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**	Class XII Pass with Biology & Chemistry	**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 hours :10**

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 hours : 4**

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 hours: 7**

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 hours: 9**

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.

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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 hours: 3

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 hours: 7**

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 hours: 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 hours: 6**

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 hours: 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: 4**

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

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