ST JOSEPH'SUNIVERSITY

BENGALURU-27

Re-accredited with **'A++' GRADE with 3.79/4 CGPA** by
NAAC Recognized by UGC as College of Excellence

SYLLABUS FOR B.Sc. BIOLOGY

(AS PER SEP 2024)

I to VI Semesters

2024-2027

Department of Biology
School of Life Sciences
St. Joseph's University
Bengaluru - 560 027

St Joseph's University, Bengaluru- 560 027

School of Life Sciences

Department of Biology

B.Sc. Biology Course Frame Work

Semester	Code number	Title of the paper	No. of hours of teaching per week	No. of credits
I	BY124	Molecular and Cellular basis of Life	3	3
	BY1P24	Molecular and Cellular basis of Life	3	2
II	BY224	Systems and Processes in Biology	3	3
	BY2P24	Systems and Processes in Biology	3	2
III	BY325	Biology of Development and Growth	3	3
	BY3P25	Biology of Development and Growth	3	2
IV	BY425	Diversity of Flora and Fauna	3	3
	BY4P25	Diversity of Flora and Fauna	3	2
V	BY5126	Molecular systematics	3	3
	BY5P126	Molecular systematics	3	2
	BY5226	Biomaterials and Nanotechnology	3	3
	BY5P226	Biomaterials and Nanotechnology	3	2
	BY5326	Stem Cell Biology and Regenerative Medicine	3	3
	BY5P326	Stem Cell Biology and Regenerative Medicine	3	2
	BY5S426	Dissertation - Proposal design	3	2
	BY5R526	Research methodology	2	2
VI	BY6126	Forensic Biology	3	3
	BY6P126	Forensic Biology	3	2
	BY6226	Biopharmaceutical science	3	3
	BY6P226	Biopharmaceutical science	3	2
	BY6326	Neurosciences	3	3
	BY6P326	Neurosciences	3	2
	BY6S426	Bio-Innovations and Entrepreneurship	3	2
	BY6D526	Dissertation	6	4

Semester 1 – B.Sc. Biology

Semester	**I**
Paper Code	**BY124**
Paper Title	**Molecular and Cellular basis of Life**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practical per semester	**30**
Number of practical's credits	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Demonstrate good knowledge of the founding blocks of life
CO2	Understand	Demonstrate basic chemical and physical concepts underlying the formation of biomolecules.
CO3	Apply	Apply knowledge and understanding of the foundations of life to the study of biological phenomena.
CO4	Analyze	Investigate and solve basic problems and case studies pertaining to the structure and function of biomolecules.
CO5	Evaluate	To critically evaluate their foundational knowledge to biological phenomena and current related research.
CO6	Synthesize	Work in teams to design experiments that would illustrate the concepts they have studied

Learning Outcomes (LOs):

LO1	The students will be able to enumerate and explain the early conditions of life in solar system
LO2	The students will be able to outline and differentiate the volatile compounds and organic molecules that supports the life in comets.
LO 3	The students will be able to identify the evidences of life on earth by understanding the fossils and geological time scale.
LO 4	The students will be able to explain and correlate the importance of surface

	water for origin of life
LO5	The students will be able to explain, explore and critically analyze evidences of water and life supporting molecules on Mars.
LO6	The students will be able to explore and analyze theories of life on other planets in the solar system
LO7	The students will be able to identify, explain and analyze chemical and biological evidences of the evolution of life.
LO8	The students will be able to explain, describe, and analyze the unifying themes in life, from cells to organisms.
LO9	The students will be able to define, explain, and analyze the processes that govern evolution and diversification of life.
LO10	The students will be able to define, describe, and explain the fundamental processes governing the origins of cells and cell survival in different environments.
LO11	The students will be able to define, describe, and analyses energy sources of cells and biosynthesis of molecules in cells.
LO12	The students will be able to describe, explain, and analyze the tree of life
LO13	The students will be able to illustrate and differentiate the cell walls and special cells of different organisms.
LO14	The students will be able to outline, discuss and differentiate the various transportation mechanisms in living organisms.
LO 15	The students will be able to describe and appreciate various types of stem cells and their lineage.
LO 16	The students will be able to describe and animate different stages of programmed cell death.
LO 17	The students will be able to understand, capture and summarize the concepts of cancer and its types with a hold on updated diagnostic and treatment methods.

Semester 1 – B.Sc. Biology
DSC-1:BY124: Molecular and Cellular basis of Life

Topics	**45 Hours**
Unit – I: Astrobiology	**25 h**
Astrobiology: Conditions in the early Solar System, comets as reservoirs of volatiles and organic molecules, concept of habitable zones. Explorations of life in the universe – current evidences /surveys. History of life on earth through evidences. **Prospects for life on Mars**: Evidence for surface water in the past; climate change; Viking results; possible sub-surface life; Martian paleontology. Life on other planets	8+2

of Solar System, Discovery of planets around other stars. (self-study)	
Unit – II Evolution of cells	
Evolution of life: biological and chemical evolution of life, Unifying themes in life **–** structural and functional processes, Evidences from molecules to organisms. Early perspectives and theories regarding diversity of life, until Darwin-Wallace. Fundamental principles in evolutionary processes – variation, heritability, selection/drift – brief overview.	8
Cellular and Genetic basis of life: Origin of cells. Organismal differences in energy source and biosynthetic precursors. Diversification of cells, three distinct domains of Life. Comparison of Bacterial and Archea cells, genomic evolution among three domains, Eukaryotic cells and their origin. Cell survival in different environment (Self-study).	5+2
Unit – III: Cellular Processes	**20h**
Bio-molecules: Fundamentals of DNA, RNA, and Proteins. **Basic functions of the cell:** Cell protection – the cell wall(plant, bacteria, fungi). Cells as biochemical factories -special cells fixing nitrogen and carbon-dioxide. **Transport across biological membranes:** Cell permeability, passive transport, Active transport. Phagocytosis, pinocytosis, endocytosis, exocytosis (self-study).	10+2
Cell Birth: Stem cells - types and their differentiation (embryonic stem cells). Cell development and fate. Concept of cell lineage (*C. elegans* as model system*).*Overview of Programmed Cell Death/Apoptosis.	6
Cancer cells: Definition, types and causes (mutation and carcinogens). Formation of tumor cells and malignancy.	2

Note: Underlined topics are for self-study

Recommended Books/ References:

1. Handbook of Astrobiology. Edt. Vera M.Kolb (CRC Press, Taylor and Francis gp.)
2. The science of Astrobiology.Julian Chela-Flores (Springer)
3. Cell Biology by P. S Verma
4. Cell Biology by Veer Bala Rastogi.
5. Cell and Molecular Biology by PK Gupta.
6. Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt 5th Edition Publishers: Wiley

7. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley & Sons. Inc.
8. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
9. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.
10. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, videos.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
Seminars/Class work (CIA)	**10**
Assignments/Discussions (CIA)	**10**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY124**
Title of the paper: **Molecular and Cellular basis of Life**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
17	9	I
27	14	II
42	22	III
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question):**60**		

SEMESTER- I: BIOLOGY PRACTICALS

Semester	**I**
Paper Code	**BY1P24**
Paper title	**Molecular and Cellular basis of Life**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**30**
Number of credits	**2**

1. Using Simple and Compound Microscope, observe Plant cell wall/fungal cell wall.
2. Investigating osmosis/plasmolysis in Animal cell/Plant cells.
3. Study of Blood cells.
4. Cytochemical staining of DNA by Feulgen / Acetocarmine.
5. Cytochemical staining of proteins by Bromophenol blue.
6. Isolation and culturing of living organisms (yeast, bacteria)
7. Measurement of cell growth by Haemocytometer or UV- Visible spectrophotometer.
8. Vital staining of mitochondria by Janus green B in buccal epithelial cells.
9. Isolation of membranous organelles of eukaryotic cells.
10. Identification and study of types of cancer, cancer cells by permanent slides/photographs OR anatomical observation and study of locally collected leaf galls.

Recommended Books/References

1. Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt 5th Edition Publishers: Wiley
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley & Sons. Inc.
3. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.
5. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre-lab assignments	**5**
Post-lab assignments	**10**
In-lab performance	**10**
Total	**25 + 25 (ESE) = 50 marks.**

Semester II – B.Sc. Biology

Semester	**II**
Paper Code	**BY224**
Paper Title	**Systems and Processes in Biology**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practicals per semester	**30**
Number of practicals credits	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Demonstrate basic cellular and tissue organization of organs and their functions.
CO2	Understand	Demonstrate how homeostasis works and how the inter-connected functions of physiological units contribute to homeostasis or organisms. Distinguish between redundant and holistic approaches in biological sciences.
CO3	Apply	Apply foundational knowledge and understanding of homeostasis to health and disease.
CO4	Analyze	Analyze and solve basic problems in physiology of organisms.
CO5	Evaluate	Investigate and critically analyze basic patho-physiology of common human conditions.
CO6	Create	Work in teams to design experiments and/or investigate case studies relevant to current research in plant and animal physiology.

Learning Outcomes (LOs):

LO1	The students will be able to explain, illustrate, and evaluate cellular and tissue organization in different animal organs and plant systems.
LO2	The students will be able to explain, illustrate, and analyze basic functional processes in plants.
LO 3	The students will be able to define, explain, and evaluate plant photosynthesis and its importance to global health.

LO 4	The students will be able to describe, illustrate and evaluate processes underlying plant growth.
LO5	The students will be able to explain, illustrate and examine organ systems and their functions in animals and humans.
LO6	The students will be able to explore and analyze pathophysiology of organ systems in humans.
LO7	The students will be able to explain, analyze and examine homeostasis in plants and animals.
LO8	The students will be able to explore, analyze and apply thermoregulatory strategies used by plants and animals in the context of climate change.
LO9	The students will be able to explain and analyze fundamental concepts of systems biology.
LO10	The students will be able to explore and analyze the importance of multidisciplinary approaches to studying biological processes.
LO11	The students will be able to explore and analyze the dynamic systems in cells, organs of living organisms.
LO12	The students will be able to explore and analyze network systems approaches in biology.
LO13	The students will be able to explore and analyze the applications of systems approaches in medicine and drug discovery.

Semester II – B.Sc. Biology,
DSC-2: BY224: Systems and Processes in Biology

Topics	45 Hours
Unit – I: Plant physiological processes	15h
Water Relations: Soil and water (Self-study), water absorption, Stomata (structure and mechanism), Transpiration, Ascent of sap. Mineral Nutrition: Essential elements and their role in Hydroponics	4+1
Photosynthesis: Ultrastructure of Chloroplast, Photophosphorylation, Carbon assimilation, Photorespiration, Factors affecting photosynthesis (self-study), Transport of organic solutes and their storage.	4+1
Seed physiology: Definition, structure, chemical composition of seed. physiological changes during seed germination; mobilization of stored resources in seeds for respiration, Ultra structure of Mitochondria and associated respiration	5
Unit II: Animal physiological processes	23h
Physiological systems and functions: Introduction to physiological systems	7+2

[respiratory, digestive, excretory, cardiovascular/circulatory, integumentary, muscular (self-study)] – related common pathology (one example each).	
Homeostasis. Concept of internal environment, equilibrium and feedback mechanisms, e.g. diabetes, child birth.	4
Osmoregulation: Osmoregulators and osmoconformers. Variation in marine and freshwater fishes. Electrolyte balance in mammals (normal and desert adaptations). Euryhaline and stenohaline animals. Osmoregulative dysfunction in human physiological system (kidney failure).	6
Thermoregulation: Q_{10} and metabolism. Physiological systems adaptations to extreme environments. Strategies in thermal biology - poikilotherms, homeotherms, steno and eurythermal animals. Process of thermoregulation in endotherms, role of hypothalamus in thermoregulation. Adaptations to seasonality and thermal changes – hibernation/ aestivation (self-study), Thermoregulatory dysfunction in physiological systems (heatstroke, cold stress) - Implications of Global warming.	5+1
Unit – III: Introductory Systems Biology	5h
Systems Biology: introduction, History, Scope and importance (Self-study), Fundamental concepts of dynamic systems and networks. Concepts of self-organization.	2+1
Fundamental approaches to studying systems biology (Graph theoretic analysis). Overview of Enzyme Kinetic modeling of biochemical reactions.	2

Note: Underlined topics are for self-study

Recommended Books/References

1. Plant Physiology and Biochemistry by H.S. Srivastava.
2. Plant Physiology by L. Taiz and E. Zeiger, Sinauer Associates, USA,2010
3. Introduction to Plant Physiology by W G Hopkins and N P Huner, John Wiley & Sons (Fourth Edition), 2010
4. Animal Physiology by P.S Verma and Aggarwal.
5. Animal Physiology by N. Arumugam.
6. Biochemistry and Physiology by Veer Bala Rastogi.
7. David Randall, Eckert's Animal Physiology, W.H.Freeman and Co.
8. Philips Withers; Comparative Animal Physiology. Books Cole Publishers
9. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall, ISBN 1-58488-642-0
10. Systems Biology: A Textbook, 2nd Edition (Wiley). Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald.

11. Kitano H. Systems biology: a brief overview. Science. 2002 Mar 1; 295 (5560):1662-4.
12. Ross J, Arkin AP. Complex systems: from chemistry to systems biology. Proc Natl Acad Sci U S A. 2009 Apr 21;106(16):6433-4. doi: 10.1073/pnas.0903406106. Epub 2009 Apr 20.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
Seminars/Class work (CIA)	**10**
Assignments/Discussions (CIA)	**10**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY224**
Title of the paper: **Systems and Processes in Biology**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
29	15	I
44	23	II
13	7	III
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question): **60**		

SEMESTER- II: BIOLOGY PRACTICALS

Semester	**II**
Paper Code	**BY2P24**
Paper title	**Systems and Processes in Biology**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**30**
Number of credits	**2**

1. Calculation of the stomatal index, stomatal frequency in plant samples.
2. Separation of chlorophyll pigments by paper chromatography.
3. Study of the effect of light and temperature on photosynthesis in *Hydrilla*.
4. Effect of temperature on cell permeability.
5. Ganong's Respirometer and photometer.
6. Investigation of salt gain or loss in fish.
7. Determining Q10 effects of temperature – opercular rate variation in fish.
8. Investigation of Oxygen consumption by fish.
9. Qualitative analysis of Nitrogenous wastes.
10. Measurement of blood pressure and blood glucose.

Recommended Books/References

1. Introduction to Plant Physiology by W G Hopkins and N P Huner, John Wiley & Sons (Fourth Edition), 2010
2. Plant Physiology by L. Taiz and E. Zeiger, Sinauer Associates, USA,2010
3. David Randall, Eckert's Animal Physiology, W.H. Freeman and Co.
4. Philips Withers; Comparative Animal Physiology. Books Cole Publishers.
5. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall, ISBN 1-58488-642-0
6. Systems Biology: A Textbook, 2nd Edition (Wiley). Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald.
7. Kitano H. Systems biology: a brief overview. Science. 2002 Mar 1;295(5560):1662-4.
8. Ross J, Arkin AP. Complex systems: from chemistry to systems biology. Proc Natl Acad Sci U S A. 2009 Apr 21;106(16):6433-4. doi: 10.1073/pnas.0903406106.

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre-lab assignments	**5**
Post-lab assignments	**10**
In-lab performance	**10**
Total	**25 + 25 (ESE) = 50 marks.**

Registration Number:

Date & session:

EXAMINATION PATTERN

STJOSEPH'S UNIVERSITY, BENGALURU -27
I B.Sc. (BIOLOGY) – I SEMESTER
SEMESTER EXAMINATION: OCTOBER 2024
(Examination conducted in November 2024)

BY 124 – Molecular and Cellular basis of Life

Time: 2 Hours **Max Marks: 60**

This paper contains ONE printed page and THREE sections

Part A

Answer any TEN of the following **10 x 2 = 20 marks**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

Part B

Write notes on any FIVE of the following **5 x 6 = 30 marks**

13.
14.
15.
16.
17.
18.
19.

Part C

Give a comprehensive account of any ONE of the following **1 x 10 = 10 marks**

20.
21.

ST. JOSEPH'S UNIVERSITY, BENGALURU - 5600027
SCHOOL OF LIFE SCIENCES
I B.Sc. (BIOLOGY) - I SEMESTER
BIOLOGY PRACTICAL EXAMINATION

BY 1P24 - Molecular and Cellular basis of Life

MAX. MARKS: 25 **TIME: 3 hours**

1.	Major experiment	**1 X 10 = 10**
2.	Minor experiment	**1 x 6 = 6**
3.	Spotters (A,B,C)	**3 X 3 = 9**

Semester III – B.Sc. Biology

Semester	**III**
Paper Code	**BY325**
Paper Title	**Biology of Development and Growth.**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practicals per semester	**36**
Number of practical credits	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Explain historical and current theories of developmental biology.
CO2	Understand	Describe and explain the relationship between reproduction, fertilization, and early embryonic development, including cell differentiation and pattern formation.
CO3	Apply	Apply fundamental principles of developmental biology to identify similarities and differences between plant and animal growth, and the factors that influence diversity of growth patterns across major groups.
CO4	Analyze	Evaluate and determine how intrinsic and extrinsic factors influence embryonic development and growth of organisms. Explore and analyze human embryonic development.
CO5	Evaluate	Critically evaluate and relate concepts in developmental biology to the generation of biodiversity and also extend their knowledge and understanding to applications, such as agriculture and animal husbandry.
CO6	Create	Design experiments that would illustrate and/or extend concepts of plant and animal development in laboratory settings.

Learning Outcomes (LOs): At the end of the course the students will be able to:

LO1	Define and describe fundamental principles of developmental biology
LO2	Define and differentiate between the kinds of reproduction that occur in plants and animals
LO3	Explain and illustrate how gametes are formed in plants and animals

LO4	Explain the processes of fertilization in plants and animals
LO5	Identify and enumerate the types of eggs or ovules that are formed in different plants and animals.
LO6	Define, explain and illustrate how egg/ovule structure and content influences various cleavage patterns in different animals
LO7	Identify, examine, and describe the various stages of early embryonic development in plants and animals.
LO8	Explain, describe, and analyze unifying themes or differences underlying early embryonic development in plants and animals.
LO9	Define, explain, and analyze the processes that govern embryonic development at the molecular and cellular levels.
LO10	Define, describe, and analyze the process by which tissues and organs are formed in plants and animals.
LO11	Examine, describe, and illustrate various stages of plant and animal development in model organisms.
LO12	Define, describe, and analyze the difference between development and growth in plants and animals.
LO13	Examine, describe, and explain intrinsic and extrinsic influence on plant and animal growth.
LO14	Examine and apply concepts in development and growth to real life phenomena.
LO 15	Investigate and design experiments to analyze growth of plants and animals.
LO 16	Describe and explain early human development.

SEMESTER III – B.Sc. Biology,
DSC-3: BY325: BIOLOGY OF DEVELOPMENT AND GROWTH

	45 Hours
Unit-1: History and philosophy of developmental biology	4h
Theories of animal development - preformation, epigenesis, Von Baer's theory. Definition and importance of growth and development, Overview of development, differentiation, and growth at the cellular and organismal levels.	4h
Unit-2: Developmental stages and patterns	12h
Types of reproduction, introduction to gametogenesis: Formation of male and female gametes in plants and animals, types of eggs/ovules, and fertilization in plants and animals. Embryogenesis in plant and animals - Patterns of cell division in plants and cleavage patterns based on yolk in animals. Embryology of chick.	10 + 2
Unit-3: Molecular regulation during development	10h

Introduction to inducers, organizers, and pattern formation. Spemann-Mangold experiment. Brief overview of Homeotic genes and genetic control of early development in animals. Examples of homeotic mutations. Conservation of homeotic genes across animals. Genes involved in development and differentiation of Shoot apical meristem; Root apical meristem and flower.	9 + 1
Unit-4: Hormonal and environmental influences on growth and development	13h
Endocrine regulation, relationship between hormone and environment in regulating animal growth, thyroxine and frog development, temperature and sex determination in reptiles, Allen's and Bergmann's rule of morphology and climate. Role of Plant hormones in plant growth and development: auxins, gibberellins, cytokinins, abscisic acid, ethylene. Photoperiodism.	11 + 2
Unit-5: Human development	6h
Brief overview of ovulation cycle, implantation and zygote development, development during trimesters and hormonal regulation of development.	5 + 1

Note: Underlined topics are for self-study

Recommended Books/References

1. Gilbert, S. F., & Barresi, M. J. F. (2016). *Developmental biology* (11th ed.). Sunderland, MA: Sinauer Associates.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular biology of the cell* (6th ed.). New York, NY: Garland Science.
3. Wolpert, L., Tickle, C., & Martinez Arias, A. (2015). *Principles of development* (5th ed.). Oxford, UK: Oxford University Press.
4. Tyler, M. S. (1994). *Developmental biology: A guide for experimental study* (2nd ed.). Sunderland, MA: Sinauer Associates.
5. Sankar, B. G. (Year). *Cell and molecular biology of the eye*. Publisher.
6. Cronk, Q. C. B., Bateman, R. M., & Hawkins, J. A. (Eds.). (2002). *Developmental genetics and plant evolution*. London, UK: Taylor & Francis.
7. Slack, J. M. W. (2013). *Essential developmental biology* (3rd ed.). Hoboken, NJ: Wiley-Blackwell.
8. Sanes, D. H., Reh, T. A., & Harris, W. A. (2019). *Development of the nervous system* (4th ed.). London, UK: Academic Press.
9. Maheshwari, P. (1950). *An introduction to the embryology of angiosperms*. New York, NY: McGraw-Hill.
10. Pua, E. C., & Davey, M. R. (Eds.). (2010). *Plant developmental biology - biotechnological perspectives: Volume 1*. Berlin, Germany: Springer.
11. Pandey, S. N., & Chadha, A. (2009). *Plant anatomy and embryology*. New Delhi, India: Vikas Publishing House.

12. Raghavan, V. (1999). *Developmental biology of flowering plants*. New York, NY: Springer.
13. Jangid, P. (2018). *Plant embryology: Biology of plants*. [Kindle version]. Retrieved from Amazon.com.
14. Krishnamurthy, K. V. (2015). *Growth and development in plants*. Jodhpur, India: Scientific Publishers.
15. Bhojwani, S. S., Bhatnagar, S. P., &Dantu, P. K. (2015). *The embryology of angiosperms* (6th ed.). New Delhi, India: Vikas Publishing House.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total	**20**
Assessments:	
Presentations	**5**
Quiz/Test	**5**
Science Writing	**5**
Case study/ Group projects	**5**

BLUE PRINT

Code number: **BY325**

Title of the paper: **Biology of Development and Growth**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
8	4	I
23	12	II
19	10	III
25	13	IV
11	6	V
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question): **60**		

SEMESTER- III: BIOLOGY PRACTICALS

Semester	**III**
Paper Code	**BY 3P25**
Paper title	**Biology of Development and Growth**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**36**
Number of credits	**2**

1. Frog embryology.
2. Chick embryology I
3. Chick embryology II
4. Study of segment formation in Drosophila.
5. Study of drosophila developmental stages and growth Part I.
6. Screening for drosophila mutants.
7. Study of anther anatomy in *Dhatura*.
8. Pollen tube germination.
9. Types of ovule and their arrangement within the ovary.
10. Different stages of embryo development in monocots/dicots.
11. Effect of Auxin on Root and Shoot Growth.
12. Revision

Recommended Books/References

1. Sastry, K. V., & Shukla, V. (2018). *Developmental Biology* (2nd ed.). Meerut, India: Rastogi Publications.
2. Arora, R., & Mehta, A. (2019). *Developmental Biology: Principles and Concepts*. R. Chand & Company.
3. Tyler, M. S. (1994). Developmental biology: A guide for experimental study (2nd ed.). Sunderland, MA: Sinauer Associates.
4. Experiments with Drosophila for biology courses (2001) Eds. Lahkotia, S. C. and Ranganath, H. A. Indian Academy of Sciences Press.
5. A. Bendre& A. Kumar (1984) A Textbook of Practical Botany, Volume 2, Rastogi Publications.
6. B. P. Pandey, Practical Botany for Degree Students, S. Chand Publishing.
7. Katherine Esau (1977) Anatomy of Seed Plants**,** John Wiley & Sons.
8. S. S. Bhojwani & S. P. Bhatnagar (2015) Embryology of Angiosperms**,** Vikas Publishing House.

9. A. K. Sharma (2019) Practical Manual on Plant Developmental Biology, Scientific Publishers.
10. D. K. Pandey (2020) Laboratory Manual for Plant Development and Physiology, Rastogi Publications.

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignment	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

Semester IV – B.Sc. Biology

Semester	**IV**
Paper Code	**BY425**
Paper Title	**Diversity of Flora and Fauna**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practical per semester	**36**
Number of credits for practicals	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Explain and describe basic principles taxonomy and classification of plants and animals.
CO2	Understand	Demonstrate the basis of classifications of plants and animals up to genus level.
CO3	Apply	Apply taxonomic principles to Identify and classify major plant and animal groups.
CO4	Analyze	Evaluate and identify general and unique features of different plant and animal groups.
CO5	Evaluate	Critically evaluate how form and structure are related to organismal function and their roles in ecosystems.
CO6	Create	Design experiments or surveys to document plant and animal diversity.

Learning Outcomes: At the end of the course the students will be able to:

LO1	Define and describe fundamental principles of how life can be organized.
LO2	Define and differentiate taxonomy, phylogeny, and systematic of life.
LO 3	Explain and describe fundamental concepts that influence biodiversity.
LO 4	Examine and identify key differences that differentiate plants and animals at different levels.
LO5	Identify, define and apply the meaning of taxonomic and systematic terminologies to the classification of plants and animals.

LO6	Examine and describe the relationship between major groups of plants and animals.
LO7	Identify and describe the unifying and unique features of different groups of plants and animals.
LO8	Examine and identify unique features in different groups of plants and animals.
LO9	Examine and apply principles of systematics to classify plants and animals up to the class level.
LO10	Examine and analyze the life history of different groups of plants and animals.
LO11	Examine, describe, and analyze the ecological importance of plants and animals.
LO12	Define, describe, and analyze the economic importance of key plants and animals.
LO13	Examine, describe, and explain intrinsic and extrinsic influence on plant and animal growth.
LO14	Critically evaluate how systematic has changed in the last few decades.
LO 15	Identify and classify major groups of plants and animals in the field.

Semester IV – B.Sc. Biology,
DSC- 4: BY 425: Diversity of Flora and Fauna

	45 Hours
Unit – I: Biodiversity	3h
Biodiversity: Definition, Components of Biodiversity, importance, levels of biodiversity, Impact of climate change. Bioprospecting of diverse organisms. India as mega biodiversity Nation. Hot spots and biodiversity in India.	2+1h
Unit – II: Diversity of Flora	19h
Phycology: Classification of algae by Fritsch (1935), general characteristics of different classes of Algae, types of life cycles. **Mycology**: General characteristics, thallus organization and nutrition in fungi. Ecological significance (Mycorrhizae, Lichens). Economic and ecological importance of algae and fungi.	4+1
Bryology: Classification and general characteristics of Bryophytes. Morphology, anatomy and reproduction in *Marchantia*. **Pteridology:** General characteristics of pteridophytes, fossil pteridophytes - *Rhynia*. Morphology and reproduction in *Pteris.*	6+1

Ecological and economic importance of Bryophytes and Pteridophytes.	
Phanerogams: General characteristics of gymnosperm, salient features of the classes and life cycle of *Pinus*. Description, classification, Family characters of Malvaceae, Fabaceae, Compositae and Liliaceae.	7
Unit III: Diversity of Fauna	23
Brief introduction to the organization of life –Taxonomy, classification, and systematics. **DIVERSITY OF INVERTEBRATES** **Non-Bilateria: Parazoans** as the basal animals, distinguishing features, including rudimentary immune 'system'. **EUMETAZOANS** **Non-Bilateria (Diploblasts):** Systematics and distinguishing characteristics of Cnidarians. **BILATERIA (Triploblasts).** Importance of bilateral symmetry. **Protostomia, Lophotrochozoans:** The lophophore and trochophore larva as a connecting link. Systematics and distinguishing features of Platyhelminths, Annelids, and Molluscs. Special adaptations in cephalopods - bioluminescence and camouflage.	7 + 2
PROTOSTOMIA **Ecdysozoans** and the origin of ecdysis. Systematics and distinguishing features of **Nematodes**. Parasitic and free living worms. **Pan Arthropoda And Euarthropoda*:*** *Tardigrada and Onychophora*– discovery, brief features. Systematics and distinguishing features of Euarthropod classes. Brief note on significance of **Deuterostomes**. Systematics and distinguishing features of **Echinodermata**. **Brief overview of diversity, ecological and economic importance of Invertebrates included*.	7
DIVERSITY OF THE CHORDATES Brief overview of the **Protochordates, Agnatha and Gnathostomata** with examples.	6 + 1

Systematics and general features of **Vertebrata**. Brief exploration of major adaptations -amphibious life, terrestrialization, and flight. *<u>*Brief overview of diversity, ecological and economic importance of chordates.*</u>	

Note: Underlined topics are for self-study.

Recommended Books/References

1. Singh V., Pande P.C and Jain D.K. (2019). A Text Book of Botany (5th Edition). Rastogi Publication, Meerut.
2. Sundarajan S. 1997. College Botany Vol. I and Vol II. S Chand & Co. Ltd., New Delhi.
3. Mehrotra R.S.and AnejaK.R(1990). Anintroduction to Mycology.New Age International Publications, New Delhi.
4. Rashid, A. (1998). An Introduction to Bryophyta. Vikas Publishing House, New Delhi.
5. Vashista, B.R. 1978. Bryophytes. S Chand & Co. Ltd., New Delhi.
6. Rashid, A. 1998. An Introduction to Pteridophyta. II ed., Vikas Publishing House, New
7. Vashishta, P.C.,2014. Pteridophyta.S Chand and Company, Pvt. Ltd. New Delhi.
8. Sundararajan, S. 1994.Introduction to Pteridophyta. New Age International Publishers.
9. Bhatnagar, S.P. and Moitra, A. 1997. Gymnosperms. New Age International Ltd.,New Delhi.
10. Alexepoulos CJ and Mims CW. 1989. Introductory Mycology, Wiley Eastern Ltd., New Delhi.
11. Smith, G.M. 1971. Cryptogamic Botany. Vol.I Algae & Fungi. Tata McGraw Hill Publishing. New Delhi.
12. Smith, G.M. 1971. Cryptogamic Botany. Vol. II. Bryophytes & Pteridophytes. Tata McGraw Hill Publishing, New Delhi.
13. Animal Diversity by Cleveland P. Hickman, Larry S. Roberts, and David J. K. Barnett
14. Invertebrates by Richard C. Brusca and Gary J. Brusca
15. The Animal Kingdom: A Class-Action Approach by Jeffrey E. Miller
16. Zoology by Stephen A. Miller and John P. Harley
17. Principles of Animal Diversity by George J. Bartholomew and Thomas R. McFadden
18. Biology of Animals by Cleveland P. Hickman, Larry S. Roberts, and David J. K. Barnett

<u>Pedagogy</u>: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total	**20**
<u>Assessments:</u>	
Presentations	**5**
Quiz/Test	**5**
Science Writing	**5**
Case study/ Group projects	**5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY425**
Title of the paper: **Diversity of Flora and Fauna**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
6	3	I
36	19	II
44	23	III
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question):**60**		

SEMESTER- IV: BIOLOGY PRACTICALS

Semester	**IV**
Paper Code	**BY4P25**
Paper title	**Diversity of Flora and Fauna**
Number of teaching hours per week	**3**
Total number of teaching hours per	**36**
semester Number of credits	**2**

1. Study of *Rhizopus*, *Agaricus*, Mycorrhiza and Lichens.
2. Study of *Anabaena, Spirogyra, Chara, Sargassum* and *Batrachospermum*
3. Study of *Marchantia, Anthoceros* and *Funaria*.
4. Study of *Psilotum, Selaginella, Equisetum, Pteris*
5. Study of *Pinus*
6. Study of Malvaceae, Asteraceae, and Muscaceae
7. Study of Parazoans and Eumetazoans: diversity of sponges and Cnidarians, sea anemone, Physalia, and coral types.

8. Study of Lophotrochozoans: Platyhelminths - Tapeworm, Annelids - *Trochophore* larva, examination of annelid body plans. **Molluscans –***Octopus, sepia.* Examination of molluscan body plans.
9. **Study of Ecdysozoans and Deuterostomes:** Nematodes **-** Round worm, Panarthropods- *Peripatus*, *Tardigrades. Euarthropods - Nauplius* and *Mysis* larvae. Collection and classification of local insects. Classification of echinoderms based on taxonomic features, study of *Pedicellaria*.
10. **Protochordates and Vertebrates I:** observation of *Balanoglossus, Amphioxus*, ascidian larva, *Petromyzon*.Amphibia – *Hyla, Axolotl*. Reptiles – *Draco, Phyrnosoma*, Turtle, Tortoise, Viper, Krait, Sand Boa. Report on venomous and non-venomous snakes.
11. **Vertebrates II:** Exploration of vertebrate skeleton types. Project based report of Aves and Mammals –local diversity surveys. Revision

Recommended Books/References:

1. A. Bendre & A. Kumar(2009)A Textbook of Practical Botany, Volume 1, Rastogi Publications.
2. A. Bendre & A. Kumar (1984) A Textbook of Practical Botany, Volume 2, Rastogi Publications.
3. K. N. Bhatia & S. K. Gupta (2003) A Laboratory Guide to Fungi Kalyani Publishers.
4. C. J. Alexopoulos & C. W. Mims (1996 - 4th Edition) Introductory Mycology, John Wiley & Sons.
5. A. Rashid (1998) A Laboratory Manual of Bryophytes, Vikas Publishing House.
6. C. A. Agrawal. (2209) Practical Botany: Pteridophytes, Gymnosperms & Angiosperms, Meerut College Publications.
7. P. C. Vashistha (2010) A Laboratory Manual for Pteridophytes & Gymnosperms, S. Chand Publishing.
8. B. P. Pandey, Practical Botany for Degree Students, S. Chand Publishing.
9. Lal, S. S. (2009). Practical Zoology: Invertebrate.
10. Lal, S. S. (2012). Practical Zoology Invertebrate: For Undergraduate Students.
11. Verma, P. S. (2010). A Manual of Practical Zoology: INVERTEBRATES. S. Chand Publishing.
12. Wallace, R. L., & Taylor, W. K. (1997). Invertebrate Zoology: A Laboratory Manual. Benjamin Cummings.
13. Hyman, L. H. (1938). A Laboratory Manual for Comparative Vertebrate Anatomy.
14. Jordan, D. S. (1894). Manual of the Vertebrate Animals of the Northern U.S. Inclusive of the Marine Species.
15. Jordan, D. S. (2023). Manual of the Vertebrates of the Northern United States. Legare Street Press.

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignments	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

EXAMINATION PATTERN

STJOSEPH'S UNIVERSITY, BENGALURU -27

II B.Sc. (BIOLOGY) – III SEMESTER

SEMESTER EXAMINATION: OCTOBER 2025

(Examination conducted in November 2025)

BY 325 – BIOLOGY OF DEVELOPMENT AND GROWTH

Time: 2 Hours **Max Marks: 60**

This paper contains ONE printed page and THREE sections

Part A

Answer any TEN of the following **10 x 2 = 20 marks**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

Part B

Write notes on any FIVE of the following **5 x 6 = 30 marks**

13.
14.
15.
16.
17.
18.
19.

Part C

Give a comprehensive account of any ONE of the following **1 x 10 = 10 marks**

20.
21.

ST JOSEPH'S UNIVERSITY, BENGALURU - 5600027
II B.Sc. (BIOLOGY) - III SEMESTER
END SEMESTER PRACTICAL EXAMINATION: OCTOBER 2025

BY 3P25 – BIOLOGY OF DEVELOPMENT AND GROWTH

MAX. MARKS: 25 **TIME: 3 hours**

1.	Major experiment	**1 X 10 = 10**
2.	Minor experiment	**1 x 6 = 6**
3.	Spotters (A,B,C)	**3 X 3 = 9**

Semester V – B.Sc. Biology

Semester	**V**
Paper Code	**BY5126**
Paper Title	**Molecular systematics**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practicals per semester	**33**
Number of practical credits	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Demonstrate comprehensive knowledge of molecular systematics principles, bioinformatics, and computational biology.
CO2	Understand	Understand the theoretical foundations and practical applications of programming concepts and specialized bio tools.
CO3	Apply	Apply computational methods, including sequence analysis, phylogenetic reconstruction, and molecular dynamics simulations, to biological data.
CO4	Analyze	Analyze and interpret complex biological datasets for taxonomic and evolutionary insights.
CO5	Evaluate	Critically evaluate the results of computational analyses and their implications for medicinal plant identification and structural biology.
CO6	Create	Synthesize knowledge of machine learning and artificial intelligence to address novel problems in molecular systematics and related fields.

Learning Outcomes (LOs): At the end of the course the students will be able to:

LO1	Understand the fundamental role of computers in biological research, bioinformatics, and computational biology.
LO2	Differentiate between basic programming concepts and their application in various biological tools.
LO3	Apply key bioinformatics tools for sequence analysis and phylogenetic studies.
LO4	Understand the principles of molecular dynamics simulations and their

	application in structural biology.
LO5	Explore the use of molecular systematics for medicinal plant identification.
LO6	Gain an introductory understanding of Machine Learning/AI applications in biological data analysis

SEMESTER V – B.Sc. Biology,
DSC-5: BY5126: Molecular systematics

Topics	45 Hours
Unit-1: Introduction to Bioinformatics, and Computational Biology	10h
Role of Computers in Biology: Overview of how computers are used to manage and analyze biological data. **Introduction to Bioinformatics:** Definition, scope, and key applications in biological data analysis in areas of Genomics and proteomics. **Introduction to Computational Biology:** Definition, scope, and examples of modeling and simulation in biology. Data and computational ethics, e.g., proper use of AI (ChatGPT, Gemini). **Biological Data and Databases:** Overview of different types of biological data (DNA, RNA, Protein) and major public databases (NCBI, Uniprot, PDB) and secondary databases with key applications.	8+2h
Unit-2: Basic Programming and Bio Tools	10h
Introduction to Programming Concepts: Basic concepts of programming, variables, data types, control structures. Overview of Unix/Linux commands for file management and automation. **Programming for Bioinformatics:** Understanding differences in syntax and application of languages like R and Python for biological data manipulation. Introduction to relevant libraries/packages. **Key Bio Tools for Molecular Systematics:** Brief introduction to systematics- Phylogenetic Tree Construction- concepts, methods, software. Molecular markers and barcoding. Overview and application of tools for sequence alignment (e.g., BLAST and applications of BLAST based on types, ClustalW) and phylogenetic analysis (e.g., MEGA). **Introduction to 16S rRNA Analysis:** Basic workflow for analyzing ribosomal RNA gene sequences for prokaryotes identification and classification.	8+2h
Unit-3: Molecular Systematics in Medicinal Plants, MD Simulation, and Structural Biology	15h
Molecular Systematics for Medicinal Plant Identification: Using molecular methods (e.g., DNA barcoding) for accurate identification and authentication of medicinal plants. **Introduction to Molecular Dynamics (MD) Simulation:** Principles of MD simulations and their application in studying molecular behavior, especially for bioactive ingredients. **Structural Biology with Computational Tools:** Overview of computational approaches for protein structure prediction, ligand docking, and rational drug design.	14+ 1h

Unit-4: Machine Learning/AI and Applications	10h
Introduction to Machine Learning and AI: Basic concepts of supervised and unsupervised learning: Understanding, applications with examples and case study, and common algorithms. **Applications in Molecular Systematics:** Overview of how ML/AI is used for phylogenetic analysis, species identification, and drug discovery.	9 + 1h

Note: Underlined topics are for self-study

Recommended Books/References:

1. Molecular Systematics by David M. Hillis, Craig Moritz, and Barbara K. Mable.
2. Bioinformatics and Functional Genomics by Jonathan Pevsner.
3. Computational Biology: A Practical Introduction to Computation and Statistics by Rory M. Kirby and Matthew D. R. Kirby.
4. Online Resources: NCBI, UCSC Genome Browser, Ensembl, Bioconductor, Biopython documentation, GROMACS/NAMD documentation.
5. Software: Unix/Linux, R and RStudio, Python, BLAST, ClustalW, MAFFT, MEGA, RAxML, PhyML, MrBayes, FigTree, iTOL, QIIME2/Mothur, VMD, PyMOL.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total	**20**
Assessments:	
Presentations	**5**
Quiz/Test	**5**
Science Writing	**5**
Case study/ Group projects	**5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY5126**
Title of the paper: **Molecular systematics**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
19	10	I
19	10	II
29	15	III
19	10	IV
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question): **60**		

SEMESTER- V: BIOLOGY PRACTICALS

Semester	**V**
Paper Code	**BY 5P126**
Paper title	**Molecular systematic**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Database understanding and Sequence retrieval from Genbank and Uniprot.
2. BLAST and types of BLAST with examples of DNA and protein sequences.
3. Multiple sequence alignment using CLUSTALW and MAFFT alignment tools.
4. Phylogenetic Tree Construction of species with DNA sequences using MEGA.
5. 16S rRNA Gene Analysis to identify microbial communities from various samples.
6. Molecular Systematics for Medicinal Plant Identification and authentication using DNA barcodes .
7. Stepwise Molecular Dynamics (MD) Simulation of protein–ligand complex using GROMACS.

8. MD Simulation Analysis and Interpretation of results based on plot generation and protein-ligand interaction analysis.
9. Workflow Demonstration: A walkthrough of molecular systematic workflow using gene sequences to study evolutionary relationships.
10. Hands-on exercise with a simple machine learning application of natural products with known biological activity.
11. Revision

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignment	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

Semester V – B.Sc. Biology

Semester	**V**
Paper Code	**BY5226**
Paper Title	**Biomaterials and Nanotechnology**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practical per semester	**33**
Number of credits for practicals	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Learn various methods for synthesizing and characterizing nanomaterials.
CO2	Understand	Understand the fundamental concepts and scope of nanotechnology.
CO3	Apply	Explore the interactions between nanomaterials and biological systems
CO4	Analyze	Examine the applications of nanotechnology in medicine, agriculture, food, and environmental sectors.
CO5	Evaluate	Critically evaluate how form and structure are related to organismal function and their roles in ecosystems.
CO6	Create	Design experiments or surveys to document plant and animal diversity.

Learning Outcomes: At the end of the course the students will be able to:

LO1	Define and describe fundamental principles of Nanotechnology.
LO2	Define and differentiate Nanoparticles and Nanomaterials.
LO 3	Explain and describe fundamental properties of Biomaterials
LO 4	Examine and identify key differences between Natural Biomaterials and Synthetic materials
LO5	Identify, define and apply the classification of nanoparticles and nanomaterials.
LO6	Examine and describe the major properties of nanoparticles and nanomaterials.
LO7	Identify and describe the unique features of different classes of

	nanomaterials in biological applications
LO8	Examine and analyze the compatibility of nanomaterials with cells and organs in humans
LO9	Examine, describe, and explain factors effecting in synthesis of nanoparticles and nanomaterials
LO10	Critically evaluate how nanotechnology has changed in the last few decades
LO11	Identify and classify applications of nanotechnology for betterment of human life

Semester V – B.Sc. Biology,
DSC- 6: BY5226: Biomaterials and Nanotechnology

Topics	45 Hours
Unit – I: Introduction to Nanotechnology	8h
Definition and scope of nanotechnology Classification of nanomaterials Classification of nanomaterials into 0D, 1D, 2D and 3D. Relationship between dimension and shape of nanomaterials (nanospheres, nanotubes, nanorods, nanowires, nanosheets), natural and bio-inspired nanomaterials. Effects of nanoscale dimensions on material properties	7+1h
Unit – II: Biological Nanomaterials in Nature	8h
Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes, Cell structure and organelles. Nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus).	7+1h
Unit – III: Synthesis Methods of Nanomaterials	8h
Physical synthesis: Electrodeposition, thermal evaporation. **Chemical synthesis:** sol-gel process, metal nanocrystals by reduction, **Biological synthesis:** Biomolecules as reducing and capping agents, Bacteria, fungi and plants as sources of reducing and capping agents and for biogenic synthesis of nanomaterials	6+2h
Unit IV:Properties and Characterization of Nanomaterials	10h
Properties of nanomaterials: optical, magnetic. intra- and inter-molecular bonding, nanocatalysis, surface energy Interactions between biomolecules and nanoparticle surfaces **Characterization:** X-ray diffraction (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM). UV-visible spectroscopy, Fourier Transform Infrared spectroscopy	8+2h

(FTIR), nuclear magnetic resonance (NMR).	
Unit V:Applications of Nanotechnology	11h
Bio-application: Applications of DNA based Nanostructures, Protein based Nano structures, Biochemical sensors, synthetic nanocomposites for bone, teeth replacement. **Agriculture:** Nanomaterials to improve crop productivity like seed pretreatment, growth promotion, nano-fertilizers, nano-pesticides, nano-nutrients. **Environmental:** Nanoparticles in biodegradation, Biomineralization nanomaterial-based adsorbents for water treatment. Membrane based water purification, **Medicine:** Applications in drug delivery: cancer diagnostics and treatment, imaging and detection. Development of nanoscale devices for drug discovery, micelles for drug delivery, siRNA, tumor-targeted drug delivery systems**.**	11h

Note: Underlined topics are for self-study.

Recommended Books /References

1. McNeil, S.E. (2011). Characterization of Nanoparticles Intended for Drug Delivery. Humana Press.
2. Xian, W. (2009). A Laboratory Course in Biomaterials. CRC Press.
3. Micou, M.K., & Kilkenny, D. (2016). A Laboratory Course in Tissue Engineering. CRC Press.
4. Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences. Taylor & Francis Group.
5. Holzhüter, M. (2006). Basic Methods for the Biochemical Lab. Springer-Verlag Berlin Heidelberg.
6. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
7. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.
8. Nanotechnology-S. K. Kulkarni (3rd Edition)
9. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash (4th Edition), Tata McGraw-Hill Publishing Company Ltd., New Delhi.
10. Kumar C.S.S.R., J.Hormes, C.Leuschner, Nanofabrication towards biomedical applications, Wiley -VCH Verlag GmbH & Co, Weinheim, 2004.
11. Rainer, Nano Electronics and information Technology, Wiley, 2003.
12. Drexler K.E., Nano systems, Wiley, 1992.
13. Cao G., Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total **<u>Assessments:</u>** **Presentations** **Quiz/Test** **Science Writing** **Case study/ Group projects**	**20** **5** **5** **5** **5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY5226**
Title of the paper: **Biomaterials and Nanotechnology**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
15	8	I
15	8	II
15	8	III
19	10	IV
21	11	V
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question):**60**		

SEMESTER- V: BIOLOGY PRACTICALS

Semester	**V**
Paper Code	**BY5P226**
Paper title	**Biomaterials and Nanotechnology**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Synthesis of Ag nanoparticles using Plant extracts.
2. Synthesis of Cu nanoparticles using Fungi
3. Synthesis of Al nanomaterials by Fungi
4. Determination of conductivity of DNA biomaterial
5. Characterization of Ag/Cu nanoparticles by UV Visible spectrophotometer
6. Determination of size and shape of nanoparticle/ nanomaterials by optical microscopy.
7. FTIR analysis of Ag/Cu nanoparticles
8. Determination of Toxic effect of metaloxide nanoparticles on seed germination
9. Antibacterial activity of Ag/Cu nanoparticles by MIC method
10. Antifungal activity of Ag/Cu nanoparticles by Food poison technique
11. Revision

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignments	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

Semester V – B.Sc. Biology

Semester	**V**
Paper Code	**BY5326**
Paper Title	**Stem Cell Biology and Regenerative Medicine**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practicals per semester	**33**
Number of practical credits	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Recall and define the basic concepts of stem cell biology including types, properties, and classification.
CO2	Understand	Explain the origin, characteristics, and culturing techniques of embryonic, adult, and induced pluripotent stem cells.
CO3	Apply	Apply knowledge of extrinsic and intrinsic factors to interpret how stem cell fate is regulated.
CO4	Analyse	Analyze the role of stem cells in regenerative medicine and their applications in therapy and disease modeling.
CO5	Evaluate	Evaluate the ethical concerns, societal implications, and regulatory frameworks related to stem cell research.
CO6	Create	Design a conceptual therapeutic approach or experimental model using stem cells for treating a disease or disorder.

Learning Outcomes (LOs):

LO1	Explain key concepts such as self-renewal, potency, and the classification of stem cells.
LO2	Describe the origin, properties, and culturing of embryonic and amniotic fluid-derived stem cells.
LO3	Identify various types of adult stem cells (including neural, HSCs, MSCs, and others), their sources, and roles in the body.
LO4	Define cancer stem cells and their implications in disease progression.
LO5	Differentiate between extrinsic and intrinsic controls influencing stem cell behaviour.
LO6	Illustrate the role of the stem cell niche and interactions with the

	microenvironment.
LO7	Analyze molecular regulators such as cell cycle control and key signaling pathways.
LO8	Describe the development and significance of induced pluripotent stem cells (iPSCs).
LO9	Define regenerative medicine and trace its historical development.
LO10	Distinguish between different therapeutic approaches such as cell-based therapy, immunomodulation, and tissue engineering.
LO11	Explain the use of iPSCs in disease modeling and drug discovery.
LO12	Discuss advancements in organ transplantation using stem cell technologies.
LO13	Evaluate therapeutic applications for cardiovascular, neurological, and musculoskeletal conditions.
LO14	Recognize the role of Institutional Ethical Committees in stem cell research.
LO15	Articulate key ethical debates and societal concerns surrounding the use of stem cells.
LO16	Interpret national and international regulatory frameworks governing stem cell research and therapy.

Semester V – B.Sc. Biology

DSC-7: BY5326: Stem Cell Biology and Regenerative Medicine

Topics	45 Hours
Unit- I: Foundations of Stem Cell Biology	8h
Stem cell concepts (self-renewal, potency) and classification of stem cells. **Embryonic stem cells:** Origin, basic properties, culture. **Amniotic Fluid Derived and Adult stem cells:** Types (Neural, HSCs, Sensory organ, Skin, Skeletal muscle, Internal organ and MSCs), their sources and role.**Cancer stem cells**	6+2h
Unit – II: Controls of Stem cell fate	10h
Extrinsic controls - Stem Cell Niche: Concept of the stem cell niche and its importance.Interactions between stem cells and their microenvironment. **Intrinsic Controls: Molecular regulation:** Cell cycle regulation in stem cells.Signaling pathways governing stem cell fate. **Induced Pluripotent Stem Cells (iPSCs)**	10h
Unit – III: Regenerative medicine and Tissue Engineering	7h
Regenerative medicine: Definition - History. Introduction to cell-based therapy and immunomodulation therapy. **Tissue engineering:** Definition, Concept of Scaffolding, 3D scaffolding, Organoids and Spheroids.	6+1h
Unit - IV: Stem Cell Applications in Therapy and Research	14h
Disease Modelling: Using iPSCs to study the causes and	12+2h

mechanisms of diseases. **Drug Discovery:** Screening potential drugs using stem cell-derived models organoids, and speroids and uses,. **Organ Transplantation:** Developing strategies for generating organs, using stem cells like liver and kidney. **Therapeutic Applications:** Stem cell-based therapies for various conditions, including: **Cardiovascular Disease:** Repairing damaged heart tissue. **Neurological Disorders:** Treating conditions like Parkinson's and Alzheimer's disease. **Bone and Tissue Regeneration:** Repairing damaged bones and tissues.	
Unit - V: Bioethical and Regulatory Considerations	6h
Institutional ethical committee, Ethical debates surrounding stem cell research.Regulatory frameworks and guidelines. Societal implications and public perception.	5+1h

Note: Underlined topics are for self-study

Recommended Books/ References:

1. Lanza, Robert, Atala, Anthony, & West, Michael D. (2013). *Essential Stem Cell Biology* (3rd ed.). Academic Press.
2. Knoepfler, Paul. (2013). *Stem Cells: An Insider's Guide*. World Scientific Publishing.
3. Marshak, David R., Gardner, Richard L., & Gottlieb, David. (2001). *Stem Cell Biology*. Cold Spring Harbor Laboratory Press.
4. Atala, Anthony, Lanza, Robert, Thomson, James A., & Nerem, Robert M. (Eds.). (2008). *Principles of Regenerative Medicine* (1st ed.). Academic Press.
5. van Zant, Gary, Verfaillie, Catherine M., & Goodell, Margaret A. (2004). *The BiologyofStem Cells*. Garland Science.
6. Totey, Satish Mahadeo. (2010). *Stem Cell Biology*. New India Publishing Agency.
7. Bansal, Sanjay Kumar, & Arora, Sarika. (2014). *Stem Cells and Regenerative Medicine*. Narosa Publishing House.
8. Chadha, Gita. (2017). *Introduction to Stem Cell and Regenerative Medicine*. Ane Books Pvt. Ltd.
9. Dhawan, Jyotsna. (2018). *Textbook of Stem Cell Biology*. Universities Press (India) Pvt. Ltd.
10. Kumar, Ajit. (2015). *Essentials of Stem Cell Biology and Regenerative Medicine*. Daya Publishing House.
11. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press.
12. Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press

13. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer,

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total **Assessments:** **Presentations** **Quiz/Test** **Science Writing** **Case study/ Group projects**	**20** **5** **5** **5** **5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: BY5326
Title of the paper: **Stem cell biology and Regenerative medicine**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
19	10	I
19	10	II
10	5	III
27	14	IV
11	6	V
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question):**60**		

SEMESTER- V: BIOLOGY PRACTICALS

Semester	**V**
Paper Code	**BY 5P326**
Paper title	**Stem Cell Biology and Regenerative Medicine**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Culturing and handling of Planaria
2. Planaria regeneration experiment/Hydra (workshop)
3. Investigating Environmental Effects on Regeneration
4. RNAi technology in the study regeneration in planaria.
5. Totipotency of plant cells in tissue culture.
6. Plant Cell proliferation assays by haemocytometer after staining with trypan blue
7. Isolation of stem/ bone marrow cells from animal bone tissues.
8. Cytotoxicity assay by Methyl Thiazolyl Tetrazolium (MTT).
9. Biocompatibility Testing of biomaterial by hemolysis assay.
10. Biodegradability Testing of biomaterial by In Vitro Degradation Studies
11. Revision: Visit/Guest talk

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignment	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

SEMESTER- V: BIOLOGY PRACTICALS

Semester	**V**
Paper Code	**BY 5S426**
Paper title	**Dissertation: Proposal design**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Selection and identification of broad Research problem.
2. Selection and identification of specific Research problem.
3. Selection and proposals of tentative titles of Research Problem.
4. Searching and writing of review of literature on tentative title of Research problem.
5. Seminar presentation on review of literature of tentative Research problem (Batch- 1).
6. Seminar presentation on review of literature of tentative Research problem (Batch- 2).
7. Understanding and writing the research proposal on the tentative title of project.
8. Searching and identification of standard protocols/methods on the tentative project title of project.
9. Seminar presentation of research proposal on the tentative title of project (Batch-1).
10. Seminar presentation of research proposal on the tentative title of project (Batch- 2).
11. Reviewing the proposal and finalizing the project

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Seminar 1	**5**
Seminar 2	**10**
Proposal	**10**
Total	**25 + 25 (ESE) = 50 marks.**

Semester V – B.Sc. Biology

Semester	**V**
Paper Code	**BY5R526**
Paper Title	**Research Methodology**
Number of teaching hours per week	**02**
Total number of teaching hours of theory per semester	**30**
Number of theory credits	**02**

Course description:

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Define basic concepts of research methodology, including types of research, research design, and ethical considerations.
CO2	Understand	Explain the structure of research reports, theses, and scientific manuscripts, and interpret standards of scholarly journals and databases.
CO3	Apply	Apply appropriate biostatistical methods to classify, tabulate, and graphically represent biological data.
CO4	Analyze	Analyze biological data using measures of central tendency, dispersion, and inferential statistical tests.
CO5	Evaluate	Evaluate research findings using appropriate experimental designs and statistical tools to ensure validity and reliability.
CO6	Create	Design a basic research proposal and perform data analysis using suitable statistical software for biological research.

Learning Outcomes: At the end of the course the students will be able to:

LO1	Recall the fundamental concepts, types, and significance of research in biological sciences.
LO2	Identify the essential steps involved in the research process.
LO 3	Explain the process of defining a research problem and formulating research objectives.
LO 4	Describe different research and experimental designs used in biological research.
LO5	Explain the structure and components of research reports, theses, and scientific manuscripts.

LO6	Demonstrate the ability to search, retrieve, and organize scientific literature using databases and repositories.
LO7	Apply ethical principles, including plagiarism avoidance and copyright compliance, in scientific writing.
LO8	Apply methods of classification, tabulation, and graphical representation to biological data.
LO9	Calculate measures of central tendency for biological datasets.
LO10	Analyze biological data using measures of dispersion and inferential statistical tools.
LO11	Interpret results obtained from statistical tests such as *t*-test, chi-square, and ANOVA.
LO12	Evaluate the suitability of experimental designs for specific biological research problems.
LO13	Assess proportion and count data using appropriate statistical approaches.
LO14	Design a basic research proposal relevant to biological sciences.
LO 15	Perform data analysis using statistical software and present results in a scientific format.

Semester V – B.Sc. Biology,
DSC: BY5R526: Research Methodology

	30 Hours
Unit – I: Foundations of Research & Scientific Communication	13h
Introduction to Research: Meaning, basic and applied research, significance of research in biological sciences. **Research Process**: Identification of research problem, formulation of objectives and hypotheses, overview of research and experimental designs. **Scientific Literature & Ethics**: ***Literature Collection*** - Literature Citation use of scientific databases. ***Scientific Writing****:* Structure of research reports, thesis/ dissertation format, manuscript/ research and review articles, bibliography, plagiarism, citation - i10 index, impact factor **Access to Archives and Databases** – Science Direct, Sciverse, Pubmed, PubChem. National Informatics Center Network Services - Information Retrieval. ***Online Database Library*** – DELNET, INFLIBNET – shodhganga, e-shodhsindhu	12+1 h
Unit – II: Biostatistics & Data Representation in Biology	10h
Introduction to Biostatistics: Scope and applications in biological research. **Data Handling**: Classification, tabulation, and graphical	9+1 h

representation of biological data (bar diagrams, histograms, frequency polygons). **Measures of central tendency** (mean, median, mode) and **measures of dispersion** (range, standard deviation). **Inferential Statistics (Introductory level)**: Student's t-test, chi-square test, and basic understanding of ANOVA (conceptual emphasis).	
Unit III: Research Ethics, Biosafety, IPR & Basic Data Tools	7
Research Ethics (Overview): Responsible conduct of research; academic integrity, Institutional Ethics Committee (IEC/IAEC/IBSC) and misconduct. **Ethics in Handling Biological Materials**: Authentication of plant materials (taxonomic identification and voucher specimens); ethical handling of microorganisms with emphasis on safe disposal; awareness of animal ethics and humane practices (no experimental protocols). **Basic Statistical Tools**: biological data analysis software - SPSS, R, and GraphPad Prism.	6+1h

Note: Underlined topics are for self-study.

Recommended Books/References

1. Kothari, C. R. (2014). Research Methodology: Methods and Techniques. 3rd ed. New Delhi: New Age International Publishers.
2. Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. 11th ed. Hoboken: Wiley India.
3. Goon, A. M., Gupta, M. K., & Dasgupta, B. (2011). Fundamentals of Statistics. Vol. I & II. Kolkata: World Press.
4. Singh, Y. K. (2010). Fundamentals of Research Methodology and Statistics. New Delhi: New Age International Publishers.
5. Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches. 4th ed. Thousand Oaks: Sage Publications.
6. Day, R. A., & Gastel, B. (2012). How to Write and Publish a Scientific Paper. 7th ed. Cambridge: Cambridge University Press.
7. Zar, J. H. (2010). Biostatistical Analysis. 5th ed. Upper Saddle River: Pearson Education.
8. Montgomery, D. C. (2017). Design and Analysis of Experiments. 9th ed. Hoboken: Wiley.
9. Subramanyam, K. (2001). Scientific and Technical Information Resources. New York: Marcel Dekker.

10. Sokal, R. R., & Rohlf, F. J. (2012). Biometry: The Principles and Practice of Statistics in Biological Research. 4th ed. New York: W. H. Freeman and Company.
11. Field, Andy (2017). Discovering Statistics Using SPSS. 5th Edition, SAGE Publications, London.
12. Dalgaard, P (2008). Introductory Statistics with R. 2nd Edition, Springer, New York.
13. Nandan, R (2014). Intellectual Property Rights: Laws and Practice, 2nd Edition, Oxford University Press, New Delhi.
14. WIPO (World Intellectual Property Organization). Intellectual Property Handbook: Policy, Law and Use.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA Total	**10**
Assessments:	
Presentations	**5**
Quiz/Test	**5**
Science Writing	**5**
Case study/ Group projects	**5**
Total	**20 + 30 (ESE) = 50**

BLUE PRINT
Code number: BY5R526
Title of the paper: Research Methodology

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
19	12	I
17	10	II
13	8	III
49	**30**	**TOTAL**
Maximum marks for the paper (Excluding bonus question): **30**		

EXAMINATION PATTERN

ST JOSEPH'S UNIVERSITY, BENGALURU - 27

B.Sc., BIOLOGY – V SEMESTER

SEMESTER EXAMINATION – NOVEMBER

BY5R526: RESEARCH METHODOLOGY

Time: 1 hr **Max. Marks: 30**

This question paper contains ONE printed page with THREE parts

Part A

Answer any FIVE of the following **5x2=10 Marks**

1.
2.
3.
4.
5.
6.
7.

Part B

Answer any TWO of the following **2x5=10 Marks**

8.
9.
10.

Part C

Answer any ONE of the following **1x10=10 Marks**

11.
12.

Semester VI – B.Sc. Biology

Semester	**VI**
Paper Code	**BY6126**
Paper Title	**Forensic Biology**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practical per semester	**33**
Number of credits for practicals	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Use Knowledge of forensic science to solve crimes in society
CO2	Understand	Understand the role of biological evidence in forensic science.
CO3	Apply	Apply methods of collecting and preserving biological samples.
CO4	Analyze	Develop skills in analyzing biological evidence using various laboratory techniques.
CO5	Evaluate	Critically evaluate and Interpret biological data within the framework of legal investigations.
CO6	Create	Recreates the crime scene for solving cases

Learning Outcomes: At the end of the course the students will be able to:

LO1	to collect the important evidences from crime scene indoor/ outdoor area
LO2	Investigate the case thoroughly by considering legal and protective measures
LO3	Identify the cases and classifications of crimes in terms of legal aspects
LO4	Collection, analysis and interpretation of biological evidences of crime scene
LO5	Used the plant sample like pollen grains as evidences to understand the caused and time of death
LO6	Used the forensic biology for solving the poisoning cases
LO7	Used the diatoms as evidences for understanding drowning cases
LO8	Applies the procedures, for legal protection of crime scene areas
LO9	Recreates the entire crime scene for better understanding and solving the cases

Semester VI – B.Sc. Biology,
DSC- 8: BY6126: Forensic Biology

Topics	45 Hours
Unit – I: Introduction to Forensic Biology	5h
Definition and scope of forensic biology. Historical development and significance in criminal investigations**.** **Overview of biological evidence types:** blood, semen, saliva, hair, and other bodily fluids.	4+1h
Unit – II: Crime Scene Management and Evidence Collection	10h
Crime scene types and classification: indoor, outdoor, mobile. Roles of first responders and investigating officers. Crime scene management: safety measures, protection, and searching methods. Classification, handling, collection, preservation, and transportation of biological evidence. Chain of custody and legal considerations.	9+1h
Unit III: Biological Evidence Analysis	15
Blood: Composition and functions of blood. Collection, preservation, and identification of bloodstains: preliminary and confirmatory tests. **Semen:** Composition and morphology of spermatozoa. Collection, preservation, and identification of semen; forensic significance. **Other Bodily Fluids:** Composition, functions, and forensic significance of saliva, sweat, urine, and fecal matter. Test for identification. **Hair:** Structure, morphology, and biochemistry of human hair. Transfer, persistence, and recovery; determination of body sites and species origin. **Molecular tools:** DNA fingerprinting	13+2h
Unit IV: Forensic Botany	5h
Introduction, Nature & Scope, types of plant materials, Woods & their Identification and Matching, Diatoms and their Forensic Significance in Drowning Cases, Study and Identification of Pollen Grains collected in crime samples.	4+1h
Unit V:Forensic Toxicology and Medicine	10h
Introduction to forensic toxicology and medicine: definition, scope, and significance. Role of forensic toxicologists. Causes, manners, and characteristics of death; signs and changes following death (poison death); common poisoning cases in India (Pesticides); medico-legal aspects. Thanatology: collecting evidences. determination of time since death; modes of death; Importance of post-mortem examinations (poisoning cases); suspended animation; Objectives and procedures of autopsy: autopsy reporting.	9+1h

Note: Underlined topics are for self-study.

Recommended Books/References

1. Nanda, B.B., & Tewari, R.K. (2001). Forensic Science in India: A Vision for the Twenty-First Century. Select Publisher.
2. James, S.H., &Nordby, J.J. (2003). Forensic Science: An Introduction to Scientific and Investigative Techniques. CRC Press.
3. Saferstein, R. (2007). Criminalistics: An Introduction to Forensic Science. Prentice Hall.
4. Nabar, B.S. (2024). Forensic Science in Crime Investigation. Asia Law House.
5. Bakkannavar, S. (2018). Forensic Medicine and Toxicology Practical Manual. Elsevier.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total **Assessments:** **Presentations** **Quiz/Test** **Science Writing** **Case study/ Group projects**	**20** **5** **5** **5** **5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY6126**
Title of the paper: **Forensic Biology**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
9	5	I
19	10	II
29	15	III
10	5	IV
19	10	V
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question): **60**		

SEMESTER- VI: BIOLOGY PRACTICALS

Semester	**VI**
Paper Code	**BY6P126**
Paper title	**Forensic Biology**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Securing and evaluating indoor and outdoor scene of crime
2. Searching indoor and outdoor scene of crime using spiral technique and grid search technique and listing evidence.
3. Photographing five evidence and sketching of indoor and outdoor crime scene using base line method.
4. Collection, preservation, sealing and forwarding of soil sample from crime scene.
5. Collection, preservation, sealing and forwarding of blood sample from crime scene and making contemporaneous notes while investigating a scene of crime.
6. Extraction and Examination of Diatoms.
7. DNA fingerprinting
8. Mounting and microscopic examination of human epithelial cells.
9. Mounting and microscopic examination of human hair.
10. Crime scene reconstruction of a simulated scene of murder/burglary.
11. Revision : Visit/Guest talk

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignments	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

Semester VI – B.Sc. Biology

Semester	**VI**
Paper Code	**BY6226**
Paper Title	**Biopharmaceutical science**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practical per semester	**33**
Number of credits for practicals	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Recall the fundamental concepts of pharmacology, drug classification
CO2	Understand	Explain the pharmacokinetics (ADME), pharmacodynamics and drug safety
CO3	Apply	Apply the principles of Good Laboratory Practices (GLP), Quality Assurance (QA), and Quality Control (QC)
CO4	Analyze	Analyze the drug development process by interpreting physico-chemical properties, preclinical and clinical toxicity studies, and design clinical trial protocols and delivery systems for biopharmaceuticals.
CO5	Evaluate	Classify phytopharmaceuticals, and skills in phytochemical screening and bioassay-guided fractionation using chromatographic, spectrometric techniques and to Evaluatethe antimicrobial agents by understanding their sources, mechanisms of action, resistance, and perform pharmacological assays (*in vitro* and *in vivo*) to assess biological activity.
CO6	Create	Compare and contrast the use of prokaryotic and eukaryotic systems in biopharmaceutical production, explain recombinant DNA technology principles, and to identify recombinant biopharmaceutical products relevant to therapeutic applications.

Learning Outcomes: At the end of the course the students will be able to:

LO1	Understand the Fundamentals of Pharmacology and Drug Development

LO2	Identify and Classify Drugs Based on Source, Nomenclature, and Legislation
LO 3	Explain the Principles of Pharmacokinetics and Pharmacodynamics
LO 4	Demonstrate knowledge of Good Microbiological Practices (GMP), Good Laboratory Practices (GLP), and Quality Assurance (QA) and Quality Control (QC) guidelines
LO5	Analyze the impact of chemical reactions such as oxidation, reduction, hydrogenation, and dehydrogenation on pharmaceutical product stability
LO6	Explain the principles of Good Manufacturing Practices (GMP), packing procedures, and regulatory compliance
LO7	Summarize the importance of initial product characterization by identifying the key physico-chemical properties of drug candidates
LO8	Describe the stages of pre-clinical and clinical evaluation
LO9	Evaluate different biopharmaceutical delivery system
LO10	Classify phytopharmaceuticals and explain their key properties
LO11	Assess the sources, classification, mechanisms of action, and resistance patterns of antimicrobial agents
LO12	Validation of pharmacological assay techniques
LO13	Differentiate between prokaryotic and eukaryotic cells and explain their roles in pharmaceutical production
LO14	Describe the principles of recombinant DNA technology and discuss the limitations of traditional pharmaceutical production methods
LO 15	Identify, classify recombinant biopharmaceutical products and its production

Semester VI – B.Sc. Biology,
DSC- 9: BY6226: Biopharmaceutical science

Topics	45 Hours
Unit – I: Introduction to Pharmacology and Biopharmaceuticals	10h
Introduction to Pharmacology and Pharmaceutical Biology: Definition and scope of Pharmacology - Historical Perspective of Pharmaceutical Biology. **Drugs:** Introduction to pharmacopoeia - Nomenclature and Classification of drugs. **Source of Drugs**: Plants, Animals, Microbes and Minerals. **Drug Regulation and Safety:** Drug and Cosmetics Act, Narcotic Drugs and Psychotropic Subs Act, Pharmacy Act, Controlled Subs Act, Misuse of Drugs Act, Drugs and Magic remedies Act. **Drug metabolism**: **Pharmacokinetics** – Drug Metabolism: Absorption, Distribution, Metabolism and Excretion (ADME), Lipinski rule of Five. **Pharmacodynamics** – Mechanism of drug action – Drug Doses. **Drug Effectiveness** - Drug efficacy & toxicity - Therapeutic window -	9+1h

Therapeutic Index. **Drug Availability and Comparison** - Concept of Bioavailability and Bioequivalence.	
Unit – II: Drug Manufacturing Principles and Regulatory Aspects	8h
Good Microbiological Techniques and Good Laboratory Practice (GLP) - Good Manufacturing Practice (GMP). Basic principles of Quality Assurance (QA) and Quality Control (QC). **ICH Guidelines for QA and QC**: Raw materials, Sterilization, Media, Stock cultures and Products. Validation study and toxicity testing. Guidelines for packing procedure. **Regulatory authorities**: Central Drug Standards control organization (CDSCO), Food and Drug Administration (FDA), European regulations, World Health Organization.	6+2 h
Unit III: Drug Development Process and Delivery Systems	7h
Initial product characterization: Physico – chemical properties of the drugs. **Pre-clinical studies**. **Toxicity studies**: Reproductive toxicity and Teratogenicity, Mutagenicity, Carcinogenicity. **Clinical Trials:** clinical trial design - trial size design and study population. **Delivery of biopharmaceuticals**: Oral – Nasal – Transmucosal – Transdermal – Parenteral: Intravenous – Intramuscular.	6+1h
Unit IV: Phytopharmaceuticals and Pharmacological Assays	10h
Phytopharmaceuticals: General classes and properties of phytopharmaceuticals - Phytochemical screening of medicinal plants. **Bioassay guided fractionation methods:** TLC, HPTLC, HPLC, GC–MS, LC-MS. **Antimicrobial agents: Antibiotics** – Source – Classification - Mode of Action. Antimicrobial resistance. **Antimicrobial activity studies**: antibacterial – antiviral – antifungal - antiparasitic. **Pharmacological Assays:** *In vitro* assays - chemical (anti-oxidant), Biological (anti-cancerous and assay system based on enzymes and cells), and immunological (RIA and ELISA). *In vivo* assays (Anti-inflammatory and Anti-analgesic).	9+1h
Unit V: Production of Biopharmaceuticals by rDNA Technology	10h
Drawback of Traditional Approaches - Principle of Recombinant DNA Technology. **Prokaryotic and Eukaryotic Cells in Pharmaceuticals Production**: Use of Bacteria and *Actinomycetes*, *Saccharomyces cerevisiae*. Plant Cell Culture - Use of animal cell culture system as Bioreactors for pharmaceuticals Production. **Recombinant Biopharmaceutical products**: **Hormones** – Insulin and	9+1h

Human Growth Hormone. **Blood Products**: Clotting Factor VIII and Tissue Plasminogen Activator. **DNA Sub Unit vaccines** – Hepatitis B Surface Antigen.	

Note: Underlined topics are for self-study.

Recommended Books/References

1. Satoskar RS and Bhandarkar (2013). Pharmacology and Pharmacotherapeutics. Revised 23rd Edition, Bombay Popular Prakasam Publishers.
2. Rang H and MM Dale (2003). Pharmacology, Fifth Edition, Churchill-Livingstone, 2003
3. Tripathy K. D, Essentials of Medical Pharmacology, 6th edition, Jaypee publishers
4. Shoba rani R Hiremath (2008). Text book of industrial pharmacy, orient longman Pvt Ltd.,
5. Crommelin Daan J. A., Sindelar D. Robert (2007). Pharmaceutical Biotechnology: Fundamentals and Applications, 3rd edition, CRC Press.
6. Trease, G.E.and Evans, W.C., (2011) Pharmacognosy, 12th edition, Bailliere Tindall Eastbourne, U.K
7. Mukherje P.K., (2005). Quality Control Herbal Drugs–An approach to evaluation of botanicals. Business Horizons Pharmaceutical Publishers.
8. Sambamurthy K., Pharmaceutical Biotechnology, 1st edition, New Age International
9. Quality control in the Pharmaceutical Industry by Murray S. Cooper Volume.II. Published by Academic Press New York.
10. Goodman and Gilman's (2013). The Pharmacological Basis of Therapeutics 12th Edition, MacMillan Publishing Company.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project-based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total **<u>Assessments:</u>** **Presentations** **Quiz/Test** **Science Writing** **Case study/ Group projects**	**20** **5** **5** **5** **5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY6226**
Title of the paper: **Biopharmaceutical science**

Total marks for which the questions are to be asked (including bonus questions)	Number of hours	Unit number
19	10	I
16	8	II
13	7	III
19	10	IV
19	10	V
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question):**60**		

SEMESTER- VI: BIOLOGY PRACTICALS

Semester	**VI**
Paper Code	**BY 6P226**
Paper title	**Biopharmaceutical science**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Demonstration of animal handling for experimental purposes - cervical dislocation, dissection of mice, cardiac puncture, blood sample preparation and its handling. (Demo)
2. Qualitative analysis of Phytochemicals (Any 5)
3. Quantitative analysis of Phytochemicals in Plant Extracts by TLC and HPLC (Demo)
4. Estimation of Total Flavonoids/ Alkaloids in plant extracts.
5. Antimicrobial Activity by Agar Well diffusion method – Determination of MIC.
6. Determination of antioxidant activity by DPPH assay.
7. Determination of iron chelating activity of Plant Extract.
8. Spectrophotometric determination of Allantoin and Griseofulvin.
9. Microbial analysis of Pharmaceuticals (syrups).

10. Sterility Testing of Commercial Pharmaceuticals and Injectables as per Indian Pharmacopoeia.
11. Revision.

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignments	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

Semester VI – B.Sc. Biology

Semester	**VI**
Paper Code	**BY6326**
Paper Title	**Neurosciences**
Number of teaching hours per week	**03**
Total number of teaching hours of theory per semester	**45**
Number of theory credits	**03**
Total number of teaching hours of practical per semester	**33**
Number of credits for practicals	**02**

Course Outcomes (COs): At the end of the course the student should be able to:

CO1	Knowledge	Possess a broad understanding of Neurosciences and neurobiology of plants and animals
CO2	Understand	Explain, demonstrate, and differentiate sensory modalities and systems in plants and animals.
CO3	Apply	Describe and compare major neurological and physiological systems in plants and animals and their disorders in animals and plants.
CO4	Analyze	Analyze systemic processes behind communication in plants and animals and their importance in ecology.

CO5	Evaluate	Integrate plant and animal biology to Investigate the causes and origins of neurological disorders and assess emerging therapeutic and preventive approaches.
CO6	Create	Design research to arrive at conceptual models to assess emerging therapeutic and preventative approaches in Neurosciences and apply them to plants and animals.

Learning Outcomes: At the end of the course the students will be able to:

LO1	Explain core mechanisms of sensory detection and signal transduction in plants and animals.
LO2	Describe the structural and functional features of animal nervous systems and plant signaling systems
LO 3	Compare sensory modalities (light, touch, gravity, chemicals) across taxa.
LO 4	Evaluate experimental data and conduct simple behavioral and sensory biology experiments.
LO5	Appreciate the evolutionary diversity of communication and adaptation strategies in living organisms
LO 6	Investigate factors involved in neurological systemic disorders in plants and animals.

Semester VI – B.Sc. Biology,
DSC- 10: BY 6326: Neurosciences

Topics	45 Hours
Unit – I: Foundations of Sensory Biology	5h
Overview of Sensory biology, sensory modalities, and signaling networks. **Overview of animal sensory modalities*:*** nervous system, sensory systems and pathways, receptor-ligand systems, cortical processing. **Overview of plant sensory modalities** (phloem, plasmodesmata, hormones) **Analogies and distinctions**: Information processing without neurons	4 + 1 h
Unit – II: Signaling pathways in biology	15h
Signaling pathways: Signal transduction, protein interactions, signal pathways, eg., Wnt, MAP-K pathways, secondary messengers - Ca cGMP, cAMP. **Signaling in animals:** Generation and propagation of action potentials. Synaptic transmission: electrical and chemical synapses. Neurotransmitters and signal modulation. Neuronal junctions and gap potential. Influence of hormonal pathways (endocrine, paracrine, autocrine, direct). Circadian rhythms, case studies of circadian rhythm disorders. **Signaling in plants:** Calcium, ROS, hormonal and light signaling.	13 + 2h

Long-distance signaling via phloem and hydraulic cues.	
Unit III:Communication biology	15h
Animal communication: Visual, auditory, olfactory, chemical, tactile, and electrical communication in animals with examples. Importance in ecology, animal behavior, social and collective behaviors. Learning, and learning plasticity. Plant-animal interactions: coevolution in pollinators, herbivores, invertebrates. **Plant communication:** chemical communication e.g. Herbivores attack, intra-organismic communication. Root mediated communication. Communication in symbiotic relationships. Root-network communication.	14 + 1h
Unit IV: Diseases and Disorders	10h
Human disorders: Motor and movement disorders, dyskinesis, Alzheimer's, Parkinson's: pathology and therapies, recent developments such as Robotics and prosthetics (case study), Computer brain Interface and applications (case study of eye/vision applications, global remote control of prosthetics). Psychiatric conditions: depression and anxiety, schizophrenia, ASD, Cognitive deficits in neuro-developmental and neurodegenerative disorders, Emerging approaches: CBT, pharmacology, TMS, neuro-feed back **Plant health and disorders**: Abiotic disorders, Infectious and physiological disorders.	9 + 1h

Note: Underlined topics are for self-study.

Recommended Books/References

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant Physiology and Development* (6th ed.)
2. Kandel, E. R., Schwartz, J. H., Jessell, T. M. (2013). *Principles of Neural Science* (5th ed.)
3. Trewavas, A. (2014). *Plant Behaviour and Intelligence*
4. Baluska, F., Mancuso, S., Volkmann, D. (2006). Communication in plants: neuronal aspects. *Plant Signal Behav*.
5. Taiz, L., Alkon, D., et al. (2019). Plants neither possess nor require consciousness. *Trends in Plant Science*.
6. Chamovitz, D. (2012). *What a Plant Knows*. (Introductory-level popular science)
7. Kerber, K. A. (2008). Fundamental neuroscience for basic and clinical applications.
8. Galizia, G. C and Lledo, P-M. (2013) Neuroscience; from molecular to behavior.
9. Purves, D. et. Al., (2001). Neurosciences.

Pedagogy: ICT tools, Chalk & Talk, Models & Charts, presentations, project based learning.

Formative Assessment (Internal assessment) Theory	
Assessment Occasion/ type	**Weightage in Marks**
Continuous evaluation and mid semester examination	**20**
CIA 1 and 2 Total **<u>Assessments:</u>** **Presentations** **Quiz/Test** **Science Writing** **Case study/ Group projects**	**20** **5** **5** **5** **5**
Total	**40 + 60 (ESE) = 100**

BLUE PRINT
Code number: **BY6326**
Title of the paper: **Neurosciences**

Total marks for which the questions are to be asked (including bonus questions)	**Number of hours**	**Unit number**
9	5	I
29	15	II
29	15	III
19	10	IV
86	**45**	**TOTAL**
Maximum marks for the paper (Excluding bonus question):**60**		

SEMESTER- VI: BIOLOGY PRACTICALS

Semester	**VI**
Paper Code	**BY6P326**
Paper title	**Neuroscience**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Measure sensory-motor reaction time using simple tools. (Reflex and tactile resolution experiments)
2. Observe directional growth in response to light.
3. Test behavioral response to chemical gradients.
4. Study root and shoot orientation in response to gravity/ Geotaxis in Drosophila.
5. Optical illusion interpretation and associated brain function mapping.
6. Assess effect of gibberellins on plant growth.
7. Assess working memory span and auditory processing animals
8. Observe habituation or exploratory behavior.
9. To study the effect of ethylene on shelf life of cut flowers
10. To study the effect of cytokininon leaf senescence.
11. Revision

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Pre- Lab assignments	**5**
In-lab performance	**8**
Post - Lab assignments	**5**
Lab Record	**7**
Total	**25 + 25 (ESE) = 50 marks.**

SEMESTER- VI: BIOLOGY PRACTICALS

Semester	**VI**
Paper Code	**BY 6S426**
Paper title	**Bio-Innovations and Entrepreneurship**
Number of teaching hours per week	**3**
Total number of teaching hours per semester	**33**
Number of credits	**2**

1. Cultivation of Edible/ Medicinal Mushrooms (Biology and types of edible mushrooms, substrate preparation, cultivation and harvesting methods, development of value-added mushroom products, cost analysis, and assessment of market potential)
2. Mass Production of *Spirulina / Azolla* as a Nutraceutical and Health Supplement (Cultivation techniques, harvesting and drying methods, nutritional profiling, quality standards, packaging, and commercialization prospects)
3. Large-Scale Cultivation of *Rhizobium* for Sustainable Agriculture (Growth requirements, solid state fermentation, harvesting techniques, application as biofertilizer and entrepreneurial scope)
4. Extraction and Commercial Utilization of Plant-Based Bioactive Compounds (Extraction of phytochemicals, pigments, applications in pharmaceutical and cosmetic industries, packaging, shelf-life considerations, and small-scale business opportunities)
5. Production of Wine/ Beer Using Yeast Technology (Principles of fermentation, preparation of fruit must, controlled fermentation process, clarification, bottling, quality assessment, and regulatory guidelines)
6. Vermiculture and Organic Vermicompost Production as a Sustainable Enterprise (Earthworm biology, vermicompost unit setup, compost preparation, harvesting, packaging, cost–benefit analysis, and market demand)
7. Development of Probiotic Products for Functional Food Applications (Selection of probiotic strains, formulation methods, health benefits, quality control measures, shelf-life, and commercialization potential)
8. Case Study Analysis of Successful Bio-Entrepreneurship and Innovation Models (Study of real bio-enterprises, biological processes involved, investment requirements, challenges faced, innovation strategies, and success factors)

9. Mini Project on Design and Development of a Bio-Based Innovative Product (Identification of a bio-product idea, description of biological processes, production workflow, cost estimation, feasibility analysis, sustainability, and innovation component)
10. Project on Commercialization, Branding, and Market Strategy for Bio-Products (Product branding and positioning, packaging and labeling, marketing strategies (traditional and digital), SWOT analysis, regulatory considerations, and startup pitch presentation)
11. Revision.

Reference Books and Manuals:

1. Arya, A., & Rusevska, K. (Eds.). (2022). Biology, cultivation and applications of mushrooms. Springer Singapore.
2. Amaresan, N., Dharumadurai, D., & Babalola, O. O. (Eds.). (2023). Food microbiology based entrepreneurship: Making money from microbes. Springer Singapore.
3. Arora, N. K., & Bouizgarne, B. (Eds.). (2022). Microbial biotechnology for sustainable agriculture (Vol. 1). Springer Singapore.
4. Sangtam, K. S., Kikon, Z. J., Ezung, N. K., & Biswas, P. K. Skill training manual on vermicompost producer. Krishi Vigyan Kendra, Nagaland.
5. Harborne, J. B. (1998). Phytochemical methods: A guide to modern techniques of plant analysis (3rd ed.). Chapman & Hall.
6. Sasidharan, S., et al. (2011). Extraction, isolation and characterization of bioactive compounds. (Elsevier)
7. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of fermentation technology* (3rd ed.). Butterworth-Heinemann (Elsevier).
8. Singh, A. (2025). Entrepreneurship in Biotechnology (1st ed.). NPH India (Narendra Publishing House) / Nirali Prakashan.
9. Desai, V. (2019). Dynamics of entrepreneurial development & management (6th rev. ed.). Himalaya Publishing House.
10. Shimasaki, C. (Ed.). (2020). Biotechnology entrepreneurship: Leading, managing, and commercializing innovative technologies (2nd ed.). Academic Press.

SEMESTER- VI: BIOLOGY PRACTICALS

Semester	**VI**
Paper Code	**BY 6D526**
Paper title	**Dissertation**
Number of teaching hours per week	**6**
Total number of teaching hours per semester	**66**
Number of credits	**4**

1. Initiation of experimental work
2. Recording and interpretation of results.
3. Setting up experiments based on the objectives
4. Recording and interpretation of results.
5. Setting up experiments based on the objectives
6. Recording and interpretation of results.
7. Seminar presentation on the 1st progress report of the project – batch 1
8. Seminar presentation on the 1st progress report of the project – batch 2
9. Setting up experiments based on the objectives
10. Recording and interpretation of results.
11. Seminar presentation on final progress report of the projects

Formative Assessment (Internal assessment) Practical	
Assessment Occasion/ type	**Weightage in Marks**
Seminar 1	**15**
Seminar 2	**15**
Dissertation copy	**10**
Total	**40 + 60 (ESE) = 100 marks.**

Registration Number:

Date & session:

EXAMINATION PATTERN

STJOSEPH'S UNIVERSITY, BENGALURU -27
III B.Sc. (BIOLOGY) – V SEMESTER
SEMESTER EXAMINATION: OCTOBER 2025
BY5126 – MOLECULAR SYSTEMATICS

Time: 2 Hours **Max Marks: 60**

This paper contains ONE printed page and THREE sections

Part A

Answer any TEN of the following **10 x 2 = 20 marks**

1.
2.
3.
4.
5.
6.
7.
8
9
10
11
12

Part B

Write notes on any FIVE of the following **5 x 6 = 30 marks**

13.
14
15
16.
17.
18.
19.

Part C

Give a comprehensive account of any ONE of the following **1 x 10 = 10 marks**

20.
21.

ST JOSEPH'S UNIVERSITY, BENGALURU - 5600027
III B.Sc. (BIOLOGY) - V SEMESTER
END SEMESTER PRACTICAL EXAMINATION: OCTOBER 2025
BY 5P126 – MOLECULAR SYSTEMATICS

MAX. MARKS: 25 **TIME: 3 hours**

1	Major experiment	**1 X 10 = 10**
2	Minor experiment	**1 x 6 = 6**
3	Spotters (A,B,C)	**3 X 3 = 9**

ST JOSEPH'S UNIVERSITY, BENGALURU - 5600027
III B.Sc. (BIOLOGY) - V SEMESTER
END SEMESTER PRACTICAL EXAMINATION: OCTOBER 2025

BY 5S426 – DISSERTATION: PROPOSAL DESIGN

Time: multiple hours **MAX. MARKS: 25**

1. Submission of Dissertation proposal copy 10M
2. Seminar presentation on project title 10M
3. Viva Voice 5M

Note: Each seminar presentation: 10+2 minutes

ST JOSEPH'S UNIVERSITY, BENGALURU - 5600027
III B.Sc. (BIOLOGY) - V SEMESTER
END SEMESTER PRACTICAL EXAMINATION: OCTOBER 2025

BY 6D526 – DISSERTATION / PROJECT

Time: multiple hours **MAX. MARKS: 60**

1 Submission of Dissertation/ Project 20M
2 Seminar presentation on Dissertation 25M
3 Viva Voice 15M

Note: Each seminar presentation: 12+3 minutes