Appendix-15
AC - 11.08.2023

BIOLOGICAL SCIENCE
(Sri Venkateswara College)
SEMESTER-VI

SEMESTER -VI

Category I

Biological Science Courses for Undergraduate Programme of study with BiologicalScience as a Single Core Discipline

(BSc Honors in Biological Science in three years)

DISCIPLINE SPECIFIC CORE COURSE – 16:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Molecular Biology II (601)	**4**	**2**		**2**	Sem V Of a BSc course	**Should have done Molecular biology I**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes.
- To understand how these processes are regulated.
- To enable them to apply this knowledge in enhancing their analytical and problem- solving skills.

Learn **CREDITS:2** **TOTAL HOURS: 15 weeks** ing outcomes

On successful completion of the course, students will be able to:

1. Acquire basic knowledge about the processes of transcription and translation in prokaryotes and eukaryotes
2. Learn about the features of the genetic code and various experimental approachesused to crack the code
3. Develop understanding of the molecular basis of RNA processing and RNA splicing
4. Learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms

SYLLABUS

FOR DSC-16

UNIT I: Transcription in Prokaryotes and Eukaryotes **No. of weeks : 5**

Transcription cycle in bacteria, Sigma factor, bacterial promoters and RNA Polymerases, various stages of RNA synthesis- initiation, elongation and termination, rho-dependent and rho-independent termination. Introduction of basal eukaryotic transcription machinery: threeclasses of eukaryotic RNA polymerases – I, II and III, and their respective promoters. Details of transcription by RNA polymerase II, features of RNA polymerase II core promoters. Inhibitors of eukaryotic and prokaryotic transcription and their applications.

UNIT II: RNA Processing **No. of weeks : 2**

Various types of mRNA processing- polyadenylation and capping, brief overview of rRNA andtRNA processing. Chemistry of RNA splicing, the spliceosome machinery, group I and group IIintrons, alternative splicing.

UNIT III: Translation **No. of weeks: 3.5**

Salient features of the genetic code, triplet nature, degenerate, wobble hypothesis, codon usage bias. Experimental approaches used to decipher the genetic code. Messenger RNA, transfer RNA, charging of tRNA. Structure of the ribosome. Three stages of translation- initiation, elongation and termination in prokaryotes and eukaryotes, charging of tRNA and aminoacyl tRNA synthetases.

UNIT IV: Regulation of gene expression **No. of weeks: 4.5**

Concept of operons, regulatory proteins, activators, repressors, DNA binding domains,regulation of *lac* and *trp* operon, riboswitches, induction of SOS response. Eukaryotic gene regulation by chromatin remodeling, heterochromatin and euchromatin, regulation of galactose metabolism genes in yeast, action of enhancers and insulators, working of activatorsand repressors, synthesis and mechanism of action - siRNA and miRNA.

PRACTICAL:

Credit: 2 **Total Hours: 60**

1. Quantitative estimation of RNA by Orcinol Method
2. Extraction of total RNA from bacteria /yeast
3. To study growth curve and diauxic growth curve in *E. coli*
4. To study the effect of inhibitors on protein synthesis

5. DNA Footprinting (Dry Lab)

Essential readings:

1. Nelson, D.L. and Cox, M.M (2017) *Lehninger: Principles of Biochemistry* (7th ed.) W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) *Watson: Molecular Biology of the Gene* (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN-13: 9780321762436

Suggested readings:

Lewin, B., Krebs, J.E., Kilpatrick, S.T., Goldstein, E.S., (2018) *Lewin's Gene X* (10th edition).Bartlett Learning publishers, LLC, ISBN: 978-0-7637-6632-0.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, Universityof Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 17

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Defense mechanisms in living organisms (BS-DSC-602)	4	2		2		SEM V

Learning Objectives

The Learning Objectives of this course are as follows:

- to focus on the integrative working and regulation of both the innate and induced/adaptive defense mechanism that operate in the vertebrate system as well as in the plant kingdom.
- to differentiate between innate and induced/adaptive immune mechanisms and their importance in maintaining a healthy system in both the animal and plan tkingdoms.

Learning outcomes

Upon completion of the course, the students will be able to:

- Get an overview of the immune system and learn about the various cells, organs and tissues of the immune system.
- to describe the basic mechanisms, differencesand functional interplay of innate and adaptive immunity.
- Students will be able to define the pathways of humoral and cell-mediated immune responses.
- Students will learn about the various preexisting structural and induced defenses in plants, the genetic basis of plant- pathogen interaction and how pathogens can cause disease in plants.

SYLLABUS OF DSC- 17

Theory

TOTAL HOURS: 30 **CREDITS: 2**

Unit I: Introduction to Defense Mechanisms **No. of weeks: 1**

Overview of immunity. Source of infection and spread of infection in plants and animals.

Unit II: Innate Defense mechanisms in plant **No. of weeks: 2.5**

Pre-existing structural defenses -waxy coat, cuticle, epidermal layer, hydathodes, thorns, sclereids,mineral crystals (idioblasts,) and cell wall. Biochemical defenses- secondary metabolites (terpenoids, glycosides, phenolics and alkaloids) Innate Immunity in Plants- Pattern triggered immunity (PTI)

Unit III: Adaptive Defense mechanisms in plant **No. of weeks: 4**

Factors causing plant stress: biotic stress. Classification of biotic stresses, major pests and diseasesof economically important crops, interaction in host-pathogen systems, Flor's gene for gene concept, R gene mediated resistance, effector triggered immunity (ETI), receptor-elicitor model, Cytological protection and induced resistance. Concept of signal transduction and other host- defense mechanisms. Heat shock proteins, Basic ROS cycle and adaptation during stress, SystemicAcquired Resistance (SAR), Phytoalexins Jasmonic acid, MAPKS,SROS,HPL, systemins , mechanism of production and scavenging of NO.

Unit IV: Innate Defence mechanisms in animals **No. of weeks: 3**

Anatomical barriers, soluble molecules and membrane associated receptors (PRR). Complement system - biological consequences and regulation of the pathway. Haematopoiesis, cells of the innate immune system, primary lymphoid organs. inflammatory response; connections between innate and adaptive immunity.

Unit V: Adaptive Defence mechanisms in animals **No. of weeks: 4.5**

Antigens and haptens, Factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes of immunoglobulins (Ig). Secondary lymphoid organs and tissues B cell maturation and generation of antibody diversity. Generation of humoral immune response. Histocompatibility antigens – structure and function, T cell maturation – Positive and Negative selection of thymocytes, Antigen Presentation by the exogenous and endogenous pathways, cell mediated immunity, role of NK cells and Antibody dependent cellular cytotoxicity.

PRACTICALS

TOTAL HOURS: 60 **CREDIT: 2**

1. Characterization of diseases symptoms and identification of pathogenic organisms (bacterial- Xanthomonas campestris; viral- TMV; fungal- Puccinia, graminis tritici, pest and nematodes- Meloidogyne spp.).
2. Survey of structural plants defences: viz. cuticle, wax, lignin, bark, thorns, prickles, trichomes, armour in different plants species including thigmonasty, camouflage, mimicry.

3. Precipitation reactions – DID and SRID.

4. Immunoelectrophoresis (IEP), Counter current IEP, Rocket IEP

5. Agglutination reaction.

6. Cell isolation and viable Counting- Spleen/PBMC

7. Survey report on infections in plants and animals

REFERENCES

1. B.B.Buchanan, W. Gruissem & R.L.Jones. (2015). Biochemistry and MolecularBiology of Plants. Oxford: Wiley Blackwell.
2. Coico, R & Sunshine, G., John (2009). Immunology: A Short Course. New Jersey:Wiley& sons.
3. Kindt, T.J., Goldsby, R.A. & Osborne, B.A.(2007) . Kuby Immunology. New York: W.H Freeman.
4. Leslie Hudson & Frank C. Hay (1980). Practical Immunology. Oxford: Blackwell Scientific 5. Lincoln Taiz & Eduardo Zeiger.(2010). Plant Physiology. Sunderland,Mssachusetts: Sinauer associates Inc.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch,University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –18 :

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibilitycriteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Evolutionary Biology(BS-DSC-603)	4	2		2	Class XII pass with Biologyand chemistry, as one of the papers in Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To stress the importance of evolution in biology and introduce students to all aspects of evolutionary biology.
- to make the students familiar with basic history of evolutionary concept, its criticism and its development as a science.
- They will learn about history of life through fossils and other evidences helping them analyze the evolutionary relationships between species.
- They will develop a deep understanding of the mechanisms that fuel the evolution of biological systems and will have an insight into the origin and evolution of species.

Learning outcomes

By the end of the course, the student will be able to:

- Students will learn about the origins and development of evolutionary thought.
- Students will learn about the compelling evidence in favor of evolution likefossils, comparative anatomy and molecular homologies.
- Students will learn about the origin and history of life through fossil records.
- Students will understand how biodiversity is generated by repeated speciation andlost over time due to mass extinctions.
- Students will understand how the forces of evolution like variations, naturalselection, genetic drift and migration shape populations.
- Students will learn how novelty in organisms arises, how organisms adapt to theirenvironment and about our origins from our primate ancestors.

SYLLABUS OF DSC-18

Theory

Credits: 2 Total weeks: 15

Unit I: Historical Review of Evolutionary Concept No. of weeks: 1.5

Pre-Darwinian ideas: List of contributors influencing Darwin indicated as a *timeline.*
Lamarckism: Darwinism: Post-Darwinian era: Modern synthetic theory; Neo-Darwinism.

Unit II: History of Life **No. of weeks: 3.5**

Chemogeny: An overview of prebiotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny: RNA firsthypothesis. Biogeny: Cellular evolution based on proto-cell models (coacervates and proteinoid microspheres). Origin of photosynthesis, Evolution of oxygen and ozone buildup and significance. Evolution of Eukaryotes from Prokaryotes (endosymbiotic theory), multicellularity. Cambrian explosion and timeline of plant and animal evolution in the Phanerozoic eon. Mass-scale extinctions: causes, significance and events. Cretaceous-Tertiary Mass Extinction in detail.

Unit III: Evidences of Evolution **No. of weeks: 2.5**

General evidences, Fossils, Concept of Stratigraphy and geological timescale, Dating methods (K-Argon and Radiocarbon dating); Convergent and Divergent Evolution, Adaptiveradiation, Phylogeny of horse as a model. Molecular clock, Neutral theory of evolution and;Basics of molecular phylogenetics.

Unit IV: Forces of Evolution **No. of weeks: 3**

Concept of micro- and macro-evolution (Role of gene regulation in macroevolution usingexample of beak development in Darwin's finches): A brief comparison Natural selection asa guiding force: Its attributes and action, basic characteristics of natural selection. Co-adaptation and co-evolution, Industrial melanism; antibiotic resistance. Modes of selection(Stabilizing, directional, disruptive), sexual selection, kin selection, artificial selection, Polymorphism and Balanced lethal systems.

Hardy Weinberg equilibrium,Genetic Drift (Sewall Wright effect) as a stochastic/randomforce: Basic characteristics of drift; selection vs. drift, Bottleneck effect, Founder principle.

Unit V: Product of Evolution: Speciation **No. of weeks: 2.5**

Concept of species as a real entity- Morphological and Biological species concept, Micro- evolutionary changes (inter-population variations, clines, Ring species, Races, polymorphism)Mechanisms of speciation, Allopatric, Peripatric, Parapatric and sympatric; Patterns of speciation. Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation: Isolating mechanisms

Unit VI: Human Ancestry and Phylogeny **No. of weeks: 2**

Primate characteristics and unique Hominin characteristics. Advantages and adaptations of bipedalism. General characteristics , distribution of Australopithecines, Homo habilis, Homoergaster, Homo erectus (Java Man , Peking man), Neanderthal man and Homo sapiens. Briefoverview of

Multiregional and Out of Africa hypothesis for origin and migration of Modern humans.

PRACTICALS

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of types of fossils (e.g. Body fossils, trails, casts, molds and others) and Index fossils of Palaeozoic era
2. Connecting links/transitional forms - *Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx and* Living fossils - Eg. *Limulus, Peripatus*, *Latimeria, Sphaenodon*
3. Vestigial, Analogous and Homologous organs using photographs, models orspecimen
4. Problems based on Hardy Weinberg equilibrium
5. Simulation experiments using colored beads to understand the effects of Naturalselection on allele frequencies
6. Simulation experiments using colored beads to understand the role of Bottleneckeffect/Founder effect on allele frequencies
7. Darwin's finches with diagrams/ cutouts of beaks of different species.
8. Digit reduction and teeth modification in horse phylogeny (study from chart),
9. Study of monkey and human skull - A comparison to illustrate common primate andunique Hominin features
10. Construction of Phylogenetic tree using morphological characters
11. Educational visit to Geology/ Anthropology museums, Delhi University

Essential readings:

1. Barton N.H., Briggs D.E.G., Eisen J.A., Goldstein D.B. and Patel N.H.,(2007)1st Ed. *Evolution*, Cold Spring Harbor Laboratory Press.
2. Futuyma Douglas and Mark Kirkpatrick (2017) 3rd Ed.*Evolutionary Biology*,Oxford University Press
3. Hall B. K. and Hallgrimson B., (2014) 5th Ed.*Strickberger's Evolution.* Jones and Bartlett
4. Ridley M., (2003) 3rd Ed.*Evolution* Wiley-Blackwell
5. Zimmer C. and Emlen D. J., (2013) 1st Ed. *Evolution: Making Sense ofLife*, Roberts & Co.

Additional resources

1. Darwin C., (2003)*The Origin of Species: 150th Anniversary Edition* , PenguinUSA
2. https://evolution.berkeley.edu/evolibrary/home.php
3. Kolbert E., (2015)*The Sixth Extinction: An Unnatural History,* Bloomsbury
4. Weiner J. (1995),*The Beak of the Finch: A Story of Evolution in Our Time*, Vintage

Note: Examination scheme and mode shall be as prescribed by the Examination Branch,University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-10

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant development and anatomy (BS-DSE-10)	**4**	**2**		**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NA**

Learning Objectives:

The objective of this paper is to provide the students with internal basic structure and cellular composition ofthe plant body. This will help them to understand how different plant tissue structures evolve and modify theirfunctions with respect to the environment. To acquaint the students with the study of various plant tissue systems and their development and functions in plants.

Learning Outcomes:

On successful completion of the course, a student will:

- Have knowledge about the various cells and tissues, meristems, epidermal and vascular tissue systemsin plants.
- Understand various aspects of growth, development of the tissues and differentiation of various plantorgans.
- Have knowledge of basic structure and organization of plant parts in angiosperms.
- Correlate the structure with morphology and functions.

SYLLABUS FOR DSE-10

Course Contents - Theory

Unit 1: Meristematic and Permanent Tissues **No. of weeks: 5**

Classification of Tissues, Simple and complex tissues (no phylogeny), Types of meristems: Root and Shoot Apical Meristems (describe theories in brief with special reference to Tunica Corpus andKorper-Kappe Theory), Pits and plasmodesmata, wall ingrowths and transfer cells, Ergastic substances

Unit 2: Secondary growth **No. of weeks: 5**

Vascular Cambium: Structure and function, seasonal activity; Structure of monocot and dicot stem, root and leaf; Secondary growth in root and stem; wood (Heartwood and Sapwood; Tension wood; Ring and Diffuse porous wood; early and late wood); Tyloses Cork Cambium and its derivatives and function: Rhytidome

Unit 3: Adaptive and Protective Systems **No. of weeks: 5**

Epidermal tissue system; Cuticle; Epicuticular waxes; Trichomes (Uni and multicellular, glandular and non- glandular, two examples of each); secretory tissues (hydathodes, mucilage ducts, resin ducts, oil glands, laticifers, lysigenous and schizogenous cavities); Stomata (Classification); Adcrustation and Incrustation; Anatomical adaptation of xerophytes and hydrophytes.

PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1. Study of root and shoot apical meristem through permanent slides. Study of distribution and types ofParenchyma, Collenchyma and Sclerenchyma through permanent slides.
2. Study of xylem and phloem elements through maceration.
3. Study of primary growth in Monocot and Dicot stem through temporary mounts
4. Study of secondary growth in Dicot stem through temporary mounts
5. Study of Monocot and Dicot root through temporary mounts – Primary growth
6. Study of secondary growth in Dicot root through temporary mounts
7. Study of isobilateral and dorsiventral leaf through temporary mounts/permanent slides
8. Study of different types of wood (ring porous; diffuse porous; tyloses; heartwood and sapwood)through permanent slides/museum specimens.
9. Study of stomata types through epidermal peel mount.
10. Study of trichomes (glandular and non-glandular), cystoliths, druses, raphides, starch grains, sclereidsand stone cells through permanent slides
11. Study of anatomical adaptations in Hydrophytes (*Nymphaea* or *Hydrilla*) and Xerophytes (*Nerium*leaf).

Essential Readings

i. Dickinson, W.C. (2000). *Integrative Plant Anatomy.* Cambridge, U.K. : Harcourt Academic Press.
ii. Esau K. (1977). *Anatomy of Seed Plants.* New Delhi, Delhi: John Wiley & Sons, Inc.
iii. Evert, R.F., Eichhorn, S.E. (2006). *Esau's Plant Anatomy: Meristems, Cells, and tissues of the plantbody: their structure, function and development.* New Jersey, U.S.: Wiley-Liss.
iv. Fahn, A. (1974). *Plant Anatomy.* Pergmon Press, USA and U.K.

Suggested Readings

1. Mauseth, J.D. (1988). *Plant Anatomy.* San Francisco, California: The Benjammin CummingsPublisher.
2. Raven, F.H., Evert, R.F., Eichhorn, S.E. (1992). *Biology of Plants.* New York, NY: W.H. Freemanand Company.

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-11

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pharmacology and Toxicology (BS-DSE-11)	**4**	**2**		**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NA**

Learning Objectives:

This is an introductory course to lay the foundation for understanding basic concepts in Pharmacology and thepharmacological basis of therapeutics. The objective of the course is to introduce students to the core principles of drug action in terms of bioavailability, pharmacokinetics, pharmacodynamics, and mechanism of action of drugs in the treatment of diseases. The course will also provide basic principles of toxicology, toxic substancesand their effects on body systems.

Learning Outcomes:

On successful completion of the course, a student will:

- Understand the basic scientific concepts and principles that serve as the foundational underpinnings of the pharmacological sciences including pharmacokinetics; pharmacodynamics; drug metabolism; and drug-drug interactions.
- Learn an introduction to the processes by which new drugs are discovered.
- Understand the specific pharmacology of the major drugs and drug classes currently used in medical practice including their indications, clinical use and mechanisms of action,
- Discuss the basic principles of toxicology; the mechanisms by which excess exposure to certain drugs,toxins, chemicals, heavy metals and poisons can lead to adverse toxicological effects

SYLLABUS FOR DSE-11
Course Contents -Theory

Unit 1: Introduction to Pharmacology **No. of weeks: 2.5**

History and Scope of Pharmacology, Nature and source of drugs, Routes of drug administration, Drugreceptors and receptor subtypes, Drug Discovery and Development, Computer Aided Drug Design

Unit 2: Pharmacokinetics and Pharmacodynamics **No. of weeks: 4**

Absorption, Distribution, Metabolism, and Excretion (ADME) of drugs. Bioavailability, First Passmetabolism, Biological half-life of drug and its significance, Drug-drug interactions.

Unit 3: Drug Classification and their mechanism of action **No. of weeks: 5**

Drugs of Inflammation: Analgesics and Anti-inflammatory Drugs, NSAIDs; Drugs of autonomic and central nervous system -Adrenergics: Isoprenaline, Propranolol; Dopaminergics, Dopamine, Syndopa; General Anesthetics: Halothane; Sedatives and Hypnotics: Diazepam; Cholinergics: Bethanechol, Rivastigmine; Anticonvulsant, Drugs of Cardiovascular system*:* Anticoagulant (Heparin, Warfarin) Blood Pressure LoweringDrugs (Diuretics, Reserpine), Lipid Lowering Drugs (Statin); Drugs of Gastro-Intestinal tract*:* Antacid(Cimetidine), Acid Blocker and Laxative ;Drugs of Renal functions: Diuretics; and Anticancer Drugs (Cistatin,Methotrexate, 5-fluorouracil).

Unit 4: Toxicology **No. of weeks:3.5**

Classification of toxic substances, Drugs, Toxins and Heavy metal poisoning, Xenobiotics, Mechanism of toxicity, Tolerance to toxicants, Dose-response relationship, Therapeutic Index, Bioaccumulation and Antidotes.

3.1 PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1. To study the presence of paracetamol (acetaminophen) in given sample by spectroscopic method
2. Determination of LD50/LC50 of antibiotic/drug
3. Model Systems to study Dose-Response
4. Drug Binding assay to Albumin by Spectroscopic Analysis
5. Effect of heavy metal/toxin on enzyme activity
6. Colchicin effect on cell division.
7. Case Studies in Toxicology
8. Small Molecule Databases mining and Protein-ligand Docking
9. Visit to Pharmaceutical or Toxicology laboratory

3.2 Essential Readings

1. Tripathi, K.D. (2010). 7th Edition. Essentials of medical pharmacology. Delhi, India: Jaypee Brothers.ISBN-13:9788184480856.
2. Katzung, Bertram G. , Basic &Clinical Pharmacology, 14th Edition, McGraw Hill Education, 2017
3. Klaassen, C. D. and Watkins J. B. (2021), 4th Edition, Casarett & Doull's Essentials of Toxicology NewYork, USA: McGraw Hill.ISBN: 978-1-26-045229-7.

4 Kulkarni, S.K. (2012). 4th Edition. Handbook of experimental pharmacology. Delhi, India: VallabhPrakashan, ISBN-13: 97881857311.

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-12

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology (BS-DSE-12)	**4**	**2**		**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NA**

Learning Objectives:

The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences. The relevance of Developmental Biology to the study of human disease will be exemplified throughout using different model organisms.

Learning Outcomes:

Upon completion of the course, students will be able to:

- Understand the fundamental processes that underpin the fertilization of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism.
- Learn how a cell behaves in response to an autonomous determinant or an external signal depends on the combination of transcriptional and posttranscriptional regulators, signaling pathway components, cytoskeletal elements, and other proteins and RNAs that it has synthesized earlier: i.e., on its developmental history. Students learn best by doing and by having the opportunity to put what they havelearned into practice. Therefore, various model organism will be used as a learning tool.
- Understand that cells only express a proportion of their genome, and that differential gene expression underlies cell differentiation and any alteration in the entire process of development leads to devastating diseases.

SYLLABUS FOR DSE-12
Course Contents- Theory

Unit 1: Introduction **No. of weeks: 2.5**

Historical perspective and basic concepts of developmental biology: cell division, cell differentiation, morphogen and morphogenetic gradient, patterning; EVO-DEVO concept. Model organisms

Unit 2: Early Embryonic Development **No. of weeks: 5**

Post fertilization events: 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 3: Late and post Embryonic Development **No. of weeks: 5**

Fate of Germ Layers; Formation of neural tube and neural tube defects , Formation of Extra-embryonic membranes in birds; Placenta (Structure, types and functions of placenta) Modes of regeneration-epimorphosis,morphallaxis and compensatory regeneration (with one example each). Aging- genes involved in alteration in timing of senescence

Unit 4: Gene regulation in development No. of weeks: 2.5 Axis specification in Drosophila: role of maternal genes, patterning of early embryo by zygotic genes: gapgenes, pair-rule genes, segment polarity genes, homeotic selector genes- bithorax and antennapedia complex.

3.1 PRACTICAL

Credit: 2 **Total Hours: 60**

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 (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours, Stage 7-24 hours, Stage 8-28 hours, Stage10-33 hours, Stage 11-40 hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation
3. Demonstration of culture of chick embryo from fertilized eggs to study various developmental stages.
4. Study of the developmental stages and life cycle of Drosophila from stock culture.
5. Study of different sections of placenta (photomicrographs/ slides).
6. Project report on Drosophila culture/chick embryo /Zebra fish development.
7. A visit to Poultry Farm/IVF Centre/Zebra fish lab

3.2 Essential readings:

1. Gilbert, S. F. (2010). Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers,Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition, InternationalThompson Computer Press.
3. Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley- Blackwell.

Suggested Readings:

1. Wolpert, L. (2002). Principles of Development. II Edition, Oxford University Press.
2. Kalthoff, K. (2001). Analysis of Biological Development. II Edition, McGraw Hill Publishers.
3. Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.
4. Arora, R. and Grover, A. (2018) Developmental Biology: Principles and Concepts. I Edition, R. Chand& Comp

DISCIPLINE SPECIFIC ELECTIVE COURSE –DSE-19

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Research Methodology (BS-DSE-12)	**4**	**2**		**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NA**

Learning Objectives:

The main objective of this paper is to provide students with a general introduction to the methodological foundations and tools used in research for an understanding of the ways to identify problems, develop hypotheses and research questions and design research projects. The course will expose students to the range of designs used in research in laboratory, field experiments, surveys and content analysis. It will also provide an introduction to the concept of controls, statistical tools and computer applications used in research. In addition, the course will impart knowledge of scientific writing, oral presentation and the various associated ethical issues.

Learning Outcomes:

Upon completion of the course, students will be able to:

- Define research, learn the importance of research and its link with theoretical knowledge
- Describe the research process and the principle activities, skills and ethics associated with the researchprocess
- Describe and compare the major quantitative and qualitative research methods
- Construct an effective research proposal
- Understand the importance of research ethics use the computer software for organization and analysisof data.
- Develop skills in the art of scientific writing and oral presentation

SYLLABUS FOR DSE-19

Course Contents- Theory

Unit 1: Introduction to Research **No. of weeks: 2**

Objectives and characteristics of research; significance of research, types of research methods-qualitative andquantitative; basic and applied; descriptive and analytical; various phases of research-problem identification, generation of hypothesis, experimental design, results and discussion. Writing a research proposal-schematic presentation.

Unit 2: Basic principles of research design **No. of weeks: 4**

Review of literature using appropriate sources – reviews, patents, research papers, books and e-

resources; Significance of controls in research, Types of research designs – exploratory, descriptive, experimental, surveyand case study.

Unit 3: Statistical tools and Report writing **No. of weeks: 6**

Data collection, analysis and graphical presentation; Sample – types and characteristics; Basic Statistical Tools
- Measures of central tendency, Arithmetic mean, Median, Mode, Standard deviation, Co-efficient of variation (Discrete serious and continuous serious), Correlation, Regression, Multiple Regression, hypothesis testing, P-value, data analysis and interpretation; Report writing, format of publications and presentations-oral and poster.

Unit 4: Scientific conduct and ethics in Research **No. of weeks: 3**

Biosafety and Ethics - compliance and concerns; Plagiarism-Software tools and Creative Commons; Introduction to Intellectual Property Rights; Citation and acknowledgement, Impact factor, h-index, Indianand international funding agencies.

3.1 PRACTICALS

CREDITS: 2 **TOTAL HOURS: 60**

1. Use of search engine tools for retrieving research papers
2. Preparation of bibliography in different formats
3. Use of Plagiarism tools
4. Design of a research survey on a specific problem
5. Writing a concept note / research proposal
6. Writing of a mini-review paper
7. Systematic review, meta data analysis and presentation
8. Poster/oral presentations

3.2 Essential readings

1. Cresswell, J. (2009) *Research Design : Qualitative and quantitative Approaches* Thousand Oaks CA,(3rd ed.), Sage Publications
2. Kothari, C.R. (2004) *Research Methodology: Methods and Techniques* (2nd ed.), New AgeInternational Publishers.
3. Kumar, R. (2011) *Research Methodology: A Step-by-Step Guide for Beginners* (5th ed.), SAGEpublisher
4. Walliman, N. (2017*) Research Methods: The Basics,* **(**2nd ed.), London ; New York : Routledge
5. *WHO (2001) Health Research Methodology – A Guide for Training in Research Methods.*