Prelog (CIP) rules.

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Colligative Properties 5h

Definition of colligative properties- relative lowering of vapour pressure-Raoult's law; Osmotic pressure; elevation of boiling point and depression of freezing point; thermodynamic relation between molecular weight and colligative property (derivations not required) -Problems.

5. Reference Books

General reference: B.Sc. I Year Chemistry : Semester II, Telugu Academy publication, Hyd.

Module- I

1. Puri, B. R., Sharma, L. R., & Kalia, M. S. (1996). Principles of inorganic chemistry. Vishal Publications.
2. Lee, J. D. (1981). Concise inorganic chemistry (3rd ed.). Oxford University Press.
3. Cotton, F. A., Wilkinson, G., & Gaus, P. L. (2001). Basic inorganic chemistry (3rd ed.). Wiley.
4. Greenwood, N. N., & Earnshaw, A. (1989). Chemistry of the elements. Pergamon Press.
5. Shriver, D. F., & Atkins, P. W. (1999). Inorganic chemistry (3rd ed.). Oxford University Press.
6. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). Inorganic chemistry: Principles of structure and reactivity (4th ed.). Harper Collins College Publishers.
7. Gopalan, R. (2009). Textbook of inorganic chemistry. University's Press.

Module- II

1. Morrison, R. T., & Boyd, R. N. (2011). Organic chemistry. Pearson Education (Prentice Hall).
2. Solomons, T. W. G., & Fryhle, C. B. (2016). Organic chemistry. Wiley (John Wiley & Sons).
3. Bruice, P. Y. (2017). Organic chemistry. Pearson Education.
4. Wade, L. G., Jr. (2013). Organic chemistry. Pearson Education.
5. Jones, M., Jr. (2010). Organic chemistry. W. W. Norton & Company.
6. McMurry, J. (2015). Organic chemistry. Cengage Learning (Brooks/Cole).
7. Soni, P. L., & Soni, H. M. (2012). Organic chemistry. Sultan Chand & Sons.
8. Ghosh, S. K. (2009). General organic chemistry. Bharati Bhawan Publishers.
9. Pillai, C. N. (2008). Organic chemistry. Universities Press (India) Pvt. Ltd.

Module-III

1. Glasstone, S., & Lewis, D. (1966). Elements of physical chemistry. Macmillan.
2. Maron, S. H., & Lando, J. B. (1966). Fundamentals of physical chemistry. Macmillan Limited.
3. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2013). Principles of physical chemistry (46th ed.). Vishal Publishing Company.
4. Atkins, P. W. (2001). Physical chemistry (7th ed.). Oxford University Press.

b. Components on Skill Development/Entrepreneurship Development/Employability

SD/ED /EMP	Syllabus Content	Description of Activity
SD	Module I	Encourage them to compare and discuss trends in reactivity and chemical behaviour.
EMP	Module II	Design and present a synthetic pathway for an industry-relevant product using halogen, hydroxy, ether, and carbonyl compounds, including mechanism and yield.
ED (NSQF level 3 or 4)	Module III	Enables students to identify opportunities and develop innovative, cost-effective solutions in energy storage, corrosion control, electroplating, and other electrochemical industries.
EMP	Module IV	Solve and present a set of application-based problems on chemical bonding, stereochemistry, and colligative properties, explaining reasoning and calculations.

c. IKS component:

IKS	Syllabus Content	Module
	Introduced Case studies on The Iron Pillar of Delhi – Metallurgical Excellence and Monazite Sands of Kerala – Source of Rare Earths and Thorium.	I

7. Pedagogy

S. No.	Student Centric Methods Adopted	Type / Description of Activity
1	Experiential learning	Field trips
2	Participative Learning	Presentations/Peer-teaching
3	Problem solving	Case studies/ Data interpretation

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8. Course Assessment Plan

a) Weightage of Marks in Continuous Internal Assessments and End Semester Examination

CO	Continuous Internal Assessments CIA - 40%	End Semester Examination-60%
CO1	**CIA-1:** Written Exam	Written Exam
CO2	**CIA-2:** Quiz/Assignment/3D model making	
CO3	**CIA-1:** Written Exam	
CO4	**CIA-2:** Assignment (Crossword/Word search/ Problem solving)	

b) Model Question Paper - End Semester exam Theory

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(An Autonomous College Affiliated to Osmania University)
Faculty of Science – Department of Chemistry
MODEL PAPER
B.Sc. I YEAR SEMESTER -II
CHEMISTRY - II

Time: 2 hrs **Course Code: U26/DSC/CHE/201**

Max. Marks: 60

SECTION –A (Essay Questions)

I. Answer the following **4x 10=40 Marks**

1. What are Transition elements? Explain the general properties with reference to Complex formation, magnetic properties and variable oxidation states. 10M

OR

2. a. What is lanthanide contraction and explain its consequences. 5M

   b. How are lanthanides separated by ion exchange method? 5M

3. a. Explain the mechanism and stereochemistry of S_N1 reaction. 5M

   b. How are 1°, 2° and 3° alcohols prepared from carbonyl compounds using Grignard reagent? 5M

OR

4. Formulate the steps involved in the mechanism of (i) Reimer -Teimann reaction and (ii) Cannizaro reaction. 10M

5. a. Explain standard hydrogen electrode (SHE). 5M
   b. State Ostwald's dilution law. Discuss its uses and limitations. 5M

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OR

6. a. State Kohlrausch law and mention its applications. 5M
   b. Describe Hittorf method for the determination of Transport number. 5M
7. Write the postulates of MOT and explain the MOED of O_2. 10M

   OR

8. a. State and explain Raoult's law. 5M
   b. What are enantiomers? Explain the optical isomers of Tartaric acid. 5M

SECTION –B (Short Answer Questions)

II. Answer any four. **4x5=20 Marks**

9. Compare the properties of lanthanides with actinides.
10. How do you differentiate 1°, 2° and 3° alcohols based on the Lucas test?
11. Give equations for Williamson's ether synthesis and Clemmensen's reduction..
12. Write short notes on conductometric titrations.
13. What is an electrochemical series? What is its significance?
14. Discuss the R,S configuration of L-Alanine and D-Glyceraldehyde based on CIP rules.

Question Paper Format - Blooms Taxonomy Level

SECTION A - INTERNAL CHOICE				4 X 10 = 40 M
Question Number	**Module**	**Question**	**CO**	**BTL**
1	I	What are Transition elements? Explain the general properties with reference to Complex formation, magnetic properties and variable oxidation states. 10M OR	CO1	Level 1 & 2
2	I	a. What is lanthanide contraction and explain its consequences. 5M b. How are lanthanides separated by ion exchange method? 5M	CO1	Level 1 & 3
3	II	a. Explain the mechanism and stereochemistry of S_N1 reaction. 5M b. How are 1°, 2° and 3° alcohols prepared from carbonyl compounds using Grignard reagent? 5M OR	CO2	Level 3

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4	II	Formulate the steps involved in the mechanism of (i) Reimer -Teimann reaction and (ii) Cannizaro reaction. 10M	CO2	Level 4
5	III	a. Explain standard hydrogen electrode (SHE). 5M b. State Ostwald's dilution law. Discuss its uses and limitations. 5M OR	CO3	Level 2
6	III	a. State Kohlrausch law and mention its applications. 5M b. Describe Hittorf method for the determination of Transport number. 5M	CO3	Level 2 & 3
7	IV	Write the postulates of MOT and explain the MOED of O_2. 10M OR	CO4	Level 2 & 3
8	IV	a. State and explain Raoult's law. 5M b. What are enantiomers? Explain the optical isomers of Tartaric acid. 5M	CO4	Level 2 & 3
SECTION B - Short answer questions **ANSWER ANY 4 OUT OF 6**				**4 x 5 = 20M**
9	I	Compare the properties of lanthanides with actinides.	CO1	Level 4
10	II	How do you differentiate 1°, 2° and 3° alcohols based on the Lucas test?	CO2	Level 4
11	II	Give equations for Williamson's ether synthesis and Clemmensen's reduction..	CO2	Level 2
12	III	Write short notes on conductometric titrations.	CO3	Level 2
13	III	What is an electrochemical series? What is its significance?	CO3	Level 2
14	IV	Discuss the R,S configuration of L-Alanine and D-Glyceraldehyde based on CIP rules.	CO4	Level 5

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c) Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	COs Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1	15	CO1	2	10	6 (By taking at least one question from each module)	5
2	15	CO2	2	10		10
3	15	CO3	2	10		10
4	15	CO4	2	10		5

9. CO-PO Mapping

CO	PO	Cognitive Level	Classroom sessions (h)
1	1,3	Understand	15
2	1,2	Analyse	15
3	1,2	Apply	15
4	1,7	Remember	15

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(An Autonomous College Affiliated To Osmania University)
FACULTY OF SCIENCE- DEPARTMENT OF CHEMISTRY
SEMESTER -II
LABORATORY COURSE-II - QUALITATIVE ANALYSIS

1. Course Description

Program: B.Sc. **Max. Hours: 20**
Course Code: U26/CHE/DSC/201/ P **Max. Marks: 50**
Course type: DSC-2 **Hours per week: 2**
No. of Credits: 1

2. Course Objective

- To enable students to systematically identify and analyze anions and cations in salt mixtures using semi-micro qualitative analysis techniques.

3. Course outcomes

CO 1: Students will be able to systematically identify anions and cations in salt mixtures, interpret experimental observations, and write balanced equations for the reactions involved.

CO 2: Students will be able to apply the principles of common ion effect and solubility product to explain and justify the systematic separation and identification of both anions and cations in semi-micro qualitative analysis.

4. Course Content

QUALITATIVE ANALYSIS - Semi micro analysis of mixtures

Analysis of two anions (one simple, one interfering) and two cations in the given mixture.
Anions: CO_3^{2-} , SO_3^{2-} , S^{2-}, Cl^- , Br^-, I^-, CH_3COO^-, NO_3^-, PO_4^{3-}, BO_3^{3-}, SO_4^{2-}

Cations: Hg_2^{2+}, Ag^+, Pb^{2+}
Hg^{2+}, Bi^{3+}, Cd^{2+}, Cu^{2+}, As^{3+} / As^{5+} , Sb^{3+} / Sb^{5+}, Sn^{2+} / Sn^{4+}
Al^{3+}, Cr^{3+}, Fe^{3+}
Mn^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}
Ca^{2+}, Ba^{2+}, Sr^{2+}
Mg^{2+}, NH_4^+

Reference Books

1. Svehla, G. (1996). Vogel's qualitative inorganic analysis (7th ed.). Prentice Hall.
2. Gopalan, R., Subramanian, P. S., & Raghavan, K. (2004). Elements of analytical chemistry. Sultan Chand & Sons.
3. Ahluwalia, V. K., and Sunita Dhingra, (2005). A Laboratory Manual of Organic and Inorganic Chemistry, 1st Edition, University Press, Hyderabad, ISBN: 9788173715623

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4. Giri, A. N. (2010). A textbook of practical chemistry. Himalaya Publishing House.
5. Sharma, R. K. (2013). Experiments and techniques in inorganic chemistry. Krishna Prakashan Media.
6. O.P. Pandey, D.N. Bajpai, & S. Giri. (2020). Practical chemistry. 10th Revised Edition, S. Chand Publishing. ISBN: 9789352535859.
7. Gopalan, R., Venkappayya, D., and Nagarajan, S. (2012). Textbook of Inorganic Chemistry (Lab Manual), 3rd Edition, University's Press, Hyderabad, ISBN: 9788173718204
8. Vogel, A. I. and Svehla, G.Vogel's Textbook of Macro and Semi-Micro Qualitative Inorganic Analysis, 5th Edition, Longman Group Ltd., 1979. ISBN: 9780582446939

6. Model Question Paper - End Semester Exam Practical

St. FRANCIS COLLEGE FOR WOMEN, BEGUMPET, HYDERABAD-500016
(An Autonomous College Affiliated to Osmania University)
Faculty of Science – Department of Chemistry
MODEL PAPER
B.Sc. I YEAR SEMESTER -II
LABORATORY COURSE-II - QUALITATIVE ANALYSIS

Program: B.Sc. **Course Code: U26/DSC/CHE/201/P**
Type of course: DSC-2 **Time: 2 hrs**
No. of credits: 1 **Max. Marks: 50**

1. Using systematic procedure, identify and report two anions and two cations present in the given an unknown salt mixture. 30M

2. Record + Attendance 10M
3. Viva voce 10 M

Prepared by	Checked & Verified by	Approved by
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PANEL OF EXAMINERS							
FACULTY OF SCIENCES - DEPARTMENT OF CHEMISTRY							
CBCS-2026							
S. No	Course Title	Examiner	Name & Designation	Place of Work	Yrs of Experience	Contact No.	Email Id.
1	Semester I	Dr. Aliya Begum	Dr. Aliya Begum Assistant Professor of Organic Chemistry	Head, Dept of Chemistry, Veeranari Chakali Ilamma Women's University	Above 20	9849170130	aliyads@yahoo.com
		Dr. S. Sreekanth	Dr. S. Sreekanth Assistant Professor of Organic Chemistry	Dept of Chemistry Veeranari Chakali Ilamma Women's University	22	8465945408	Sivan.sreekanth@gmail.com
		Dr. Radhika. M	Dr. Radhika. M Assistant Prof. of Inorganic Chemistry	Head, Dept of Chemistry, Nizam college,Hyderabad	20	9032841181	radhikamone@yahoo.com
2	Semester II	Dr. Mary Nygi. K	Dr. Mary Nygi. K Assistant Professor of Organic Chemistry	Head,Dept of Chemistry Bhavan's Vivekananda Degree and PG College	20	9963123387	knygi@yahoo.com
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SEMESTER II

MICROBIOLOGY & IMMUNOLOGY

1. Course Description

Programme: B.Sc. **Max. Hours: 60**
Course Code: U26/BIT/DSC/201 **Hours per week: 4**
Course Type: DSC-2 **Max. Marks: 100**
No. of credits: 4

2. Course Objectives

- To learn about the principles of microbiology and acquire an understanding of fundamental microbiological concepts as well as several ways for isolating pure cultures
- To understand an overview of different types of immunity, cells & organs involved in the immune system and comprehend the immunoglobulins and autoimmune disorders

3. Course Outcomes

On completion of the course the student will be able to:

CO1: Recognize and summarize the contributions of scientists in the field of Microbiology, gain an insight into characterization of microorganisms and apply skills in handling microscopes. **((REMEMBER, UNDERSTAND, APPLY) L I, II & III**

CO2: Outline, apply and evaluate microbiological practices like Sterilization techniques, isolation, and culturing of microorganisms to study the microbial cells. **(UNDERSTAND, APPLY, EVALUATE) L II, III & V**

CO3: Remember, interpret, and use the basic concepts to have a comprehensive understanding of antigen-antibody interactions and their relevance in immunology **(REMEMBER, UNDERSTAND) L I & II**

CO4: Define, summarize, use, and analyze the knowledge, skills, and competencies to understand immunoassays effectively in various scientific and biomedical sciences **(UNDERSTAND, ANALYZE) L II & IV**

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4. Course Content

MODULE I: FUNDAMENTALS OF MICROBIOLOGY **(15HRS)**

1.1 Historical development of Microbiology and Contributors of Microbiology
1.2 Basic Microscopy: Bright field microscopy, Dark field microscopy, Phase contrast microscopy
1.3 Advanced Microscopy: Fluorescent microscopy, Scanning and Transmission Electron microscopy
1.4 Introduction to Microorganisms (Archaea, Bacteria, Algae, Fungi, Mycoplasma and Viruses)
1.5 General characteristics of bacteria and virus, disease-causing pathogens, and symptoms (*Mycobacterium*, Hepatitis)
1.6 General characteristics and applications of micro-algae and fungi

MODULE II: CULTURE AND IDENTIFICATION OF MICROORGANISMS (15HRS)

2.1 Methods of sterilization - physical and chemical methods
2.2 Bacterial nutrition - nutritional types of bacteria, essential macro, micronutrients and growth factors.
2.3 Bacterial growth curve - batch and continuous cultures, synchronous cultures, measurement of bacterial growth-measurement of cell number and cell mass
2.4 Factors affecting bacterial growth
2.5 Culturing of anaerobic bacteria and viruses
2.6 Pure culture and its characteristics

MODULE III: BASICS OF IMMUNOLOGY **(15HRS)**

3.1 Types of Immunity - innate and adaptive Immunity
3.2 Cells of the immune system: T-cells (helper and cytotoxic cells), B-cells, Natural killer cells, Macrophages, Basophils and Dendritic cells
3.3 Primary organs of immune system - Thymus and Bone marrow
3.4 Secondary organs of immune system - Spleen and Lymph nodes
3.5 Antigens-immunogenicity vs antigenicity, factors affecting antigenicity, Epitopes,
3.6 Haptens & types of adjuvants

MODULE IV: HUMORAL AND CELL MEDIATED IMMUNITY **(15HRS)**

4.1 Structure of immunoglobulin - types and functions of immunoglobulins
4.2 Major Histocompatibility Complex (MHC) & Human Leukocyte Antigen (HLA)- role in organ transplantation
4.3 Cell mediated immunity- T-cell receptor (TCR), Antigen Presenting Cells (APCs), ternary complex (TCR, peptide & MHC); cytokines
4.4 Hypersensitivity- types I, II, III & IV
4.5 Autoimmunity- Mechanisms of autoimmunity; Autoimmune diseases - Systemic lupus erythematosus, Rheumatoid arthritis
4.6 Monoclonal antibody (MAbs) production and its applications, Vaccines

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5. Reference books

1. Biology of Microorganisms by: Brock, T.D. and Madigan, M.T.
2. Microbiology by: Prescott, L.M., Harley, J.P. Klein, D.A.
3. Microbiology by: Pelczar, M.J, Chan, E.C.S., Ereig, N.R.
4. Microbiological applications by: Benson
5. Essential Immunology. Publ: Blackwell by: Roitt I.
6. Immunology. Publ: Blackwell by: Reever G. & Todd I.
7. Cellular and Molecular Immunology. Saunders Publication, Philadelphia by: Abbas A.K. Lichtman A.H., Pillai S.
8. Kuby's Immunology. W.H. Freeman and Company by: Golds R.A., Kindt T.J., Osborne

6. Syllabus Focus

a. Relevance to Local, Regional, National and Global Development Needs

Local/Regional/National /Global Development Needs	Relevance
National Development (Module 1, 2 & 3)	Addressing Health, Agriculture, Environment, and industry challenges through Research Innovation with an interdisciplinary collaboration of Microbiology and immunology.
Global development (Module 4)	The course addresses global imperatives by fostering interdisciplinary scholarship, innovation, and sustainable solutions for pressing societal challenges.

b. Components on Skill Development/Entrepreneurship/Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
Skill Development	(Module 1 & 2)	Seminar presentations, Art projects, group discussions to understand and evaluate the basics of Microbiology and Immunology.

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Employability	(Module 2, 3 & 4)	Hands on training on different media preparations, pure culture procedures, handling of varied microscopes and Immunoassays are useful in enhancing employability across a range of diagnostic and research labs.

7. Pedagogy

S. No	Student Centric Methods Adopted	Type / Description of Activity
1.	Participative Learning	Seminar
2.	Experiential Learning	Quiz
3.	Participative Learning	Group Discussion
4.	Participative Learning	Presentation
5.	Experiential Learning	Art projects
6.	Problem Solving	Research projects
7.	Experiential Learning	Science experiments
8.	Experiential Learning	Internship opportunities

8. Course Assessment Planp

A) Weightage of Marks in Continuous Internal Assessments and End Semester Examination

CO	Continuous Internal Assessments - CIA (40%)	End Semester Examination - (60%)
CO1	CIA-1 Written Exam	Written Exam
CO2	CIA-2 Quiz/ Assignment/Seminar Presentation	
CO3	CIA-1 Written Exam	
CO4	CIA-2Presentation/ Art projects/ Science experiments/ Case studies	

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b. Model Question Paper- End Semester Exam

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Faculty of Science – Department of Biotechnology

MODEL QUESTION PAPER

END SEMESTER EXAM

MICROBIOLOGY & IMMUNOLOGY

TIME: 2hrs **Course Code: U26/BIT/DSC/201**

MAX.MARKS: 60

SECTION – A

I.Answer the following **4 x 10 = 40 M**

1. How would you summarize the principle and working of Transmission Electron Microscopy

OR

2. Illustrate the salient features of bacterial cell structure with well labelled diagrams

3. Explain about Batch culture. Add a detailed note on bacterial growth curve

OR

4. Define sterilization. Assess the different physical sterilization methods.

5. Contrast between Innate and adaptive immunity.

OR

6. Explain in detail Secondary organs of immune system

7. Analyze Major Histocompatibility Complex (MHC) & Human Leukocyte Antigen (HLA)- and its role in organ transplantation

OR

8.Summarize autoimmune response with suitable examples

SECTION – B

II. Answer any <u>FOUR</u> of the following **4 x 5 = 20 M**

9. List the contributions of Louis Pasteur.

10. Demonstrate the factors affecting bacterial growth

11. Compare the isolation of different pure culture techniques

12. Describe Haptens

13. Analyse the role of APC in cell mediated immune response

14. Explain Monoclonal antibodies

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SEMESTER-END MODEL QUESTION PAPER

SECTION A - INTERNAL CHOICE 4 Q X 10 M = 40 M				
Question Number	**Question**	**Question**	**CO**	BTL (Blooms Taxonomy Level)
1	Module 1	How would you summarize the principle and working of Transmission Electron Microscopy	CO 1	II
2	Module 1	Illustrate the salient features of bacterial cell structure with well labelled diagrams	CO 1	III
3	Module 2	Explain about Batch culture. Add a detailed note on bacterial growth curve	CO 2	II
4	Module 2	Define sterilization. Assess the different physical sterilization methods.	CO 2	V
5	Module 3	Contrast between Innate and adaptive immunity	CO 3	II
6	Module 3	Explain in detail Secondary organs of immune system	CO 3	II
7	Module 4	Analyze Major Histocompatibility Complex (MHC) & Human Leukocyte Antigen (HLA)- and its role in organ transplantation	CO 4	IV
8	Module 4	Summarize autoimmune response with suitable examples	CO 4	II

SECTION B - ANSWER ANY 4 OUT OF 6 4 Q X 5 M = 20 M (To compulsorily have **ONE** question from **each** module)				
9	Module 1	List the contributions of Louis Pasteur.	CO 1	I
10	Module 2	Demonstrate the factors affecting bacterial growth	CO 2	III
11	Module 3	Compare the isolation of different pure culture techniques	CO 2	IV
12	Module 4	Describe Haptens	CO 3	II
13	Any Module	Analyse the role of APC in cell mediated immune response	CO 4	IV
14	Any Module	Explain Monoclonal antibodies	CO 4	II

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c. Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	COs Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1	15	CO-1	2	10	6 questions with at least 1 from each module	5
2	15	CO-2	2	10		5
3	15	CO-3	2	10		5
4	15	CO-4	2	10		5

9. CO PO Mapping

CO	PO	Cognitive Level	Class room sessions (hrs)
1	1, 3, 7	Remember, understand, and apply	15
2	1, 2, 6, 7	Understand, apply and evaluate	15
3	1,2,7	Remember and understand	15
4	1,2,7	Understand and analyse	15

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SEMESTER-II
MICROBIOLOGY & IMMUNOLOGY - PRACTICAL

1. Course description

Programme: B.Sc.
Course Code: U26/BIT/DSC/201/P
Course Type: DSC-2
No. of credits: 1

Max. Hour: 30
Hours per week: 2
Max. Marks: 50

2. Course objective:

- To aid students gain hands on experience in basic Microbiological techniques including aseptic handling, staining and culture methods and apply this knowledge in research or clinical findings.
- To provide hands-on training in fundamental immunological techniques and diagnostic procedures, enabling students to understand antigen–antibody interactions and immune response mechanisms.

3. Course Outcomes:

On completion of the course the student will be able to

CO-1: apply skills to prepare and sterilize media for isolation and culturing of microorganisms. **(APPLY & ANALYSE) L III & IV**

CO-2: Demonstrate and assess basic immunological techniques such as antigen–antibody reactions, blood grouping, and immunoassays. **(APPLY, EVALUATE) L III & V**

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PRACTICAL SESSIONS

1. Sterilization methods – Autoclave, Hot Air Oven, Filtration
2. Preparation of microbiological media (bacterial, algal & fungal)
3. Isolation of bacteria by streak, spread and pour plate methods
4. Isolation of bacteria from soil
5. Simple staining and differential staining (Gram's staining)
6. Bacterial growth curve
7. Blood grouping
8. Single radial immunodiffusion
9. ELISA
10. Viability test of cells/bacteria (Evans blue test or tryphan blue test)

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SEMESTER-II

MICROBIOLOGY & IMMUNOLOGY -PRACTICAL

Course Code: U26/BIT/DSC/201/P **Max. Marks: 50**

Credits: 1 **Time: 2Hrs**

I. MAJOR: **(20M)**

Perform Gram's staining using the given sample and report the results. Write the principle and procedure for the same

II. MINOR: **(10M)**

Perform and report your blood group using the given sample. Write the principle and procedure for the same

III. IDENTIFY THE GIVEN SPOTTERS: **(10M)**

IV. VIVA **(5M)**

V. RECORD **(5M)**

Prepared by	Checked & verified by	Approved by
Dr. Deepa Switha Teaching faculty	Ms. Shouni Niveditha HoD	Prof. Uma Joseph Principal

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PANEL OF EXAMINERS

FACULTY OF SCIENCE-DEPARTMENT OF BIOTECHNOLOGY

CBCS-2026

S.No.	B.Sc-Course Title	Examiner	Designation Place of Work	Years of Experience	Contact No.	Email Id.
1.	Semester I	Ms. D. Metilda Roselin	Asst. Prof., Dept of Genetics & Biotechnology, BVC	12	9160612832	metilda2324@gmail.com
		Dr.K.Madhuri	Associate Prof, Dept of Biotechnology, Mahatma Gandhi University	14	9000595973	madhuriphd09@yahoo.com
		Dr. Sushma Patkar	Asst. Prof, Dept of Genetics & Biotechnology, BVC	18	8790265800	Sushma.biotech @bhavansvc.ac. in
2.	Semester II	Dr.K.Madhuri	Associate Prof, Dept of Biotechnology, Mahatma Gandhi University	14	9000595973	madhuriphd09@yahoo.com
		Dr.T. Siva Ram	Asst. Prof, Dept of Biotechnology,	12	9032694559	tsram@outlook. com
		Dr.Madhuri	Loyola Degree & PG College, Alwal	21	9849442334	

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SEMESTER - II

COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY

1. COURSE DESCRIPTION

Programme: B. Sc
Course Code: U26/ ZOO/ DSC/201
Type of Course: DSC-II
No. of Credits: 4

Max. Hours: 60
Hours per week: 4
Max. Marks: 60

2. COURSE OBJECTIVES

1. To impart a comparative understanding of vertebrate organ systems, highlighting structural and functional modifications across evolutionary lineages.
2. To provide foundational knowledge of developmental biology, emphasizing embryonic processes, organogenesis, and evolutionary developmental mechanisms.

3. COURSE OUTCOMES

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

CO1: **Compare and contrast** integumentary, skeletal, muscular, and other organ systems across vertebrates, recognizing evolutionary modifications and adaptive significance. (L IV)

CO2: **Explain** the evolutionary trends in digestive, respiratory, circulatory, excretory, reproductive, nervous, and sensory systems, linking structure to function. (L II)

CO3: **Explain** the evolutionary trends in reproductive, nervous, and sensory systems, linking structure to function. (L II)

CO4: **Describe and analyze** key developmental processes such as gametogenesis, fertilization, cleavage, gastrulation, organogenesis, and placentation in vertebrates. (L II)

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4. COURSE CONTENT

MODULE I: INTEGUMENTARY, SKELETAL, AND MUSCULAR SYSTEMS 15 HRS

1.1 Comparative study of structure and function of integument and its derivatives (glands, scales, feathers, and hair) from fishes to mammals.

1.2 Comparative study of axial skeleton in fishes to mammals (skull and vertebrae).

1.3 Comparative study of appendicular skeleton in fishes to mammals (pectoral and pelvic girdles; limbs).

1.4 Comparative anatomy of axial, appendicular, branchiomeric and integumentary muscles.

1.5 Comparative study of adaptive modifications in vertebrate locomotion (swimming, walking, and flying).

MODULE II: DIGESTIVE, RESPIRATORY, CIRCULATORY AND EXCRETORY SYSTEMS 15 HRS

2.1 Evolution of the Digestive System – Structural and functional modifications of the alimentary canal and digestive glands from fishes to mammals.

2.2 Respiratory System Adaptations – Comparative study of respiratory structures (gills, swim bladders, lungs, and air sacs) and their evolutionary significance.

2.3 Circulatory System Variations – Morphological and functional diversity of the heart, aortic arches, Lymphatic System in vertebrates.

2.4 Excretory System and Osmoregulation – Evolution of kidneys, urinary bladders, and their ducts in different vertebrate groups with adaptations to aquatic and terrestrial environments.

2.5 Nephron and Kidney Evolution – Comparative anatomy of nephron structure, types of kidneys (pronephros, mesonephros, metanephros), and their evolutionary succession.

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MODULE III: REPRODUCTIVE, NERVOUS, AND SENSORY SYSTEMS **15 HRS**

3.1 Evolution of Reproductive Organs – Structural and functional modifications in male and female reproductive organs from fishes to mammals.

3.2. Reproductive & Parental Care Strategies across vertebrates.

3.3 Comparative Anatomy of the Nervous System – Structural variations in the vertebrate brain and cranial nerves from fishes to mammals.

3.4 Spinal Cord and Peripheral Nervous System – Comparative study of the spinal cord and spinal nerves, their structural and functional modifications in vertebrates.

3.5 Sensory Organs and Receptor Systems – Comparative study of sensory organs (vision, hearing, taste, smell, and touch) and sensory receptors (special somatic and special visceral receptors) from fishes to mammals.

MODULE IV: DEVELOPMENTAL BIOLOGY **15 HRS**

4.1 Early Embryonic Development: Gametogenesis (spermatogenesis and oogenesis) in mammals; vitellogenesis in birds; Fertilization mechanisms, and blocks to polyspermy.

4.2 Cleavage and Gastrulation: Structure of the fertilized chick egg; Patterns of cleavage, presumptive areas, fate maps.

4.3 Late Embryonic Development: Implantation of the rabbit embryo; Extraembryonic membranes; Placenta and types.

4.4 Organogenesis: Morphogenetic movements; Neurulation and notogenesis in frogs.

4.5 Assisted Reproductive Technologies (ART): Artificial insemination, In vitro fertilization (IVF), Embryo transfer and cryopreservation.

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5. SUGGESTED READINGS:

1. E.L.Jordan and P.S. Verma 'Chordate Zoology' -. S. Chand Publications.

2. Mohan P. Arora. 'Chordata – I, Himalaya Publishing House Pvt.Ltd.

3. Marshal, Parker and Haswell 'Text Book of Vertebrates'. ELBS and McMillan, England.

4. Alfred Sherwood Romer. Thomas S. Pearson 'The Vertebrate Body, Sixth edition, CBS College Publishing, Saunders College Publishing

5. George C. Kent, Robert K. Carr. Comparative Anatomy of the Vertebrates, 9th ed. McGraw Hill.

6. Kenneth Kardong Vertebrates: Comparative Anatomy, Function and Evolution, 4th ed, McGraw Hill.

7. J.W. Young, The Life of Vertebrates, 3rd ed, Oxford University Press.

8. Harvey Pough F, Christine M. Janis, B. Heiser, Vertebrate Life, Pearson, 6th ed, Pearson

9. Education Inc.2002.

10. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc.,

11. Publishers, Sunderland, Massachusetts, USA.

12. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.

13. Carlson, R. F: Patten's Foundations of Embryology

14. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.

15. Berril. N.J. and Karp: Developmental Biology. McGraw Hill, New York.

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6. SYLLABUS FOCUS

a) Relevance to Local, Regional, National and Global Development Needs

Local /Regional/National /Global Development Needs	Relevance
Global Development Needs	It is important to develop an understanding of the anatomical structures that help explain functional adaptations and evolutionary relationships among vertebrates. Developmental biology studies include stages such as fertilization, cleavage, gastrulation, and organogenesis that help to understand how organisms grow from a single fertilized egg to a complex organism.

b) Components on Skill Development/Entrepreneurship Development/Employability

SD/ED/EMP	Syllabus Content	Description of Activity
SD	I, II, III & IV	Guest lecture and Seminar

7. PEDAGOGY

S. No	Student Centric Methods Adopted	Type / Description of Activity
1.	**Experiential Learning**	Field Trips, Science Experiments
2.	**Participative Learning**	Presentation, Seminar & Workshops

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8. COURSE ASSESSMENT PLAN

a) Weightage of Marks in Continuous Internal Assessments and End Semester Examination

CO	Continuous Internal Assessments CIA - 40%	End Semester Examination-60%
CO1	CIA-1 Written Test	Written Exam
CO2	CIA-1 Written Test	
CO3	CIA-2 Assignment	
CO4	CIA-2 Objective Test	

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b) Model Question Paper – End Semester Exam Theory

COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY

Course Code: U26/ ZOO/ DSC/201
Credits: 4

MAX MARKS: 60
TIME: 2 hours

Note: This question paper consists of Section A and B.

The answer to Section A & B must be written in the answer book given.

SECTION – A (Long Essay Type)

Answer ALL questions: **Marks: 4 x 10 = 40**

1. Compare the structure and function of integument and its derivatives of Aves and Mammals.

OR

2. Explain adaptive modifications in vertebrate locomotion

3. Trace the evolution of heart in vertebrate series.

OR

4. Explain the Evolution of kidneys, in different vertebrate groups with adaptations to aquatic and terrestrial environments.

5. Compare the Structural variations in the vertebrate brain

OR

6. Explain functional modifications in female reproductive organs in Amphibians and Reptiles.
7. What is gametogenesis? Explain spermatogenesis and write how it differs from Oogenesis.

OR

8. Write about the structure and functions of placenta and add a note on its significance.

SECTION –B (Short Essay Type)

II. Write short notes on any **FOUR** of the following: **Marks: 4 x 5 = 20**

9. Integumentary muscles.
10. Pelvic girdles.
11. Air sacs.
12. Digestive glands in fishes
13. Sensory receptors
14. Patterns of cleavage

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Question Paper format – Blooms Taxonomy Level

SECTION A - INTERNAL CHOICE				**4Q X 10 M = 40 M**
Question Number	**Module Covered**	**Question**	**CO**	**BTL (Blooms Taxonomy Level)**
1	Module 1	Compare the structure and function of integument and its derivatives of Aves and Mammals.	CO 1	Level II & IV
2	Module 1	Explain adaptive modifications in Vertebrate locomotion	CO 1	Level IV
3	Module 2	Trace the evolution of heart in vertebrate series.	CO 2	Level II & IV
4	Module 2	Explain the Evolution of kidneys, in different vertebrate groups with adaptations to aquatic and terrestrial environments.	CO 2	Level II
5	Module 3	Compare the Structural variations in the vertebrate brain	CO 3	Level IV
6	Module 3	Explain functional modifications in female reproductive organs in Amphibians and Reptiles.	CO 3	Level II
7	Module 4	What is gametogenesis? Explain spermatogenesis and write how it differs from Oogenesis.	CO 4	Level IV
8	Module 4	Write about the structure and functions of placenta and add a note on its significance.	CO 4	Level II & III
SECTION B - ANSWER ANY 4 OUT OF 6 (To compulsorily have ONE question from each module)				**4Q X 5 M = 20 M**
9	Module 1	Integumentary muscles.	CO 1	Level I
10	Module 1	Pelvic girdles	CO 1	Level II
11	Module 2	Air sacs	CO 2	Level II
12	Module 2	Digestive glands in fishes	CO 2	Level I
13	Module 3	Sensory receptors	CO 3	Level II
14	Module 4	Patterns of cleavage	CO 4	Level I

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c) Question Paper Blueprint

Modules	Hours Allotted in the Syllabus	CO Addressed	Section A (No. of Questions)	Total Marks	Section B (No. of Questions)	Total Marks
1	15	CO-1	2	4x10=40	6 (By taking at least one question from each Module)	4x5=20
2	15	CO-2	2			
3	15	CO-3	2			
4	15	CO-4	2			

9. CO-PO MAPPING

CO	PO	Cognitive Level	Classroom sessions (hrs)
1	1, 2	Compare & Contrast	15
2	2, 7	Explain	15
3	1, 2	Explain	15
4	1, 2	Describe & Analyse	15

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COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY

PRACTICAL SYLLABUS

1. COURSE DESCRIPTION

Programme:	**B. Sc**	**Max. Hours:**	**30**
Course Code:	**U26/ ZOO/ DSC/201/P**	**Hours per week:**	**2**
Type of Course:	**DSC-II**	**Max. Marks:**	**50**
No. of Credits:	**1**		

2. COURSE OBJECTIVES

- To provide hands-on experience in comparative anatomy and developmental biology through observation, dissection, histological study, and embryological analysis, thereby reinforcing theoretical knowledge with practical skills.

3. COURSE OUTCOMES

1. Identify and compare skeletal structures, tissues, and organ systems across representative vertebrates, recognizing evolutionary modifications and functional adaptations.
2. Demonstrate practical understanding of vertebrate embryology by observing and analysing developmental stages such as cleavage, gastrulation, and neurulation using prepared slides.

4. COURSE CONTENT

1. Comparative Study of Vertebrate Skeletons:
   Observation and identification of skeletal structures from different vertebrate groups (Fishes, amphibians, reptiles, birds, mammals).
2. Histological Examination of Tissues: Microscopic study of integumentary, muscular, and glandular tissues in different vertebrates.
3. Virtual Dissection and Organ System Comparison: Dissection of representative vertebrates to study the digestive, respiratory, circulatory, nervous and urogenital systems.
4. Comparison of the anatomy of locomotory appendages in different groups of vertebrates.
5. Developmental Biology Experiments: Study of frog/chick embryology through prepared slides, observation of cleavage, gastrulation, and neurulation stages.

5. SUGGESTED MANUALS:

1. Freeman; Bracegirdle, An atlas of embryology
2. George C. Kent, Robert K. Carr. Comparative Anatomy of the Vertebrates, 9th ed.McGraw Hill.
3. Kenneth Kardong Vertebrates: Comparative Anatomy, Function and Evolution, 4th ed, McGraw Hill.

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6. MODEL QUESTION PAPER – END SEMESTER EXAM PRACTICAL

COMPARATIVE ANATOMY OF VERTEBRATES AND DEVELOPMENTAL BIOLOGY

Programme: B.Sc. **Course Code: U26/ZOO/DSC/201/P**

Type of Course: DSC-II **Max. Marks: 50**

No. of credits: 1

I. Comparative Study of Vertebrate Skeletons:

Observation and identification of skeletal structures from different vertebrate groups (fishes, amphibians, reptiles, birds, mammals). 4x3M=12 M

Skull, Vertebrae, Girdles and Limb bones

II. Microscopic Identification of Tissues:
Integumentary, Muscular, and Glandular tissues in different vertebrates. 2X3M=6M

III. Draw and label the dissected model of any 2 vertebrate groups (fishes, amphibians, reptiles, birds, mammals) 2 X5M= 10M

Digestive/ Respiratory/ Circulatory/ Nervous and Urinogenital systems.

IV. Comparison of the anatomy of locomotory appendages in different groups of vertebrates. 1x2M=2M

V. Identification of Developmental Biology slides: 4x2.5M=10M

VI. Record 10M

Prepared by	Checked & Verified by	Approved by
Name and Signature of the teaching faculty S. SRAVANTHI	**Name and Signature of HoD** Dr. JYOTHI RANI	**Name and Signature of Principal** Principal St. Francis College for Women Begumpet, Hyderabad-16.

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