JAI HIND COLLEGE

Basantsing Institute of Science & J. T. Lalvani College of Commerce
and Sheila Gopal Raheja College of Management.

Empowered Autonomous

"A" Road, Churchgate, Mumbai - 400 020, India

Affiliated to
University of Mumbai

Bachelor of Science

Program: B.Sc. in Life Sciences

Choice Based Credit System (CBCS) under NEP-2020
with effect from the academic year 2023-2024

Syllabus as approved by Statutory Committees

LOCF Document

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CONTENTS

Preamble

The learning outcomes-based curriculum framework for B. Sc. (Program) Life Sciences is structured to offer a broad outline within which a holistic biology program could be developed.

Life Sciences is an interdisciplinary subject that includes concepts of zoology, botany, microbiology and biotechnology. The course curriculum includes practical and theoretical modules applied from molecular and cellular levels to molecular and physiological levels. It is the study of origin, growth, life processes and reproduction and behaviour in plants, animals, bacteria, fungi, algae and viruses. Topics like applied biology, biodiversity, neurobiology, developmental biology, genetics and genetic engineering, fermentation technology, biotechnology, ecology, molecular biology, biostatistics and bioinformatics are a part of this course. Skills like analytical-thinking, logical-thinking, critical and logical-reasoning and decision-making are enhanced through various laboratory experiments, case-studies, assignments, discussions, role-plays, seminars, workshops and certificate programmes that are included in the course. A graduate in Life Sciences can obtain a Masters in Life Sciences with specialization in: Biotechnology, Neurobiology, Applied Medicine, Reproductive biotechnology, Genetic engineering, Environmental science, Macromolecular biology, Immunology, Bioanalytical Science, D.M.L.T., Clinical Research, Bioinformatics, MBA in Pharmaceutical Management, or pursue M.Sc. by research.

Credit Framework

Types of Courses

Sr No	Type of Course	Learner Category
1	Major	Life Sciences Major
2	Minor	Life Sciences Minor
3	OE	Commerce / Arts Stream
4	SEC	Life Sciences Major/Minor
4	VSC	Life Sciences Major/ Minor

Number of Courses and Credits

Type of Course	Number offered of each	Credits of each (Theory + Practical)
Major/ Minor Courses	02	4 (3 + 1)
Open Elective Courses	02	2 (Theory)
Skill Enhancement Elective Courses	01	2 (Practical)
Vocational Skill Elective Courses	01	2 (Practical)

Semester-wise Courses

Semester	Course Code	Course Title	Type of course	Credit
I	JUSLSC-DSC101	Biological macromolecules, Separation techniques and Life processes	Major	03
I	JUSLSC-DSCPR101	Life Sciences Practical I	Major	01
I	JUSLSC-MIN101	Biological macromolecules, Separation techniques and Life processes	Minor	03
I	JUSLSC-MINPR101	Life Sciences Practical I	Minor	01
II	JUSLSC-DSC201	Cell organelles, cytoskeletal elements and Genetics	Major	03
II	JUSLSC-DSCPR201	Life Sciences Practical II	Major	01
II	JUSLSC-MIN201	Cell organelles, cytoskeletal elements and Genetics	Minor	
II	JUSLSC-MINPR201	Life Sciences Practical II	Minor	01
I/ II	JUSLSC-OE101/201	Biohacking your Brain	Open Elective	02
I / II	JUSLSC-OE102/202	Science of Sleep	Open Elective	02
I / II	JUSLSC-SEC101/201	Model organisms in Scientific Research - I	Skill Enhancement Elective	02
I/ II	JUSLSC-VSC101/201	Laboratory Techniques and Instrumentation in Biology-I	Vocational Skill Elective	02

Learning Outcome-based Approach

A student graduating with the Degree B.Sc Life Science Major should be able to:

1) Develop a deep understanding of core principles in biology, including genetics, molecular biology, developmental biology, immunology ecology, cellular biology etc.
2) Cultivate teamwork and collaboration skills through laboratory work and group projects.
3) Apply critical thinking to analyse biological phenomena and conduct experiments. Demonstrate proficiency in laboratory techniques, data analysis, and scientific communication.
4) They will demonstrate the ability to apply this conceptual knowledge to analyse complex biological phenomena and solve problems in diverse life science contexts.
5) Students will not only acquire a comprehensive understanding of life sciences but will also develop entrepreneurial skills. This includes the ability to identify opportunities, innovate in life science contexts, and effectively communicate and commercialize scientific discoveries.

Graduate Attributes

1) **Disciplinary knowledge:** Capable of demonstrating (i) comprehensive basic knowledge of major concepts, theoretical principles and experimental findings in Life sciences and its different subfields including biodiversity, physiology, biochemistry, biotechnology, genetics, evolutionary biology, and immunology and some of the other applied areas of study (ii) interdisciplinary knowledge of allied biological sciences and environmental science (iii) learning of the various techniques and computational softwares used for analysis of animal's forms and functions.
2) **Effective communicator:** Ability to grasp complex information effectively and efficiently.
3) **Logical thinking and reasoning**: Develop the capability to seek solutions logically, resolving them by experimentation and processing the data either manually or through software.
4) **Team spirit:** Trained to be interdisciplinary and possess the ability to work effectively in a heterogeneous team.
5) **Leadership quality:** Ability to recognise and mobilise relevant resources which are essential for a project, and to manage the project in a responsible way by following ethical scientific conduct and biosafety protocols.
6) **Ethical awareness:** Avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, as well as appreciating the environmental and sustainability issues.

Programme Objectives

1) To provide an environment that ensures cognitive development of students in a holistic manner in the subject of Life Sciences.
2) To keep them abreast with the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discover learning.
3) To equip the students with the knowledge of key processes during development of an organism both at cellular and molecular levels

4) To nurture students into responsible citizens who are socially and environmentally sensitive and aware of most basic domain-independent knowledge.
5) To enable the graduate prepare for national as well as international competitive examinations
6) To prepare the student to meet professional challenges.
7) To develop critical thinking, logical reasoning, research ethics among the students and inculcate research-oriented thinking.
8) To encourage peer-learning so as to achieve higher educational goals together
9) To help students gain self-awareness and spirituality by spending more time with nature.

Teaching Learning Process

(i) Use ICT tools for Teaching-Learning: Online virtual classroom 'Google classroom' for all classes for disbursement of study material, Adaptive learning using videos, visuals, simulations, Use Google workspace for continuous assessment, quizzes and assignments (paper-less).

(ii) Participative learning: Active discussions, Problem solving sessions (Golden Hour), Peer Teaching, Classroom Polls.

(iii) Experiential learning: DIY experiments to perform at home, Field Trips, Virtual reality software (simulations), Visits to renown institutes, Workshops, Internships, Research Projects, Hand-on working with software's for Bioinformatics and Biostatistics.

(iv) Other methods: Flipped classroom, Mind-maps, Peer Teaching-Learning

(v) Inculcating Higher Order Thinking Skills: assignments like analyzing Contradictory Scientific Papers, Clinical Trial analysis, Scientific Precis writing, Entrepreneurship: Set-up an industry, Documentary / Video making, Riddles, etc,

(vi) Regular Revision: Revision with fun games like Bingo, Pictionary, 20 questions, treasure hunt, Dumb charades, etc.

(vii) Feedback: OMF (One Minute Feedback) from students at the end of a particular topic. It is a simple Google form which is anonymous.

(viii) Class Test, CA and SEE Questions based on HOTS that target basic principles and applications to increase aptitude of students and prepare them for competitive exams. Reduction in Knowledge based questions from FY to TY and gradual increase in application, analysis and evaluation type questions.

(ix) Mentoring: Academic, Research, Peer, Alumni and Personal (if needed) Guidance. Students who need mentoring are identified via Class interaction and games, Class tests, CAs and Attendance (Weekly defaulters lists are made). These students are then mentored as follows:

a) Golden Hour: Academic, Research, Entrance Exams & Personal Mentoring by Teachers
b) Alumni Mentoring:
- Career guidance (Humans of JHC Life Sciences)
- For Entrance Exams
c) Peer Mentoring: Teaming up slow learners with advanced learners.

Assessment Methods / Evaluation Scheme

(a) For Major/Minor having 3 credits in Theory and 1 credit in Practical:

i) Theory will be of 75 marks:
50 marks SEE – 2 hours
25 marks Internal – Will include class tests, quizzes, assignments, etc.

ii) Practical will be Internal Assessment = 25 marks
Continuous assessment of practical conducted during regular turns + Worksheets.
SEE practical = 25 marks
Total of Internal + SEE practical = 50 marks which is to be submitted as 50/2 out of 25

(b) For OE (02 credits of Theory only)

25 marks SEE of 1 hour
25 marks internal assessment – Will include class tests, quizzes, assignments, etc.

(c) For VSC and SEC (02 credits each Practical only)

50 marks for Practical – Will include Semester End Exam, Viva, Worksheets, etc.

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Discipline Specific Core Courses – Major/Minor

Course Code JUSLSC-DSC101/ JUSLSC-MIN101	Course Title: Biological macromolecules, Separation techniques and Life processes	Credits:03 03 Lectures/Week
Course description	The first step to appreciate life forms is to understand the molecular logic of a living cell. This course develops the concept of biochemical basis of plant and animal life and the underling uniformity that forms the basis of all organisms at the cellular level.	
Learning objectives	1. Understand prokaryotic and eukaryotic cell structures. 2. Study microbial growth and life cycle of viruses. 3. Learn about biomolecules and techniques used to separate them. 4. Learn concepts of anatomy and physiology like nutrition, digestion, respiration and circulation in plants and animals.	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Differentiate between prokaryotes and eukaryotes; and understand microbial growth and life cycles of various viruses 2. Know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids and knowledge of techniques to separate them. 3. Understand types of nutrition in plants and animals; nutritional adaptations; anatomy and physiology of digestion 4. Explain functions of organ systems and cellular functions (Life processes including transport and circulation in plants and animals; respiration and gaseous exchange, excretion, and osmoregulation) 5. Integrate physiology from the cellular and molecular level to the organ system and organismic level of organization.	
	THEORY	**Total 45 Lectures**
Sub-Unit	**Unit – I: Macromolecules and Separation techniques**	**15 lectures**
1	**Proteins:** a) Amino acids: Classification (Nutritional and Structural) b) Chemical reactions (Ninhydrin test for amino acids), Zwitter ion c) Peptide bond formation and Primary structure of protein d) Secondary (α and β), Tertiary and Quaternary structure and types of bonds contributing to protein structure e) Globular proteins (Hemoglobin) & Fibrous proteins (keratin),	**03**
2	**Carbohydrates:** Classification and Structure, chemical and physical properties: a) Monosaccharides (Glucose, galactose, Fructose, (glyceraldehydes, Simple Aldose, Simple Ketoses, D-glucose, Conformation of D-glucose, Epimers) b) Disaccharides (maltose, sucrose, lactose),	**03**

	c) Polysaccharides (starch, glycogen and cellulose)	
3	**Lipids:** a) Classification of lipids (simple, derived and complex with one example each). b) A brief note on saturated, unsaturated, hydroxy and branched chain fatty acids c) Biological role of fatty acids	03
4	**Nucleic acid:** a) Structure of nucleosides and nucleotides b) Structure of nucleic acids (A,B,Z forms) c) Structure of DNA lends itself to its function as hereditary molecule.	03
5	**Separation techniques:** **a) Filtration:** Gravity filtration, vacuum filtration, ultrafiltration **b) Chromatography:** Techniques based on: Solubility – Paper chromatography, TLC Charge – Ion exchange chromatography Size – Size Exclusion chromatography Affinity of molecules – Affinity Chromatography Sophisticated Chromatography techniques – HPLC **c) Electrophoresis:** Brief overview of AGE, PAGE, 1-D and 2-D electrophoresis **d) Centrifugation:** Differential centrifugation, Density gradient centrifugation	03
Sub-Unit	**Unit – II: Concept of prokaryotic and eukaryotic cells**	**15 lectures**
1.	**Study of Prokaryotic and Eukaryotic cell:** a) Microscopy as a tool for Cell Biology studies: Principles of light and electron microscopy b) Prokaryotic cell structure. E.g. *E. coli* c) Eukaryotic cell structure: Plant and Animal cell d) Evolutionary origin of organelles (Endosymbiont Theory)	05
2.	**Viruses:** a) Virion structure b) Bacteriophage (Virulent and Temperate) and their Life cycles (Lytic and Lysogenic) c) Plant viruses: TMV d) Animal virus: DNA virus – E.g. HSV, RNA virus – E.g. MMTV, COVID-19	05
3.	**Microbial growth:** a) Microbial culture media – Selective, Differential, Enriched, Enrichment, Minimal, Transport media b) Factors influencing bacterial growth – pH, temperature, pressure, nutrients, oxygen levels, salt concentration. c) Isolation techniques – Streak plate, Spread plate, Pour-plate (Bulk-seed) techniques, single cell isolation.	05

	d) Preservation of bacteria e) Growth curve of bacteria (Eg. *E. coli.*)	
Sub-Unit	**Unit – III: Life processes**	**15 lectures**
1.	**Nutrition and digestion** a) Auxotrophic nutrition b) Heterotrophic nutrition i) Holozoic nutrition- fluid feeders (eg. housefly), microphagous (eg. amoeba or paramecium), macrophagous (mammals) ii) Saprophytic (fungi) and parasitic (tapeworm) nutrition **Digestive systems of mammals** With respect to the function of each organ	**04**
2.	**Excretion and Osmoregulation** a) Nitrogenous excretory products (ammonia, urea and uric acid) b) Concept of osmoregulation and processes associated with osmoregulation - Ultrafiltration, Reabsorption, Tubular secretion	**04**
3.	**Transport and Circulation** **In plants-** Transport of water and inorganic solutes, transpiration, Ascent of sap, stomatal function and regulation, Transport of organic solutes - the mechanism and its regulation **In animals:** a) Types of circulatory system: i) Open and closed system ii) Single and Double Circulation; b) Circulating fluids - water, blood & lymph c) Hearts - Types of hearts	**04**
4.	**Respiration and Gaseous Exchange** a) Aerobic and anaerobic respiration, b) Gas exchange in small animals (across the surface) and cutaneous respiration. c) Gas exchange in plants pneumatophores. d) Gaseous exchange in invertebrates - trachea in insects, book lungs in scorpions. e) Gaseous exchange in vertebrates- gills in Fishes; counter-current exchange and lungs in Man. f) Respiratory pigments - haemoglobin, structure and function. O2 and CO2 Transport	**03**
	Evaluation Scheme: **Total: 75 Marks** (a) 50 Marks Semester End Exam (SEE) of 2 hours (b) 25 Marks Internal Assessment: 10 marks CA-I (Test with Objective Questions) 10 Marks CA-II (Assignment like Poster/model making, video making, presentation, etc	

Application of Bloom's Taxonomy in SEE (50 marks Exam):

Thinking Skills	Weightage of Marks				
	Unit I	Unit II	Unit III	Total	%
Remembering / Knowledge	08	08	09	25	50
Understanding	2.5	2.5	2.5	7.5	15
Applying, Analyzing, Evaluating, Creating	06	06	5.5	17.5	35
Total Marks	**16.5**	**16.5**	**17.0**	**50**	**100**

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8. Simon EJ., Dickey JL., Reece JB., Hogan KA.(2015) Campbell 4. Essential Biology with Physiology, Pearson
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Course Code JUSLSC-DSCPR101/ JUSLSC-MINPR101	Course Title: Life Sciences Practical -I	Credits: 01 1 Practical/Week
	PRACTICAL	**Total 30 hours**
Learning objectives	This course aims at achieving the following objectives: 1. Understand the principles and significance of Good Laboratory Practices (GLP) in scientific research and experimentation. 2. Demonstrate proficiency in using a compound light microscope for specimen observation and measurement. 3. Understand the basic principles of colorimetry and its application in quantitative analysis.	
Course Outcomes	On completion of course students will be able to: 1. Operate a compound light microscope effectively to magnify and observe microscopic specimens. 2. Apply staining techniques to enhance the visibility of specific structures within microscopic specimen 3. Successfully extract DNA from a suitable plant source using standard laboratory procedures 4. Comprehend the basic principles and working of colorimetry in quantitative analysis	
1. & 2.	An introduction to Laboratory discipline: a. GLP (Good Laboratory practices) b. Lab safety (instruments and chemicals) c. Survey of the organization of laboratory instruments, chemicals and glassware	
3.	Study of Compound Light Microscope	
4.	Monochrome Staining	
5.	Cell wall staining	
6.	Qualitative detection of: a) Carbohydrates (Molisch Test) b) Proteins (Biuret Test) c) Lipids (Spot test and solubility test)	
7.	Extraction of DNA from a suitable plant source	
8.	pH Meter: a. Principle of working of pH meter and calibration of the pH Meter with standard buffers	

	b. Checking of pH for common foodstuff or other relevant samples	
9.	Colorimetry: a. Basic Principle and working b. Estimation of Lambda max of a coloured solution c. Verification of Beer Lambert's law for a coloured solution	
10. & 11.	Study of Plant Tissues: i. Comparison between Dicot stem and Monocot stem (Temporary mounting) ii. Comparison between Dicot root and Monocot root (Temporary mounting)	
12.	Study of Animal Tissues (Permanent slides) i. Epithelial – Squamous, Cuboidal, epithelial ii. Connective – Areolar, Adipose, cartilage, bone iii. Muscular – Striated, non- striated, Cardiac iv. Nervous – Medullated, non-medullated neurons	
13. & 14.	Comparative assessment of mouth-parts of insects: a. Biting and Chewing type – Eg. Cockroach (if available or from photograph) b. Piercing and sucking type – Eg. Mosquito c. Sponging type – Eg. Housefly	
15.	Mounting of nephridium of earthworm and study of permanent slide of kidney	
	Evaluation Scheme: (a) Continuous Assessment during regular practical turns + Worksheets (b) 25 Marks SEE Practical Exam: Experiment, Identification, Viva. Total of Internal assessment + SEE Practical exam = 50 marks which is to be as 50/2 out of 25 Marks	

Course Code JUSLSC-DSC201/ JULSC-MIN201	Course Title: Cell organelles, Cytoskeletal elements and Genetics	Credits: 03 03 Lectures/Week
Course description	This course aims at conceptualization of various cellular organelles and their function, cell division and recombination, Genetics, Mendelian and Non-Mendelian inheritance Genetics and Ecology.	
Learning objectives	This course aims at achieving the following objectives: 1. To understand various cell organelles and their functions. 2. To learn the process of cell division at the cellular level. 3. To conceptualise various cytoskeletal elements. 4. To understand the basics of Genetics	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Develop evidence-based critical thinking in cell biology with knowledge of the role of different cell organelles, plasma membrane and cytoskeletal elements. 2. Understand the basis and significance of cell cycle, mitosis and meiosis 3. Understand Gene concept, and Mendelian inheritance, Correlate Non-Mendelian inheritance, intra-allelic and inter-allelic gene interactions 4. Differentiate between types of mutations and human congenital disorders 5. Understand the Principles of ecology, ecological succession, ecosystems, Biogeocycles, Interspecific interactions and behavioural ecology.	
	THEORY	**Total 45 Lectures**
Sub-Unit	**Unit I: Cell Organelles: (Structure and Function)**	**15 lectures**
1.	**Nucleus:** a) Structure of an interphase nucleus b) Nucleosome model c) Euchromatin and heterochromatin	**02**
2.	**Endoplasmic Reticulum:** a) Structure and function (including sarcoplasmic reticulum) b) Role in protein synthesis (ER- Ribosome complex) and transport (Signal hypothesis)	**02**
3.	**Ribosomes:** Biochemical composition of Subunits in prokaryotes and eukaryotes (including those within chloroplast and mitochondria)	**02**
4	**Golgi complex:** a) Structure, origin, and relationship to Endoplasmic reticulum. b) Role in synthesis, storage and secretion of zymogen and glycoproteins	**02**
5.	**Lysosomes:** a) Primary and secondary lysosomes and their functions b) Lysosome associated diseases (Tay Sachs and Silicosis)	**02**

6.	**Mitochondria:** a) Structure and Biochemical composition of inner, outer membranes & the matrix with a brief mention of oxidative phosphorylation metabolism in the Mitochondrion, b) Mitochondria associated diseases (any one example)	**02**
7.	**Plastids:** a) Types b) Chloroplast morphology, c) Structure of thylakoid membrane, photosynthetic pigments & d) A brief mention of photophosphorylation; chloroplast DNA	**02**
8.	**Peroxisomes:** Structure and function in plant and animal cells. (a brief mention of catalase activity in plant and animal cells).	**01**
Sub-Unit	**Unit II: Cytoskeleton, Structure of Cell Wall and Cell division**	**15 lectures**
1.	**a) Microfilaments:** i) Structure and function in striated muscle fibers, Sliding filament theory ii) Role in Cytoplasmic streaming in plants. **b) Microtubules:** i) Structure as in cilia or in flagella, mechanism in movement ii) Function in mitotic spindle **c) Intermediate Filaments:** Types, Structure and function	**05**
2.	**Structure of Cell Wall:** a) Bacterial Cell wall: Gram positive and Gram negative b) Fungal cell wall c) Plant cell wall: Primary and secondary	**05**
3.	**Cell Division:** **a) Cell cycle:** i) Phases: G0, G1, S, G2, M phases ii) Regulation of Cell cycle **b) Mitosis and its significance:** i) Karyokinesis: Prophase, Prometaphase, Metaphase, Anaphase, Telophase ii) Cytokinesis in plant and animal cell **c) Meiosis and its significance:** i) Phases: Meiosis I and II ii) Concept of recombination and Holliday Model of recombination	**05**
Sub-Unit	**Unit III: Genetics**	**15 lectures**
1.	**Mendelian Inheritance** a) Mendel's Laws and Mono & Dihybrid ratios with problems b) Inheritance of sickle cell anaemia c) Sutton's Hypothesis	**05**

2.	**Modification of Mendel's laws:** Gene interactions - Incomplete dominance, co-dominance, Multiple alleles, Polygenic inheritance, Epistasis, Linkage, Sex limited and sex influenced traits, Penetrance and Expressivity, Lethal alleles.	**05**
3.	**Mutations:** a) Point Mutations b) Chromosomal aberrations: i) Structural: deletion, duplication, inversion, translocation. ii) Numerical: Aneuploidy (e.g. Downs, Turners, Klienfelter's syndrome), Polyploidy (autopolyploidy and allopolyploidy)	**05**
	Evaluation Scheme: **Total: 75 Marks** (a) 50 Marks Semester End Exam (SEE) of 2 hours (b) 25 Marks Internal Assessment: 10 marks CA-I (Test with Objective Questions) 10 Marks CA-II (Assignment like Poster/model making, video making, presentation, etc.) 5 Marks attendance **Application of Bloom's Taxonomy in SEE (50 marks Exam):**	

Thinking Skills	Weightage of Marks				
	Unit I	Unit II	Unit III	Total	%
Remembering / Knowledge	08	08	09	25	50
Understanding	2.5	2.5	2.5	7.5	15
Applying, Analyzing, Evaluating, Creating	06	06	5.5	17.5	35
Total Marks	**16.5**	**16.5**	**17.0**	**50**	**100**

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Course Code JUSLSC-DSCPR201/ JUSLSC-MINPR201	Course Title: Life Sciences Practical -II	Credits: 01 1 Practical/ Week
	PRACTICAL	**Total 30 hours**
Learning objectives	This course aims at achieving the following objectives: 1. Understand the principles of micrometry and its significance in biological research 2. Perform Barr body staining to detect the presence of Barr bodies in cells. 3. Understand the purpose of biostatistics in biology, including data collection and types of data. 4.Construct pedigree charts to represent the inheritance patterns of genetic traits 5. Understand the principles and criteria used in plant classification	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1.Identify and classify bacteria as Gram-positive or Gram-negative using Gram staining. 2. Interpret the results and analyze the separation patterns of amino acids 3. Describe the ultrastructure of the organelles and their functions based on the electron micrographs 4. Identify and classify white blood cells based on their staining characteristics 5. Understand the significance of Barr bodies in genetics and sex determination 6. Observe and record stomatal movements under different environmental conditions. 7. Classify plants and animals based on their characteristics and taxonomic hierarchy, including kingdom, division, class, order, family, genus, and species.	
1.	Micrometry: Using the microscope to measure size of onion cells	
2 & 3	Movements in plants and animals: a) Cytoplasmic streaming in *Vallisneria / Hydrilla* b) Culturing and observation of *Paramoecium* from Hay infusion	
4.	Differential Staining: Gram staining	

5.	Separation of amino acids using Paper Chromatography	
6.	Study of Electron Micrographs: Nucleus, Mitochondria, Ribosome	
7.	DNA and RNA from onion peel using methyl green pyronin staining	
8.	Differential WBC staining	
9.	Study of Meiosis (Demonstration/ Photograph)	
10.	Detection of Barr Body	
11.	Study and comparison of Monocot and Dicot Stomata (Temporary mounting) and Stomatal movement	
12.	Pedigree charts and analysis using suitable examples	
13.	Biostatistics: a) Purpose of Biostatistics: Data collection and types of data. b) Study of Class Intervals and calculation of frequency c) Representation – tabular and graphical – line graph, frequency curve, Ogive curve, histogram and pie diagram. (Also represented using computers – Excel) d) Measures of central tendency – Mean, Median, Mode e) Measures of dispersion – Standard deviation and Variance	
14.	Plant Classification	
15.	Animal Biodiversity: a) Classification of Animals – Invertebrates b) Classification of Animals – Vertebrates c) Digital recording and detailed classification of one animal from campus/ local environment	
	Evaluation Scheme: (a) 20 Marks Continuous Assessment during regular practical turns + Worksheets, (b) 25 Marks SEE Practical Exam: Experiment, Identification, Viva. Total of Internal assessment + SEE Practical exam = 50 marks which is to be as 50/2 out of 25 Marks	

Open Elective Courses

Course Code JUSLSC-OE101/201	Course Title: Biohacking your Brain	Credits:02 02 Lectures/Week
Course description	Biohacking your brain involves a holistic approach to optimizing its functionality through healthy lifestyle choices and targeted improvement strategies. This cutting-edge concept focuses on the modification of one's cognitive abilities, emphasizing the need for mindfulness in various aspects of life. By incorporating scientifically backed approaches into daily routines, individuals can unlock their full cognitive potential and pave their way towards an optimized brain function that leads to improved productivity and well-being.	
Learning Objectives	This course aims at achieving the following objectives: 1. To achieve physical, mental, or emotional changes to lead a healthy life. 2. Promoting a healthy lifestyle through a comprehensive understanding of the intricate workings of the brain and how it relates to overall well-being. 3. The focus will be on improvement and modification techniques that encompass various aspects, such as nutrition, exercise, and mental health. 4. Emphasizing the importance of adopting a healthy diet rich in fresh fruits, vegetables, whole grains, lean proteins, and beneficial fats will be central to this course's content. 5. Through evidence-based research and practical exercises, students will gain valuable insights into nurturing their brains for enhanced productivity and vitality in both personal and professional spheres.	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Understand the brain anatomy, including the major regions and their functions. 2. Explain the process of neurotransmission and understand the role of neurotransmitters in brain function. 3. Analyze the bidirectional relationship between the brain and the body, including the impact of nutrition, exercise, and sleep on brain health. 4. Apply mindfulness and stress reduction techniques to improve mental well-being and cognitive performance. 5. Create a personalized brain health plan that incorporates evidence-based biohacking strategies tailored to their individual needs and goals.	
	THEORY	**Total 30Lectures**
Sub-Unit	**Unit – I: Overview of Biohacking**	**15 Lectures**
1.	Introduction to Biohacking & Brain Anatomy	**04**
2.	Intellect and IQ	**01**
3.	Biohacking the sleep	**02**

4.	Supplements and brain health	**02**
5.	a. Water and brain health b. Benefits of alkaline water	**02**
6.	Brain Games	**02**
7.	Cryotherapy	**02**
Sub-Unit	**Unit – II: The Better Brain Lifestyle**	**15 Lectures**
1.	a. Brain Diet b. Mediterranean diet, keto diet, intermittent fasting c. Foods that improve brain health d. Probiotics and Microbiome	**06**
2.	Insulin resistance and its effect on the brain	**02**
3.	Benefits of cognitive and physical exercise	**03**
4.	Meditation and mindfulness	**02**

Evaluation Scheme:

Total: 50 Marks

(a) 25 Marks Semester End Exam (SEE) of 1 hour

(b) 25 Marks Internal Assessment:

10 marks CA-I (Test with Objective Questions)

10 Marks CA-II Assignment

Application of Bloom's Taxonomy in SEE (25 marks Exam):

Thinking Skills	**Weightage of Marks**			
	Unit I	**Unit II**	**Total**	**%**
Remembering / Knowledge	06	06	12	50
Understanding	02	02	04	15
Applying, Analyzing, Evaluating, Creating	04	05	09	35
Total Marks	**12**	**13**	**25**	**100**

References

1. Biohacking your brain, Dr. Willeumier Kristen, Harper Collins Publisher.
2. Biohacking Secrets, Sood Shivani

Course Code JUSLSC-OE102/202	Course Title: Science of Sleep	Credits:02 02 Lectures/Week
Course description	This course is designed to provide students with an opportunity to learn about the basic concepts of sleep. Students will be introduced to the parts of the brain, hormones and neurotransmitters involved. The different stages of sleep, brain waves and concept of dreams will be covered. Diagnostic aspects such as tools and disorders will be analyzed, giving the students a wholistic understanding of the subject.	
Learning Objectives	This course aims at achieving the following objectives: 1. Understand the concept of biological rhythms, particularly the circadian rhythm. 2. Recognize the basic concept of and importance of sleep and its duration in different age groups. 3. Learn about different parts of the brain, hormones and neurotransmitters involved in sleep. 4. Explore the concept of dreams: causes, types, brain regions involved. 5. Distinguish between the different stages of sleep. 6. Explain the different types of brain waves and their effect in daily life. 7. Be introduced to the different types of sleep disorders. 8. Identify the different diagnostic tools used to identify disorders.	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Distinguish between the different types of biological rhythms and have a complete understanding of the circadian rhythm. 2. Have a biological understanding behind the importance of sleep. 3. Enlist the regions of the brain, hormones and neurotransmitters that have an impact on sleep. 4. Understand the concept of dreams. 5. Differentiate between the different stages of sleep with proper knowledge of its properties. 6. Enumerate the types of brain waves, its effect on the different stages of sleep, and its contribution in daily life. 7. Correlate the types of sleep disorders. 8. Learn about basic mechanisms of tools such as EEG, EOG and EMG.	
	THEORY	**Total 30 Lectures**
Sub-Unit	**Unit – I: Basic Concepts of Sleep**	**15 lectures**
1	Circadian rhythms in the animal world. Introduction to and parts of the brain involved in sleep	**04**
2	Stages of sleep. Changes in the body in the different stages	**04**
3	Hormones and sleep	**02**

<table>
<tr><td>4</td><td>Introduction to neurotransmitters. Role and effect of Neurotransmitters in sleep regulation</td><td>03</td></tr>
<tr><td>5</td><td>Dreams</td><td>02</td></tr>
<tr><td>Sub-Unit</td><td>Unit – II: Measuring Electrical Activity and understanding sleep disorders</td><td>15 lectures</td></tr>
<tr><td>1.</td><td>What are Brain waves and their types</td><td>03</td></tr>
<tr><td>2.</td><td>How are Sleep studies performed?
Study of Electroencephalogram (EEG), Electrooculogram (EOG) and Electromyography (EMG).</td><td>03</td></tr>
<tr><td>3.</td><td>Disturbances in circadian rhythms</td><td>02</td></tr>
<tr><td>4.</td><td>Sleep Disorders:
a. Snoring
b. Sleep Apnea
c. Restless legs Syndrome</td><td>05</td></tr>
<tr><td>5.</td><td>Insomnia</td><td>02</td></tr>
<tr><td></td><td>Evaluation Scheme:
Total: 50 Marks
(a) 25 Marks Semester End Exam (SEE) of 1 hour
(b) 25 Marks Internal Assessment:
10 marks CA-I (Test with Objective Questions)
10 Marks CA-II Assignment

Application of Bloom's Taxonomy in SEE (25 marks Exam):
<table>
<tr><th rowspan="2">Thinking Skills</th><th colspan="3">Weightage of Marks</th><th></th></tr>
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<tr><td>Remembering / Knowledge</td><td>06</td><td>06</td><td>12</td><td>50</td></tr>
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</table></td><td></td></tr>
<tr><td>References</td><td colspan="2">1. Mendelson W. The science of sleep: What it is, how it works, and why it matters. University of Chicago Press (2017).
2. Hobson A. Dreaming: An introduction to the Science of Sleep. Oxford University Press (2003).
3. Walker M. Why we Sleep: Unlocking the Power of Sleep and dreams. Scribner. (2018)</td></tr>
</table>

Skill Enhancement Elective Courses

Course Code JUSLSC-SEC101/201	Course Title: Model Organism in Scientific Research – I	Credits:02 (60 hours)
Course description	This course is designed to provide students with hands on experience in the study of model organisms. This includes theoretical knowledge of the basic processes from fertilization to organ development, Assisted Reproductive Techniques, and the life cycle of different organisms. The practical component includes the scientific application of the basic processes, culturing techniques of model organisms and their role in research.	
Learning objectives	This course aims at achieving the following objectives: 1. Understand the concepts of embryology and organogenesis in different model organisms. 2. Learn about different mechanisms of measurement of microscopic particles. 3. Explore the different stages of division of cells. 4. Observe the differences in the growth of two model organisms.	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Conceptualize the process of embryology and organogenesis of different model organisms. 2. Be able to measure microscopic particles under the microscope. 3. Identify the different stages of division of cells. 4. Co-relate the difference in the growth and other properties of two model organisms.	
	PRACTICAL	**Total (60 hours)**
1.	Introduction to reproduction: a) Introduction to Haemocytometer b) Counting of yeast cells using a Haemocytometer	
2.	Introduction to reproduction: a) Introduction to Micrometer Pollen tube germination to calculate the tube length	
3.	Fission a) Types of Fission b) Study of fission using suitable sample	
4.	Fragmentation a) Types of Fragmentation b) Study of fragmentation using suitable sample	
5.	Budding a) Types of Budding b) Study of budding using suitable sample	

6.	Vegetation propagation a) Types of Vegetative propagation b) Study of Vegetative propagation using suitable sample	
7.	Regeneration a) Types of Regeneration b) Study of Regeneration using suitable sample	
8.	Spore Formation a) Types of Spore Formation b) Study of Spore formation using suitable sample	
9.	Syngamy and Conjugation a) Types of Syngamy b) Study of Syngamy and Conjugation using suitable sample	
10.	Mitosis a) Stages of Mitosis b) Study of Mitosis using suitable sample	
11.	Meiosis a) Stages of Meiosis b) Study of Meiosis from permanent slides	
12.	Frog Embryology and Chick Embryo organogenesis a) Structure of Gametes b) Cleavage c) Morula d) Blastula e) Gastrulation f) Neurulation g) Organogenesis h) Study of stages of development in frog embryology i) Study of organogenesis (developmental stages) of chick embryo	
13.	Model organisms in Research a) Types of model organisms b) Importance of model organisms c) Use of model organisms in clinical trials	
14.	Applications of embryology: Introduction to ART	
15.	Study of invertebrate model organism: Life cycle, development, culturing and applications a) *Hydra* and studying the regeneration process of *Hydra* b) *Drosophila melanogaster* and Observation of Egg and instars	
	Evaluation Scheme: 50 Marks – Will include SEE Practical Exam, Viva, worksheets, continuous assessment, etc.	

References	1. Wolpert L., Tickle C., and Arias AA. Principles of Development, Oxford University Press (2015). 2. Gilbert SF., Barresi M.J.F. Developmental Biology, Sinauer Associates, Oxford University Press (2016). 3. R.M. Twyman. BIOS Instant Notes in Developmental Biology, Taylor & Francis (2000).	

Vocational Skill Elective Courses

Course Code JUSLSC-VSC101/201	Course Title: Laboratory Techniques and Instrumentation in Biology – I	Credits:02 (60 Hours)
Course description	The course is designed to provide students with hands-on experience in the field of instrumentation and measurement techniques. This practical course complements theoretical knowledge by offering students the opportunity to work with a variety of scientific instruments and equipment commonly used in research, industry, and scientific applications.	
Learning objectives	This course aims at achieving the following objectives: 1. Educate students to operate the lab equipment by following lad safety protocols 2. Understand the principal, working of instruments such as microscope, pH meter and colorimeter. 3. Explore different cell disruption techniques and study its application. 4. Analyze microbial techniques. 5. Comprehend the use of and calibrate lab instruments such as analytical balance, pipettes and micropipettes.	
Course Outcomes	Upon successful completion of this course, the student will be able to: 1. Use and operate instruments in the lab and use them for practical and research purposes. 2. Understand the technical concepts of instruments like microscope, pH meter and colorimeter. 3. Co-relate separation and centrifugation techniques and use it for experimental purposes. 4. Learn various microbial techniques. 5. Calibrate instruments and learn how to maintain basic lab etiquettes.	
	PRACTICALS	**Total (60 Hours)**
1.	**Introduction to Lab (Do's and Don't)** a) Good Lab Practices b) Lab Instruments c) Lab waste disposal	
2.	**Microscopy:** a) Light microscopy b) Maintenance c) Applications of microscopy	
3.	**Colorimetry:** a) Calibration	

	b) Set-up of Colorimeter c) Maintenance d) Estimation of protein using Biuret method.	
4.	**pH Meter:** a) Calibration b) Natural pH indicators c) Use of pH papers d) Universal indicators e) Measure of the acidity or alkalinity of a solution	
5.	**Centrifuge** a) Set-up of Centrifuge b) Types of Centrifuges c) Study of Rotors d) Study of centrifugation using suitable sample	
6.	**Cell disruption techniques (Physical and Chemical)** a) Types of cell disruption techniques c) Detection of dehydrogenase enzyme activity b) Localization of starch grains using Pea extract	
7.	**Autoclave, Hot-air Oven and Incubator:** a) Preparation and sterilization of various types of microbial media. b) Streak plate isolation of bacteria c) Other Sterilization methods	
8.	**Preparation of chemicals/solutions** a) Concept of Normality b) Concept of Molarity c) Concept Percent Solution d) Concept of ppm	
9.	**Analytical Balance, Pipettes and Micropipettes** a) Calibration and maintenance. b) Working of Pipettes and Micropipettes	
10.	**Water Distillation** a) Apparatus and Equipment b) Protocol for Water Distillation	
11.	**Laminar Air Flow** a) Types of Laminar Air Flow b) Setting up and Maintaining Laminar Air Flow c) Pour sterile media into test tubes and petri plates	
12.	**Filtration** a) Types of Filtrations b) Filtration Media c) Filtration Equipment d) Study of Filtration using suitable sample	
13	**Constant temperature Water-Bath**	

	a) Set up of Water Bath b) Study the effect of temperature on *Saccharomyces cerevisiae*	
14.	**Rotary Shaker** a) Set up of Rotary Shaker b) Growth of cells	
	Evaluation Scheme: 50 Marks – Will include SEE Practical Exam, Viva, worksheets, continuous assessment, etc.	
References	1. Skoog, D.A., Holler, F.J., Crouch S.R. (2018) "Principles of Instrumental Analysis" *Cengage Learning* 2. Wilson, K. & Walker, J. (2013) "Principles and Techniques of Biochemistry and Molecular Biology" *Cambridge University Press.* 3. Sheehan, D. (2010) "Physical Biochemistry: Principles and Applications" Wiley-Blackwel. 4. Cooper, T.G. (2009) "The Tools of Biochemistry" *Wiley.*	

PRINCIPAL
JAI HIND COLLEGE

JAI HIND COLLEGE 'A' Road Churchgate Mumbai-20. AUTONOMOUS