Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Bioinformatics
(Two year- Four Semester Degree Programme- C.B.C.S.)
(B.Sc. Part I) Semester I

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-I Elementary Mathematics & Statistics		6	-	-	6	3	-	3	3	60 +20	20	-	-	100	40	P
2	AEC- I Biostatistics		-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
3	AEC-I		--	-	-	--	-	-	-	Internal Assessment at College Level/ Institute							P
4	Lab- 1 Practical Based on DSC I		-	-	6	6	-	3	3	*	-	-	25	25	50	20	P
8	# Internship/ Field Work/ Work Experience @	150 hrs. during vacation															
9	**Open elective/ GIC/ Open skill/ MOOC***																
Total			6	1	6	13		3	7	4			50	25	175	70	

Total weekly hours (Equivalent to periods) Should not exceed 30 hours.
L: Lecture, T: Tutorial, P: Practical

Note: Internship/ Field work/ Work Experience will be conducted after I semester till Vth Semester in vacations for minimum 150 hrs. It's credits and grades will be reflected in final semester VI credit grade report.

DSE: The student can select any one of the following discipline specific courses 1. ---------- 2. ---------- 3. ----------.

-OEC (Optional) i.e. GIC/MOOC/Skill course can be studied during semester I to VI, Its credits and grades will be reflected in final semester VI credit grade report.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester I

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC I	**Elementary Mathematics & Statistics**	**03**

Cos :

1. Develop conceptual as well as applied knowledge and skills in the field of Mathematics & Statistics for bioinformatics and data science for sustainable approach in order to solve scientific problems.

UNIT I :	Types of functions, d-neighbourhood of point, Limit of function, Continuity of function, Theorems on Limits and Continuity of functions. Differentiation of function. Its physical significance. Differentiation of Sum, Difference, Product, Ratio of Functions. Derivative of Trigonometric, Exponential, Logarathmic, Inverse trigonometric, Polynomial, Implicit functions. Increasing and Decreasing functions. Maxima and Minima. Derivative as a rate of change.
UNIT II :	Integration of a function , Finding a function from its derivative, Integration of Sum, Difference and Product of two Functions . Integration by substitution. Integration by partial Fractions . Definite integral . Definite integral as limit of sum. Calculating Areas and Volumes of bounded regions.
UNIT III :	Differential equation, its Formation. Its general solution and particular solution. Order and degree of differential equation. First order differential equation. Variable separable method.
UNIT IV:	Representation of data. Discrete data, continues data, Histogram, PolyGram's Frequency curves, Mean, Variability of data- the standard deviation, Median, quartiles, percentile, Skiwness, Box and Whisker diagrams. Regression and Correlation, Scatter diagrams, Regression function, Linear correlation and regression lines, Product moment correlation coefficient.
UNIT V :	Probability : Experimental probability, probability when outcomes are equally likely, subjective probabilities, Probabilities law. Probability rules for combined events, conditional probability and independent events, Probability trees. Bayes theorem.
UNIT VI :	Random Variables and Distributions : Discrete and Continuous Random Variables, Cumulative distribution function, Probability mass function and Probability density function, Expectation of random variables – Experimental Approach and theoretical.

Suggested Reading:

1. Binmore : "Mathematical Analysis", Cambridge University Press.
2. Edward Batschelet : " Introduction to Mathematics for Life Sciences"3rd Edition(1992).
3. Edwards , J:"Differential Calculas for Beginners", MacMilan and Co.ltd (1963).
4. Edwards , J:" Integral Calculas for Beginners ", AITBS Publishers & Distributors(1994).
5. Gorakh Prasad :" Differential Calculas ", Pothishala Pvt Ltd, Allahabad
6. Gorakh Prasad :" Integral Calculas ", Pothishala Pvt Ltd, Allahabad.
7. S.Dobbs and J.Miller, (2002), 'Statistics (Advanced Level Mathematics) : Cambridge.
8. Narayanan, S. and Manicavachaagam Pillai, T.S. (1993) "Calculus, Vol. I and II"; Vishwanathan Printers and Publishers.
9. Veerarajan, T. (2003) "Engineering mathematics"; Third Edition, Tata
10. McGraw Hill Publishing Co. Ltd, New Delhi.
11. Veerarajan, T. (2003) "Trignometry, Algebra and Calculus"; Third Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
12. Sharma, A.K. (2005) "Text Book of Integral Calculus", Discovery Publishing House.
13. Grewal, B.S. (2000) "Higher Engineering Mathematics"; Thirty seventh edition, Khanna Publishers, New Delhi.
14. E. Horowitz and S. Sahani, "Fundamentals of Data structures", Galgotia Booksource Pvt. Ltd., (1999)

15. Ellis Horwitz, Sartaz Sahani and Sanguthevar Rajasekaran, (1999), "Computer Algorithms", Galgotia Publications
16. T .H. Cormen, C. E. Leiserson, R .L. Rivest (2001) "Introduction to Algorithms", 3rd Ed PHI.

Learning Outcome:

By the end of the course students will be able to

1. Understand utility of Mathematics & Statistics in order to perform Bioinformatics.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester I

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
AEC I	**Biostatistics**	**01**

Cos : Student would be able acquire knowledge of Mathematics & Statistics.

Unit I Introduction to Python	Numerical description of data: Tabular, Graphical and Diagrammatic representation of data. Measures of Central tendency and Dispersion. Linear regression, Least square method, Karl Pearson correlation coefficient. Probability Theory: Concept and definitions of Probability, addition and multiplication theorems, conditional probability, independent events, Statement of Bayes' theorem. Random variables: Discrete and continuous random variables, cumulative density function, Probability density and mass functions, Joint, Marginal and Conditional distributions, mathematical expectation Distributions: Binomial, Poisson, Normal distributions (Basic concepts and applications)

Suggested Reading:

1. Ewens, W.J. and Grant, 2001. Statistical Methods in Bioinformatics: An Introduction, Springer-Verlag
2. Devore, J.L. 2002. Probability and Statistics 5th edition, Thomson Asia
3. Miller & Freund 2004 Probability and Statistics for Engineers, 7th Edition, Pearson's Education.
4. Chung, Kai Lai 2003 Elementary Probability Theory with Statistical Processes (Student Edition) Springer International
5. Feller, W. 2007 An Introduction to Probability Theory and its Applications, Wiley Eastern Limited.
6. Larson, H.J. 1982 Introduction to Probability Theory and Statistical Inference, John Wiley & Sons.
7. Goon, A.M., Gupta, M.K. and Dasgupta B. 1998 Fundamental of Statistics – Vol. 1, The World Press Pvt. Ltd.
8. Prasad, G.: Differential Calculus, Pothisala Publication
9. Boas: Mathematical methods in the Physical Sciences, Wiley Publication.
10. Yule, G.U and Kendall, M.G.: An Introduction to the Theory of Statistics, Universal Book Stall (New Delhi).
11. Shanti Narayan, A text book of Vector Calculus, S Chand & company, New Delhi
12. D T Finbeiner, Introduction to Matrices and linear transformations, CBS publishers, Delhi

Learning Outcome:

1. Explain basic principles of Mathematics & Statistics applicable to Bioinformatics.

Syllabus Prescribed for 2022 Year **UG Programme**
Programme: B. Sc. Bioinformatics

Semester I Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
- Practical – I	Practical based on DSC I	06

CO:

1. Adapt basic knowledge on various techniques and areas of Mathematics & Statistics applications in bioinformatics.

Practical-I : Elementary Mathematics and Statistics :-

1. Measures of dispersion- Range, Quartile deviation and mean deviation.
2. Computation of rank correlation coefficient.
3. Simple problems on probability- Law of addition, Law of multiplication.
4. Large sample test.
5. Application of Chi-square distribution.
6. Random Sampling- SRSWOR and SRSWR.
7. Fitting of binomial distribution. 8. Fitting of normal distribution.
8. Problems on Mean and Mode.
9. Problems on order and degree of differential equation.
10. Standard deviation and coefficient of correlation.

Learning Outcome:

Student would be able to apply the laws and equations of Mathematics & Statistics to bioinformatics.

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Bioinformatics
(Two year- Four Semester Degree Programme- C.B.C.S.)
(B.Sc. Part I) Semester II

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-II Computer Fundamentals and Operating Systems		6	-	-	6	3	-	3	3	60 +20	20	-	-	100	40	P
2	AEC- II Programming Language		-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
3	AEC-I		--	-	-	--	-	-	-	Internal Assessment at College Level/ Institute							P
4	Lab- 2 Practical Based on DSC II		-	-	6	6	-	3	3	*	-	-	25	25	50	20	P
8	# Internship/ Field Work/ Work Experience @	150 hrs. during vacation															
9	**Open elective/ GIC/ Open skill/ MOOC***																
Total			6	1	6	13		3	7	4			50	25	175	70	

Total weekly hours (Equivalent to periods) Should not exceed 30 hours.
L: Lecture, T: Tutorial, P: Practical

Note: Internship/ Field work/ Work Experience will be conducted after I semester till Vth Semester in vacations for minimum 150 hrs. It's credits and grades will be reflected in final semester VI credit grade report.

DSE: The student can select any one of the following discipline specific courses 1. ---------- 2. ---------- 3. ----------.

-OEC (Optional) i.e. GIC/MOOC/Skill course can be studied during semester I to VI, Its credits and grades will be reflected in final semester VI credit grade report.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester II

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC II	**Computer Fundamentals and Operating Systems**	**03**

Cos :

1. Develop conceptual as well as applied knowledge and skills in the field of Computer Fundamentals and Operating Systems for bioinformatics.

UNIT I :	Introduction to Computers: Characteristics, classification of computer block Diagram of computer, Memory: Types of memory, RAM, ROM, PROM, EPROM, I/O devices: keyboard, mouse, floppy disk, monitor, compact disk. Printers: Impact, Non-Impact, dot matrix, inkjet, laser Interpreter, compiler, Assembler. Introduction to Number System: Decimal, binary, octal, hexadecimal codes ASCII, EBCDIC.
UNIT II :	Windows: Introduction, features, desktop: Background screensaver, Customizing desktop, creating, moving, deleting Icons. Windows Explorer Copying, renaming, moving, deleting, operations on files and folders. My computer, My documents, control panel : Mouse, printer, date and time. MS-Word: Introduction to word, features, page setup, views, text formatting, Auto correct, spell check, grammer, table, tabs, indentation mail merge, print Preview, printing of document, hyperlink.
UNIT III :	MS- EXCEL: Introduction, features, creating and formatting worksheet, Inserting data, entering mathematical formulas and functions, autofill, Graphs: Type of charts, creating, moving charts, (column, bar, & pie) Introduction to Internet: Types of Internet connection: Direct, dial-up, Protocol : TCP / IP, FTP, HTTP. Domain name, Electronic mail address, word Wide web, search engines, browser: Internet Explorer.
UNIT IV:	Based on Unix operating system: Overview of unix O.S., Unix file system, Data structure for process and memory management, process states and state Transition diagram, process scheduling, memory management, Executing and Terminating program in unix. Unix commands: pwd, cd, ls, mv, ln, cp, mkdir, rm, rmdir, du
UNIT V :	Based on Linux operating system : Design principal, kernel modules, Process management, scheduling, memory management, file system, Inter Process communication, security
UNIT VI :	Networking : Needs and objectives, LAN- Introduction, classification, topology. Topologies – Bus, Tree, Ring, Star, Hybrid, WAN, MAN. Communication Protocols – Purpose, OSI model, Client Server Architecture

Suggested Reading:

1. Computer fundamentals: B. Ram, Nas Age publication.
2. A first course in computer: Sanjay saxena
3. PC Software: Taxali R.K.
4. Fundamentals of computer: V.Rajaraman, PHI Publication.
5. Information Technology: Alexie and Mathews, Vijay Nikole Publication.
6. IT Tool and Application: Alexie and Mathews, Vijay Niklole publication.
7. Operating system by: Achut S. Godbole Tata megrow Hill publication.
8. Operating system concept, sixth edition by silberschutz, Galvin, Gagne Wiley publication. 157 158
9. Computer Fundamentals, Pradeep K. Sinha. BPB Publication.
10. ABC of LAN – Michel Doprtech (BPB)
11. Local Area Network – Keiser - TMH

Learning Outcome:

By the end of the course students will be able to

1. Understand utility of Computer Fundamentals and Operating Systems in order to perform Bioinformatics.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester II

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
AEC II	**Programming Language**	**01**

Cos : Student would be able acquire knowledge of Programming Language.

Unit I Introduction to Programming Language	C, Data Type, Operators and Expressions in C, Control and Repetitive Statements: IF-THEN-ELSE, SWITCH, WHILE, FOR, DO; Break and Continue Statements, Input and Output functions, Function and Program Structure in C, Parameter passing, Pointers, Arrays, Structures, C-Library.

Suggested Reading:

1. Sethi, R., 1996, Programming Languages, Addison-Wesley.
2. Appleby, D. and Vandkopple, J.J., 1991, Programming Languages, Tata McGraw-Hill.
3. Kernighan, B.W. and Ritchie, D.M., 2002 The C Programming Language, Prentice-Hall, India.
4. Gottfried, B.S., 1998 Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill
5. Schildt, H., 1987 C: The Complete Reference, Osborne/ TMH.
6. Tisdall, J.D. 2001 Beginning Perl for Bioinformatics. O'Reilly & Associates.
7. Schwartz R.L. and Phoenix T. 2011 Learning Perl 6th edition, O'Reilly SPD, Mumbai.
8. Siever 2000 Perl in a nutshell O'Reilly SPD, Mumbai
9. Model M.L. 2009 Bioinformatics Programming using Python: Practical Programming for Biological Data, O'Reilly.
10. Kinser J. 2008 Python for Bioinformatics, Series in Biomedical Informatics, Jones & Bartlett.

Learning Outcome:

1. Student would able to understand Programming Language, Operating Systems and its utility for Bioinformatics.

Syllabus Prescribed for 2022 Year **UG Programme**
Programme: B. Sc. Bioinformatics

Semester II Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
- Practical – II	Practical based on DSC II	06

CO:

1. Adapt basic knowledge on Computer Fundamentals and Operating Systems applications in bioinformatics.

Practical-II : Computer Fundamentals and Operating Systems :-

1. Use of Windows operating system (Notepad, WordPad, Calculator, Paint)
2. Use of Linux (basic commands)
3. Creating word file by using paragraphs, alignments
4. Create and print file using mail merge.
5. Working with spread sheet (all operations on cell like merging.)
6. Using function wizard.
7. Calculate regression and correlation use excel.
8. Using different distribution.

9. Creation of presentation.
10. Practicals on Unix basic commands.
11. Practicals based on internet..

Learning Outcome:

Student would be able to apply the Computer Fundamentals and Operating Systems to bioinformatics.

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Bioinformatics
(Two year- Four Semester Degree Programme- C.B.C.S.)
(B.Sc. Part II) Semester III

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-III Fundamentals of Bioinformatics		**6**	**-**	**-**	**6**	**3**	**-**	**3**	**3**	**60 +20**	**20**	**-**	**-**	**100**	**40**	**P**
2	AEC- III Protein Structural Predication		**-**	**1**	**-**	**1**	**1**	**-**	**1**	**1**	**-**	**-**	**25**	**-**	**25**	**10**	**P**
3	AEC-I		**--**	**-**	**-**	**--**	**-**	**-**	**-**	**Internal Assessment at College Level/ Institute**							**P**
4	Lab- 3 Practical Based on DSC III		**-**	**-**	**6**	**6**	**-**	**3**	**3**	*****	**-**	**-**	**25**	**25**	**50**	**20**	**P**
8	# Internship/ Field Work/ Work Experience @	**150 hrs. during vacation**															
9	**Open elective/ GIC/ Open skill/ MOOC***																
Total			**6**	**1**	**6**	**13**		**3**	**7**	**4**			**50**	**25**	**175**	**70**	

Total weekly hours (Equivalent to periods) Should not exceed 30 hours.
L: Lecture, T: Tutorial, P: Practical

Note: Internship/ Field work/ Work Experience will be conducted after I semester till Vth Semester in vacations for minimum 150 hrs. It's credits and grades will be reflected in final semester VI credit grade report.

DSE: The student can select any one of the following discipline specific courses 1. ---------- 2. ---------- 3. ----------.

-OEC (Optional) i.e. GIC/MOOC/Skill course can be studied during semester I to VI, Its credits and grades will be reflected in final semester VI credit grade report.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester III

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC III	**Fundamentals of Bioinformatics**	**03**

Cos :

1. The students will learn about the chemical structures of carbohydrate, and their structural and metabolic role in cellular system

UNIT I :	Water as a biological solvent, Structure of water and polarity, Concept of osmolarity, ionization of water, weak acids and bases, Terminologies like, pH, Buffer solution, Morality, Normality, Normality, equivalent weight and their function in cell.
UNIT II :	Carbohydrates, Definition and classification of carbohydrates, structure, occurrence, and biological importance of Monosaccharide, disaccharides, oligosaccharides, polysaccharides, and Mucopolysaccharides. Proteoglycanns and glycoprotein.
UNIT III :	Lipids and fatty acids, Classification, nomenclature , structures and properties of saturated and unsaturated fatty acid, Simple and Compound lipids, Triglycerides, glycerophospholipids, Glycolipids, Isoprenoids, and Steroids, Biological functions of lipids.
UNIT IV:	Proteins, Introduction, Structure, Basic Building Blocks of Proteins, Protein structure, Primary, Secondary, tertiary and Quaternary structures. Denaturation and renaturation of proteins, Biological function of proteins.
UNIT V :	Enzymes, General characters and properties of enzymes, Nomenculature of enzymes, Holoenzymes, apoenzymes, active sites of enzymes, isoenzymes, Mechanism of enzymes action, factors affecting rate of enzyme catalized reaction, Enzyme kinetics. Km value.
UNIT VI :	Metabolism, Definition, Bioenergetics, ATP, structure and biological role, EMP pathway, TCA cycle, Beta hydrolysis, Lipid Biosynthesis, Protein synthesis.

Suggested Reading:

1. Voet, D.J., Voet, J.G., Pratt, C.W., Principles of Biochemistry, John Wiley, (2008).
2. Berg, J.M., and Tymoczko, J.L., Stryer, L., Biochemistry, W.H. Freeman (2007).
3. Garrett, R.H., Grisham, C.M., Biochemistry, Brooks/Cole, Cengage Learning,(2010.)
4. Conn, E.E., and Stump, F., Outlines of Biochemistry, John Wiley (2006).

Learning Outcome:

By the end of the course students will be able to

1. interpret molecular structure and interactions present in proteins, nucleic acids, carbohydrates and lipids
2. explain organization and working principles of various components present in living cell.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester III

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
AEC III	**Protein Structural Predication**	**01**

Cos : Student would be able acquire knowledge of Protein structure, analysis, and it's interaction.

Unit I Protein structure,	Protein structure, function and bioinformatics: Folding. Structure determination by X-ray crystallography and NMR spectroscopy. Structure modelling and analysis using molecular graphics. Protein-ligand, protein-

function and bioinformatics	DNA and protein-protein interactions. Kinetic and thermodynamic characterization of interactions. Examples for proteins: Enzymes, membrane proteins, structural proteins, regulatory proteins. Structure-function relationships. Introduction to databases for protein sequences, structures and functions and to protein bioinformatics tools and methods.

Suggested Reading:

1. Sethi, R., 1996, Programming Languages, Addison-Wesley.
2. Appleby, D. and Vandkopple, J.J., 1991, Programming Languages, Tata McGraw-Hill.
3. Kernighan, B.W. and Ritchie, D.M., 2002 The C Programming Language, Prentice-Hall, India.
4. Gottfried, B.S., 1998 Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill
5. Schildt, H., 1987 C: The Complete Reference, Osborne/ TMH.
6. Tisdall, J.D. 2001 Beginning Perl for Bioinformatics. O'Reilly & Associates.
7. Schwartz R.L. and Phoenix T. 2011 Learning Perl 6th edition, O'Reilly SPD, Mumbai.
8. Siever 2000 Perl in a nutshell O'Reilly SPD, Mumbai
9. Model M.L. 2009 Bioinformatics Programming using Python: Practical Programming for Biological Data, O'Reilly.
10. Kinser J. 2008 Python for Bioinformatics, Series in Biomedical Informatics, Jones & Bartlett.

Learning Outcome:

On completion of the course, the student should be able to:

1. comprehend the importance of chemical foundation in living organisms.
2. analyze the various types of weak interactions between the biomolecules and water.
3. correlate how the large biomolecules such as proteins, carbohydrates, lipids, nucleic acids are made from the simple precursors.

Syllabus Prescribed for 2022 Year **UG Programme**
Programme: B. Sc. Bioinformatics

Semester III Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
- Practical – III	Practical based on DSC III	06

CO:

To impart knowledge of methods and techniques for biomolecules separation and purification.

Practical-III :

Section I: Qualitative test and Biochemical Preparations

1. Qualitative analysis of Carbohydrates

2. Qualitative tests for proteins, lipids and aminoacis

3. Preparation of buffers of different pH.

4. Measurenet of pH of given sample by universal indicator solutions, ph strip and Ph meter.

Section II: Quantitative analysis

1. Paper chromatography of amino acids.

2. Paper chromatography of Sugars .

3. TLC

4. Estimation of glucose by Benedict's method

5. Estimation of glycine

6. Saponification value of oils.

7. Estimation of proteins by Biurate method.

Suggested Readings:

1. Wilson, E., Walker, J., Practical Biochemistry-Principles and techniques, Cambridge University press (2010).
2. Boyer, R.F., Modern Experimental Biochemistry. Nenjamin/Cummings publishing company Inc. Redwoodcity, California (2012).
3. Scopes, R.K., Protein Purification Principles and Practice, Narosa Pub. House (1994).
4. Cantor C.R., Schimmel P.R. Biophysical Chemistry, W. A. Fremman and Company (1980).

Learning Outcome:

1. quantify various biomolecules
2. characterize some physical properties of various biomolecules
3. determine the effect of temperature and pH on protein structure.

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Bioinformatics
(Two year- Four Semester Degree Programme- C.B.C.S.)
(B.Sc. Part II) Semester IV

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-IV Fundamentals of Molecular Biology and immune System		6	-	-	6	3	-	3	3	60 +20	20	-	-	100	40	P
2	AEC- IV Immunology		-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
3	AEC-I		--	-	-	--	-	-	-	Internal Assessment at College Level/ Institute							P
4	Lab- 4 Practical Based on DSC IV		-	-	6	6	-	3	3	*	-	-	25	25	50	20	P
8	# Internship/ Field Work/ Work Experience @	150 hrs. during vacation															
9	**Open elective/ GIC/ Open skill/ MOOC***	**OEC I**															
Total			6	1	6	13		3	7	4			50	25	175	70	

Total weekly hours (Equivalent to periods) Should not exceed 30 hours.
L: Lecture, T: Tutorial, P: Practical

Note: Internship/ Field work/ Work Experience will be conducted after I semester till Vth Semester in vacations for minimum 150 hrs. It's credits and grades will be reflected in final semester VI credit grade report.

DSE: The student can select any one of the following discipline specific courses 1. ---------- 2. ---------- 3. ----------.

-OEC (Optional) i.e. GIC/MOOC/Skill course can be studied during semester I to VI, Its credits and grades will be reflected in final semester VI credit grade report.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester IV

Code of the Course Subject **Title of the Couse/ Subject** **No. of periods/ week**

DSC IV **Fundamentals of Molecular Biology and immune System** **03**

Cos :

1. The students will learn about the immune system including organs, cells and receptors.

UNIT I :	Unit I : Structure of DNA, forms of DNA-A,B,C,D and Z DNA. Secondary structure of RNA, Replication in prokaryotes and Eukaryotes. Structural organization of Eukaryotic and Prokaryotic genomes. Organelle genome organization and Transposable genetic elements.
UNIT II :	Fundamentals of Structural, Comparative and Functional Genomics and its applications. Genome sequencing methods. Introduction to Genome analysis. Structural organization of Eukaryotic and Prokaryotic genes. Regulation of gene expression in Eukaryotes and Prokaryotes.
UNIT III :	Process of Translation in Eukaryotes and Prokaryotes: Translational factors, Initiation, Elongation and Termination. Regulation of translation in Eukaryotes and Prokaryotes. Structure of Eukaryotic and Prokaryotic Ribosomes.
UNIT IV:	Organs and cells of immune System and their function. Various types of Antibodies, their structure and function. Antigen Antibody Reaction. Antigen, Hapten.
UNIT V :	Humoral and Cell mediated immunity, MHC and immunity to infectious dieses, Vaccins, Lymphocytes trafficking, Tlymphocytes, B-lymphocytes, Macrophages, Dendritic cells, natural killers, Lymphokines, Activated killer cells, Eosinophiles, Nuetrophiles and mast Cells.
UNIT VI :	Molecular Basis of immunity: Theories of AntigenAntibody reactions. T Lymphatic and B Lymphatic responses. Different Classes of immunoglobulins and their differentiation. Interferons and Interleukins and its applications.

Suggested Reading:

1. J De Robertis, EDP and De Robertis EMF. (2006) Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th
3. Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
5. Nelson D. L. and Cox M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company
6. Voet, D. and Voet J.G. (2004) Biochemistry 3rd edition, John Wiley and Son
7. Sharma, V. K. (1991) Techniques in microscopy and cell biology. Tata McGraw Hill
8. Reimer, L. and Kohl, H. (2008) Transmission electron microscopy. Springer. udy Owen, Jenni Punt, Sharon Stranford 2013
9. Abbas AK, 2011, Cellular and Molecular Immunology 7th Ed. Elsevier Health Sciences – India.
10. Delves P, Martin S, Burton D, Roitt IM 2011 Roitt's Essential Immunology. 12th Ed. Wiley- Blackwell Scientific Publication, Oxford.
11. Murphy K, 2011 Janeway's Immunobiology. 8th Ed. Garland Science Publishers, New York.
12. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
13. Richard Coico, Geoffrey Sunshine 2008 Immunology: A Short Course, 6th Edition Wiley- Blackwell
14. Sudha Gangal 2013 Textbook of Basic and Clinical Immunology Orient Blackswan Private Limited - New Delhi

Learning Outcome:

1. This course gives an overview on the immune system including organs, cells and receptors

2. The students learns about molecular basis of antigen recognition, hypersensitivity reaction, antigen-antibody reactions
3. The course develops in the student an appreciation for principles of immunology and its applications in treating human diseases.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
AEC IV	**Immunity**	**01**

Cos : Student would be able to understand antigen and describe how antigens affect the adaptive defenses.

Unit I Immunology	Immunity to pathogens, How pathogens avoid immunity, AIDS and immunity, Cancer and Immunity. Autoimmune diseases.

Suggested Reading:

1. Roilt, I. Essential immunology. 9th Edition. USA. Blackwell Science Ltd. 1997. 114
2. Lydyard, P., Whelan, Al and Fasger, MlW. Instant notes in immunology. 2nd Edition. USA. Garland Science/ BIOS Scientific Publishers Ltd.2004.

Learning Outcome:

On completion of the course, the student should be able to:

1. Acquired knowledge and understanding of the immunological concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester IV

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
OEC I	**Protein Structural Predication**	**03**

Cos : The student would be gain knowledge about immunological against infections; humoral and cell mediated immunity; autoimmunity mechanisms and damage; immunodiagnostic tests and assays; Vaccines- preparations and use.

Unit I MOLECULAR BASIS	Microbial pathogens – Bacterial, Viral and Fungal Pathogens and Parasitic diseases. Immune response vs infection. Immunity against bacterial infections – Innate and Acquired Immune responses – cellular involvement – Macrophages, Neutrophils, NK cells, Defensins, Humoral and Cell mediated Immune responses, Intracellular infections.
Unit II INFECTION AND IMMUNITY	Immunity against bacterial and viral infections – Innate and Acquired immune responses – Effector mechanisms of HI and CMI – cytokine involvement. Immunodeficiency. Immunity to fungal and parasitic infections – overview of Humoral and Cell mediated immune responses against the pathogens. Immunomodulation in infections
Unit III CLINICAL IMMUNOLOGY	Clinical Immunology - Disease caused by immune response – hypersensitivity, immune tolerance and autoimmunity, mechanism of autoimmunity, therapy for immunological diseases - Immune complex disease, immunosuppression and immunomodulation.
Unit IV	Diagnostic Immunology - Methods based on precipitation; ODD, CIE, IEP, immunofixation and immunoblotting, RIA, RE,

IMMUNODIAGNOSIS	Immunonephlometry. Methods based on Agglutination - agglutination of whole cells, agglutination of inert particles coated with Ag/Ab. Haemagglutination – Direct, indirect, passive; CFT, labelled assays – ELISA, RIA, FISH, IFTin vivo reactions- skin tests, immune complex demonstration. Diagnostic evaluation of lymphocytic haemagglutination inhibition, lymphocytic function and CMI, phagocytosis.
Unit V VACCINES	Introduction to Vaccines and Adjuvants - Types of vaccines – Whole cell - Killed and Live Attenuated vaccines. Sub–unit vaccines – polysaccharides, proteins, Toxoids. Recombinant vector vaccines, DNA vaccines, Development of vaccines and antibodies in plants.
Unit V VACCINES	Vaccines against AIDS and Tropical Infectious Diseases – Leprosy, malaria and TB. Vaccines for control of fertility , Anti – HCG Vaccines and Anti – sperm antigen vaccine. Immunization – Active and Passive. Therapy for immunological diseases. Immune therapy for cancer. Strategies of vaccine production. Gene silencing.

Suggested Reading:

1. Talwar GP, Rao KVS and Chauhan VS, Recombinant and Synthetic Vaccines; Narosa, New Delhi. 1994.
2. Benjamini E, Coico R and Sunskise G,;Immunology – A short course, Wiley – Liss Publication, NY. Ed.4; 2000.
3. Kuby J, Immunology, WH Freeman and Co. NY. Ed.4; 1997.
4. Clark WR, The Experimental Foundations of Modern Immunology; John Wiley and Sons Inc. New York. 1991.
5. Leslie Hudson and Frank C. Hay., Practical Immunology. Wiley. Ed.3; 1989.
6. Noel R. Rose, Herman Friedman, John L. Fahey., Manual of Clinical Laboratory Immunology. ASM. Ed.3; 1986.

Learning Outcome:

At the end of the course, learners will be able to:

1. Learn the molecular basis of microbial pathogens.
2. Understand the Innate and Acquired immune responses against microbial pathogens
3. Learn various disease caused by immune response.
4. Learn immune diagnostic tests and assays against pathogens.
5. Understand the vaccines preparations and its clinical uses.

Syllabus Prescribed for 2022 Year **UG Programme**
Programme: B. Sc. Bioinformatics

Semester III Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
- Practical – IV	Practical based on DSC IV	06

CO:

The candidate will gain hands-on knowledge and acquire adequate skill required to perform molecular Biology and Immunology.

Practical-IV:

Section I : Molecular Biology

1. Isolation of plant DNA by CETAB Method.
2. Isolation of organism DNA by Modified CETAB method.
3. Isolation of Chloroplast.
4. Isolation of Mitochondria.
5. Amplification of DNA by RAPD method.
6. Introduction to Instrumentations: Laminar Air Flow, PCR, Gel Documentation System, Hi-speed centrifuges, Bench top Centrifuges, UV-Spectrophotometer.

7. Separation of Proteins by using SDS-PAGE.
8. Preparation of different percent of Agarose Gel.
9. Isolation of RNA.
10. Quantification of RNA and DNA by UV-Spectrophotometer.

Section II: Quantitative analysis

1. ELISA- test
2. Test for Salmonella strain by using Widal Kit.
3. VDRL- test.
4. Identification of Blood Groups.
5. Identification of RH factor.
6. To perform Antibiotic sensitivity test by Multiple disc method.

Suggested Readings:

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt . Roitt's Essential Immunology (Essentials). Willy Blackwell publication.
2. Frank C. Hay and Westwood MR. Practice Immunology John Wiley and Sons Ltd. 4th Edition. ISBN: 9780865429611, 9780865429611

Learning Outcome:

At the end of the course, learners will be able to:

1. Antigen-antibody interactions demonstrated in gels and to visualize the bands
2. Isolating of genomic DNA

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Bioinformatics
(Two year- Four Semester Degree Programme- C.B.C.S.)
(B.Sc. Part III) Semester V

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-V Methods in Bioinformatics		6	-	-	6	3	-	3	3	60 +20	20	-	-	100	40	P
2	AEC- V DNA Microarray		-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
3	AEC-I		--	-	-	--	-	-	-	Internal Assessment at College Level/ Institute							P
4	Lab- 5 Practical Based on DSC V		-	-	6	6	-	3	3	*	-	-	25	25	50	20	P
8	# Internship/ Field Work/ Work Experience @	150 hrs. during vacation															
9	**Open elective/ GIC/ Open skill/ MOOC***	**OEC II**															
Total			6	1	6	13		3	7	4			50	25	175	70	

Total weekly hours (Equivalent to periods) Should not exceed 30 hours.
L: Lecture, T: Tutorial, P: Practical

Note: Internship/ Field work/ Work Experience will be conducted after I semester till Vth Semester in vacations for minimum 150 hrs. It's credits and grades will be reflected in final semester VI credit grade report.

DSE: The student can select any one of the following discipline specific courses 1. ---------- 2. ---------- 3. ----------.

-OEC (Optional) i.e. GIC/MOOC/Skill course can be studied during semester I to VI, Its credits and grades will be reflected in final semester VI credit grade report.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester V

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC V	**Methods in Bioinformatics**	**03**

Cos :

1. To use & develop tools to curate (compare &analyze) biological data.
2. To utilized skill of databases for bioinformatics.

UNIT I :	UNIT-I : Introduction to Database : Importance of Database, Types of Database, Data Models, Data Abstraction, Test Databases. Database Design (DBMS & RDBMS), Data Security, Data Warehousing, capture and Analysis, Data Management and Architecture. Microarray Database, Enzyme Database, Biodiversity Database.
UNIT II :	Biology and Computer Science : Structural Organization of genome. In silico analysis of primary structures of nucleic acid sequences. Representing sequence Data , a program to store a DNA sequence, DNA Fragments, Transcription : DNA to RNA Nucleic Acid Sequence databanks : GenBank, Genomic Databases. Repositories : EST and STS, Limitation of Computation Analysis.
UNIT III :	Mutations, Randomization and genetic code : Random number generators. A program using randomization. A program to simulate DNA mutation generating random DNA analyzing DNA. The genetic code. Hashes data structures and algorithms for biology. Translating DNA into proteins. Reading DNA from files in FASTA format reading frames. Database Similarity Searches : BLAST, FASTA, PSI-BLAST, BLAST-2
UNIT IV:	Restriction Maps and Regular Expression : Regular expression restriction maps and restriction enzymes Perl operations GenBank, GenBank files, GenBank libraries, separating sequence and annotation, parsing annotations indexing GenBank with DBM. Biological Databanks : Introduction to Biological databanks, Protein Sequence databanks : PDB, SRS, SWISSPROT
UNIT V :	Protein Data Bank : The Organization of proteins. In silico analysis of primary structures of proteins, Protein Tertiary structure prediction methods: Homology modeling, fold recognition, Abintio Method. Comparison between and tertiary structure. Files and Folders PDB files parsing PDB files controlling other programs.
UNIT VI :	HMM (Hidden Marcov Model) : Introduction to HMM, its application in sequence alignment and structure prediction, based Softwares (HMMER and HMMSTR) obtaining BLAST String Matching and Homology, BLAST output files, parsing BLAST output presenting data bioperl.

Suggested Reading:

1. D.W. Mount Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark &Josaph: BLAST, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
4. A.D. Baxevanis& B.F.F. OuletteBioinformatics – A practical guide to the Analysis of Genes and Proteins,2002, Willey International publishers.
5. M.J. Bishop and C.J. Rawlings (editors), DNA and Protein Sequence Analysis---A Practical Approach IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
6. 6. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York
7. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
8. Richard Coico, Geoffrey Sunshine 2008 Immunology: A Short Course, 6th Edition Wiley- Blackwell
9. Sudha Gangal 2013 Textbook of Basic and Clinical Immunology Orient Blackswan Private Limited - New Delhi

10. J. Setubal and J. Meidanis(1997) Introduction to Computational Molecular Biology, PWS Publishing Co.
11. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Learning Outcome:

1. To gain knowledge about various Biological databases that provide information about nucleic acids and protein.
2. Introduction to Biological databases and database systems.
3. Overview about types and Biological data and database search tools.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester V

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
AEC V	**DNA Microarray**	**01**

Cos : Student would be able to understand DNA MicroArray.

Unit I DNA Microarray	DNA Microarray and its importance, Designing a MicroArray Experiment-The Basic steps, Types of MicroArray. NCBI and MicroArray Data Management, GEO (Gene Expression Omnibus), MAML, The benefits of GEO and MAML, The Promise of MicroArray Technology in Treating Disease.MicroArray Data Preprocessing, Data normalization, Measuring Dissimilarity of Expression Pattern-Distance Motifs and Dissimilarity measures, Visualizing MicroArray Data. Principal Component Analysis,MicroArray Data. NCBI and MicroArray Data Management, GEO (Gene Expression Omnibus), MAML, The benefits of GEO and MAML, The Promise of MicroArray Technology in Treating Diseases. Data Mining for specific applications.

Suggested Reading:

1. Raghurama Krishnan, Johannes Gehrke , Database Management Systems, 3rd edition, Tata McGraw Hill, New Delhi,India.
2. Elmasri Navate, Fundamentals of Database Systems, Pearson Education,India.

Learning Outcome:

On completion of the course, the student should be able to:

1. Acquired knowledge and understanding of the DNA MicroArray concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester V

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
OEC II	**Structural Bioinformatics**	**03**

Cos: The course gives an idea about the aspect of computation in structural biology and how to use these computations in solving problems and understanding structure.

Unit I	Introduction: Motivation, Central dogma of life, Type of bioinformatics databases, Nucleotide sequence databases: EMBL, GeneBank, DDBJ
Unit II Proteins	Protein amino acid sequence databases, How protein sequences are determined, DNA/mRNA coding, Edman degradation reaction, Mass spectrometry, SwissProt/TrEMBL, PIR, UniProt, UniProtKB/Swiss-Prot and UniProtKB/TrEMBL.

Unit III Protein structure databases	History of structural biology, Protein Data Bank, SCOP, CATH
Unit IV Protein function databases	Pfam: Protein family database, GO: Gene ontology, PROSITE: Protein function pattern and profile, NZYME: Enzyme commission, BioLiP: Ligand-protein binding interactions.
Unit V Pair-Wise Sequence Alignments	Pair-Wise Sequence Alignments and Database Search, Biological motivation, Scoring matrix, PAM, BLOSUM, Gap penalty, Dynamics programming.
Unit VI	Needleman-Wunsch: Global alignment algorithm, Smith-Waterman: Local alignment algorithm, Gotoh algorithm, Heuristic methods, FASTA, BLAST, Statistics of sequence alignment scores, E-Value, P-Value.
Suggested Reading: 1. Structural bioinformatics, Philip E Bourne, Helge Weisssig **2.** Protein Bioinformatics : An Algorithmic Approach to Sequence and Structure Analysis by Ingvar Eidhammer, et al;	
Learning Outcome: At the end of the course, learners will be able to: 1. explain the relationship between protein sequence and protein structure 2. describe how structure translates into function within different biological fields such as catalysis, transport and regulation	

Syllabus Prescribed for 2022 Year **UG Programme**
Programme: B. Sc. Bioinformatics

Semester V Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
- Practical – V	Practical based on DSC V	06

CO:

The candidate will gain hands-on knowledge and acquire adequate skill required to bioinformatics practices by using database systems.

Practical-IV:

Practical's :

1. Downoading primary structure of nucleic acids and proteins.
2. Protein Sequence comparison and analysis
3. Properties of primary structure of proteins using online tools.
4. In silico analysis of nucleic acids and proteins tools.
5. Installing perl and command lines arguments.
6. Access to Gene and Protein data bank.
7. Prediction of secondary structure of proteins.
8. Visulazation of tertiar structure of proteins in Rasmol or Cn3d.
9. Accessing existing databases on www.
10. Homology search tools like BLAST.
11. Database Searches : NCBI, DDBI, EMBL, Uniprot.
12. Parremire sequence alignment – BLAST.
13. Downloading and installing software/plugs in windowsSuggested Readings:
14. Spreadsheet Applications : (Database Management Sorting Records, finding, adding, deleting.)

Suggested Readings:

1. Myers E.W. (1997), Computational Methods in genomic research Plenum Press, New York.
2. NCBI : National Centre for Biotechnology Information (1993), Manual for NCBI software development tool kit version, 1.8. National Library of medicine, National Institute of Health, Washington.
3. Bioinformatics: Databases and Systems, by Stanley I. Letovsky

4. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC Mathematical Biology & Medicine), by SorinDraghici

Learning Outcome:

At the end of the course, learners will be able to

1. Compare sequences,
2. Identify features, structures and mutations to reveal evolutionary relations

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Bioinformatics
(Two year- Four Semester Degree Programme- C.B.C.S.)
(B.Sc. Part III) Semester VI

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-VI Advanced Bio-computing		6	-	-	6	3	-	3	3	60 +20	20	-	-	100	40	P
2	AEC- VI Introduction to Linux		-	1	-	1	1	-	1	1	-	-	25	-	25	10	P
3	AEC-I		--	-	-	--	-	-	-	Internal Assessment at College Level/ Institute							P
4	Lab- 6 Practical Based on DSC VI		-	-	6	6	-	3	3	*	-	-	25	25	50	20	P
8	# Internship/ Field Work/ Work Experience @	150 hrs. during vacation															
9	**Open elective/ GIC/ Open skill/ MOOC***																
Total			6	1	6	13		3	7	4			50	25	175	70	

Total weekly hours (Equivalent to periods) Should not exceed 30 hours.
L: Lecture, T: Tutorial, P: Practical

Note: Internship/ Field work/ Work Experience will be conducted after I semester till Vth Semester in vacations for minimum 150 hrs. It's credits and grades will be reflected in final semester VI credit grade report.

DSE: The student can select any one of the following discipline specific courses 1. ---------- 2. ---------- 3. ----------.

-OEC (Optional) i.e. GIC/MOOC/Skill course can be studied during semester I to VI, Its credits and grades will be reflected in final semester VI credit grade report.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester VI

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC VI	**Advanced Bio-computing**	**03**

Cos :

1. The students will learn about the Programing for bioinformatics.

UNIT I :	Object Oriented Programming using C++ : Introduction to OOPS, features, structure, data types and user defined database, Constants, variables, operators, control statements, creating and writing functions, inline functions and function overloading.
UNIT II :	Classes & Objects : Data abstraction, encapsulation, data hiding, defining class, member functions and data members, creating objects, accessing class members, constructors, destructors, array of objects, pointer to objects, operator overloading, inheritance and its types.
UNIT III :	RDBMS ORACLE 9i : Architecture, Database models : Relational, Hierarchical, Networks; data dictionary, DMI operations, Domains and attribuetes, normalization process, Normal forms : 1NF, 2NF, 3NF, 4NF, BCNF. SQL : Components of SQL, data types and operators. DDL Commands : CREATE, ALTER, DROP, for tables and views. DML Commands : SELECT, INSERT, DELETE, UPDATE, BREAK & COMPUTE.
UNIT IV:	Functions Number, Character, Concatenating functions, joins, unions, data integrity and constraints. PL/SQL : Features, Block structures, variables, constants, data types, control structures, cursor, concept, type, opening, declaring, classify and censor attributes. Transactions : Rollback, commit, save point, Rollback segment.
UNIT V :	Features of SQL form of SQL report : Users, Roles and Privileges : Concept, creating users, system and object previlage, GRANT privilege, REVOKE privilege, passing on privileges, creating roles.
UNIT VI :	Perl and Programming :- Low and long learning curve. Perl's benefits. Installing Perl on computer. Perl program peration text editors. Finding help. Individual approaches to programming Edit-RunRevise (and Save) An environment of programs, programming strategies. The programming process using the Perl. documentation calculating the reverse complement in Perl Proteins, files and arrays reading proteins in files arrays scalar and list context. Subroutines scoping and subroutines command-line arguments and arrays. Passing data to subroutines modules and libraries of subroutines fixing bugs in code.

Suggested Reading:

1. Object Oriented Programming with C++ : E.Balaguruswamy
2. Programming with C++ : R.S. Nisar Ali
3. Mastering C++ : Venugopalan.
4. C++ Programming : Ravi Chandran
5. Understanding Oracle : Perry and Latic – BPB
6. Essentials of oracle 8 : TOM Lewis.
7. An Introduction of Data Base Systems : C.J.Date – Narosa
8. Programming with C++ : Robert Lafore
9. Oracle Press Introduction to oracle (TMH)
10. Oracle Unleashed (Sams)

Learning Outcome:

1. Demonstrate comprehensive knowledge of Programing.
2. Apply Computational modelling of proteins, nucleic acids.

Part B

Syllabus Prescribed for 2022 Year **UG. Programme**

Programme **B.Sc. Bioinformatics**

Semester VI

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
AEC VI	**Introduction to Linux**	**01**

Cos : Student would be able to understand Linux for Bioinformatics.

Unit I Introduction to Linux	History and design, Principles of Linux, Functions of Linux OS, Basic shell commands, Understanding Linux file permissions, Basic script building, File creation in Linux

Suggested Reading:

1. Sethi, R., 1996, Programming Languages, Addison-Wesley.
2. Appleby, D. and Vandkopple, J.J., 1991, Programming Languages, Tata McGraw-Hill.
3. Kernighan, B.W. and Ritchie, D.M., 2002 The C Programming Language, Prentice-Hall, India.
4. Gottfried, B.S., 1998 Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill
5. Schildt, H., 1987 C: The Complete Reference, Osborne/ TMH.
6. Tisdall, J.D. 2001 Beginning Perl for Bioinformatics. O'Reilly & Associates.
7. Schwartz R.L. and Phoenix T. 2011 Learning Perl 6th edition, O'Reilly SPD, Mumbai.
8. Siever 2000 Perl in a nutshell O'Reilly SPD, Mumbai.

Learning Outcome:

On completion of the course, the student should be able to:

1. Acquired knowledge and understanding of the Linux.

Syllabus Prescribed for 2022 Year **UG Programme**
Programme: B. Sc. Bioinformatics

Semester III Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
- Practical – VI	Practical based on DSC VI	06

CO:

The candidate will gain hands-on knowledge and acquire adequate skill required to perform Bio-computing.

Practical-IV:

Practicals :-

Minimum 18 experiments based on theory paper Advanced Bio-computing covering all aspect of syllabus.

Suggested Readings:

1. Object Oriented Programming with C++ : E.Balaguruswamy
2. Programming with C++ : R.S. Nisar Ali
3. Mastering C++ : Venugopalan

Learning Outcome:

At the end of the course, learners will be able to:

1. Learn C++, Oracle and Perl programming.