

# Central University of Himachal Pradesh

Centre for Bioinformatics and Computational Biology

School of Life Sciences

Minutes of the meeting



## **THIRD BOARD OF STUDIES MEETING**

TO BE HELD ON January 22<sup>nd</sup>, 2016 at 12:30PM

Venue: Committee Room, Temporary Academic Block,  
CENTRAL UNIVERSITY OF HIMACHAL PRADESH,  
Shahpur, District Kangra(HP)

*Suraj Mehla*  
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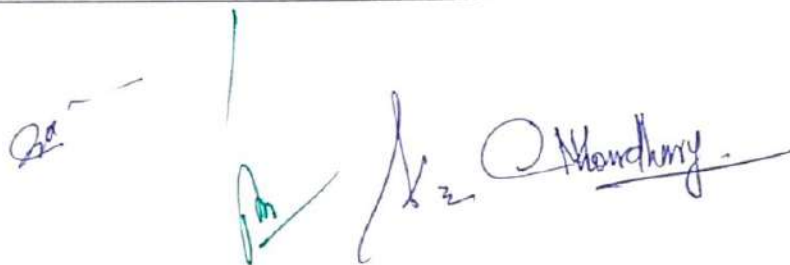
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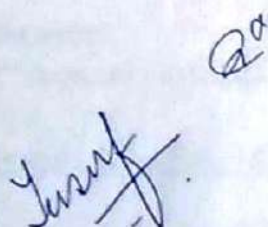
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## AGENDA-INDEX

Item No.	PARTICULARS	Information
JB-BOS-3/14-1	Review of Course Catalogue and addition of New Courses for the M.Sc. Bioinformatics and Computational Biology and Research Degree Program	Annexure -I
CBB -BOS-3/14-2	Approval of supervisor and co- supervisor	
CBB-BOS-3/14-3	Approval of List of Experts as Examiners and Supervisors for Research degree programme	Annexure - II
CBB-BOS-3/14-4	To approve Dr. Yusuf Akhter, Assistant Professor, CBB, SoLS, as Co-supervisor in Dept of Botany, AMU	Annexure -III
CBB-BOS-3/14-5	To review the suggestion from 2 <sup>st</sup> School Board meeting	
CBB-BOS-3/14-6	Reporting of Research Program Monitoring Committee Meetings	
CBB-BOS-3/14-7	Any item with the permission of the Chair	





Please find below the minutes against each Agenda items. The second Board of Studies Meeting of Centre for Bioinformatics and Computational Biology, School of Life Sciences, Central University of Himachal Pradesh (CUHP) Central University of Himachal Pradesh (CUHP) to be held on 22<sup>nd</sup> January, 2016 at 12:30 AM in Committee Room at Temporary Academic Block (TAB), CUHP, Shahpur are as given under:

**Agenda Item No. – CBB-BOS-3/14-1**

**Review of Course Catalogue and Insertion of New Courses for the M.Sc. Life Sciences and Research Degree Program**

In accordance with the draft ordinances number 4, Section 23 and Statute 16(2) of the Central Universities Act 2009, point number 4(a), the Director of the Centre for Bioinformatics and Computational Biology places before the members of the board for their approval of the additional courses that are to be included in CDC of the masters and research programs. The list of courses, respective course code, credits and level is attached as Annexure I.

**Decision:**

All members agreed and approved it.

**Agenda Item No. – CBB-BOS-3/14-2**

**To approve the appointment of Supervisors/Co-supervisors to guide research scholars admitted to the Ph D programme**

The School of Life Sciences runs PhD programme in accordance with UGC guidelines. Proposed list of supervisors for PhD students is given as under:

Sr. No.	Name of the Student	Roll No.	Name of the Supervisor
1.	Ankita Sharma	CUHP14RDCBB02	Dr. Shailender K. Verma
2.	Neha Choudhary	CUHP14RDCBB04	Dr. Vikram Singh
3.	Dixit Sharma	CUHP15RDCBB01	Dr. Shailender K. Verma
4.	Reenu Chaudhary	CUHP15RDCBB02	Dr. Shailender K. Verma
5.	Sanjay Kumar	CUHP15RDCBB03	Dr. P. Aparoy
6.	Satish Kumar	CUHP15RDCBB04	Dr. Vikram Singh
7.	Shakir Mushtaq Shah	CUHP15RDCBB05	Dr. Yusuf Akhter
8.	Vikram Singh	CUHP15RDCBB06	Dr. Vikram Singh

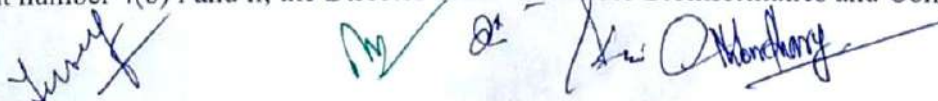
**Decision:**

All members agreed and approved it.

**Agenda Item No. – CBB-BOS-3/14-3**

**Approval of List of Experts as Examiners**

In accordance with the draft ordinances number 4(i), Section 23 and Statute 16(2) of the Central Universities Act 2009, point number 4(b) i and ii, the Director of the Centre for Bioinformatics and Computational Biology places



before the members of the board for their approval, the list of examiners for various evaluation purposes and supervisors for research. The list of examiners is attached as Annexure II.

**Decision:**

All members agreed and approved it.

**Agenda Item No. – CBB-BOS-3/14-4**

The Board of Studies (BOS), Department of Botany, Aligarh Muslim University, in its meeting held on 22<sup>nd</sup> November, 2014, has appointed Dr. Yusuf Akhter, Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences, CUHP as Co-Supervisor of Mr. Razak Hussain registered for his Ph.D. degree under the supervision of Prof. Tabreiz Ahmed Khan in the said Department at AMU (**Annexure- III**). He will complete part of his research work in CUHP. The matter is reported for approval.

**Decision:**

All members agreed and approved it.

**Agenda Item No. – CBB-BOS-3/14-5**

To review the suggestion from 2<sup>nd</sup> School Board meeting.

**Decision:**

All members agreed and approved it.

**Agenda Item No. – CBB-BOS-3/14-6**

Reporting of Research Program Monitoring Committee Meetings held after the 2<sup>nd</sup> BOS meeting.


**Agenda Item No. – CBB-BOS-3/14-7**


**Any item with the permission of the Chair**


**Following suggestions have been made by the Subject Experts**

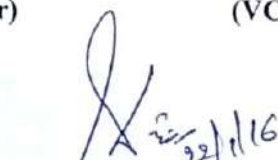
- It was proposed to make a joint committee of Faculty Members/RD Students/M.Sc. Students to suggest courses which are focused on the syllabi of NET or equivalent exams and Industry Oriented jobs.
- It was also suggested that course content and question papers should be circulated with the agenda of next BOS meetings for further suggestions and rectifications to the BOS members.

**All the Agenda items are approved by the BOS.**

  
Dr. Yusuf Akhter  
(Member)

  
Dr. Mushtaq Ahmed  
(VC's Nominee)

  
Prof. Sukesh C. Sharma  
(Subject Expert)

  
Prof. Duni Ram  
(Subject Expert)

  
Prof. Ambrish Kumar Mahajan,  
(Chairman and Convener)

**List of Examiners for the Centre for Computational Biology and Bioinformatics, School of Life Sciences, Central University of Himachal Pradesh**

Sl. No.	Name	Address	Email
1.	Prof. Manju Bansal	Molecular Biophysics Unit, Indian Institute of Science, Bangalore 560 012, India	mb@mbu.iisc.ernet.in
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3.	Prof. Somdatta Sinha	Centre for Cellular & Molecular Biology, Habsiguda, Uppal Road, Hyderabad - 500 007, Andhra Pradesh, India	sinha@ccmb.res.in
4.	Prof. B. Jayaram	Department of Chemistry, Coordinator, School of Biological Sciences & Coordinator, Supercomputing Facility for Bioinformatics and Computational Biology IIT Delhi	bjayaram@chemistry.iitd.ac.in
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*12/21/2016*



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*Sundip*

12/22/2016

*Dr. Akif*

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101.	Dr. Sachchidanand	Associate Professor, Pharmacoinformatics, National Institute of Pharmaceutical Education & Research, (NIPER), Hajipur-844 102, Bihar, India.	sachchi@gmail.com
102.	Dr. Pradeep Das	Director, National Institute of Pharmaceutical Education & Research, (NIPER), Hajipur-844 102, Bihar, India.	dasp@cal2.vsnl.net.in ; rmrims@icmr.org.in
103.	Dr. Mohammad Husain	Associate Professor and Head, Department of Biotechnology, Jamia Millia Islamia, Jamia Nagar, New Delhi	mhusain2@jmi.ac.in, superm12@gmail.com
104.	Prof. Sunil K. Khare	Department of Chemistry, MS-721, Multi-storey building, 6th Floor, IIT Delhi, Tel: +91 11 2659 6533 Fax: +91 11 2658 1102	skkhare@chemistry.iitd.ac.in
105.	Prof. Javed N. Agrewala	Chief Scientist & Professor-AcSIR, Institute of Microbial Technology (Council of Scientific & Industrial Research), Sector 39A, Chandigarh-160036, INDIA. Email: Tel: ++91-172-6665261 (O), 6665262 (Lab), Fax: ++91-172-2690632, 2690585, 2690132, 2690056.	javed@imtech.res.in, javed@scientist.com,
106.	Prof. S. Krishnaswamy	Centre of Excellence in Bioinformatics School of Biotechnology, Madurai Kamaraj University Madurai 625 021	mkukrishna@rediffmail.com mkukrishna@gmail.com
107.	Dr. P. Gautam	Centre for Biotechnology, Anna University, Sardar patel Road, Chennai - 600025 India	pgautam@annauniv.edu
108.	Dr. Sudip Kundu	Associate Professor; Department of Biophysics, Molecular Biology and Bioinformatics; University of Calcutta	skundu@caluniv.ac.in
109.	Prof. Manoj K. Dhar	Professor and Head, Department of Biotechnology University of Jammu	manojdhar@jammuuniversity.in
110.	Prof. Pinak Chakravarty	Senior Professor & Head, Centre of Excellence in Bioinformatics, Bioinformatics Centre, A.J.C. Bose Centenary Building, P-1/12, CIT Scheme - VII M, Kolkata - 700 054, India	pinak@boseinst.ernet.in pinak_chak@yahoo.co.in
111.	Prof. D.M. Mamatha	Dept of Sericulture/Seribiotechnology, Sri Padmavathi Mahila Viswavidyalayam (Women's University) Tirupati 517502 A.P. INDIA	drdmamatha@gmail.com
112.	Prof. K.P.J. Hemalatha	Department of Biochemistry, College of Science & Technology, Andhra University, Visakhapatnam - 530 003	hemalathakpj@gmail.com
113.	Dr. Suresh Rayala	Associate Professor, Dept of Biotechnology, IIT Madras	rayala@iitm.ac.in
114.	Dr. Dinesh Gupta	Staff Research Scientist, Structural and Computational Biology Group, International Centre for Genetic Engineering and Biotechnology, Aruna Asaf Ali Marg 110 067 New Delhi, India	dinesh@icgeb.res.in

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115.	Dr. Bindu Madhava Reddy Aramati	Assistant Professor, Department of Animal Sciences, School of Life Sciences, University of Hyderabad, Prof. C.R.Rao Road, Gachibowli, Hyderabad, 500046, India	abmsl@uohyd.ernet.in
116.	Dr. Krishna Kishore Inampudi	Assistant Professor, Department of Biophysics AIIMS, New Delhi	kishorehcu@gmail.com
117.	Dr. Lalitha Guruprasad	Associate Professor, School of Chemistry, University of Hyderabad, Prof. C. R. Rao Road, Gachibowli, Hyderabad, 500046, India	lgpsc@uohyd.ernet.in
118.	Prof. Pallu Reddanna,	Department of Animal Sciences, School of Life Sciences, University of Hyderabad, Prof. C.R.Rao Road, Gachibowli Hyderabad, 500046, India	prsl@uohyd.ernet.in
119.	Dr. Manish Kumar Gupta	Assistant Professor - Department of Bioinformatics Chhatrapati Shahu Ji Maharaj University, Kanpur- 208024, India	Manish.kumar.gupta@gmail.com
120.	Dr. R.K. Chaitanya	Assistant Professor, Department of Animal Sciences, School of Life Sciences, Central University of Punjab Bathinda, Punjab, India	chaitanyark@cup.ac.in
121.	Prof. Tapash Chandra Ghosh	Bioinformatics Centre, Bose Institute, Kolkata, India	tapash@boseinst.ernet.in
122.	Dr. Naidu Subbarao	Associate Professor, School of Computational and Integrative Sciences, Jawaharlal Nehru University New Delhi, India	nsrao@mail.jnu.ac.in nsrao.jnu@gmail.com
123.	Dr. Gopal Singh Bisht	Assistant Professor (Senior Grade), Biotechnology and Bioinformatics, Jaypee University Of Information Technology, Himachal Pradesh, Office: 2nd Floor, Near Auditorium, Contact No: (91) 01792-239408	gopal.singh@juit.ac.in, bisht.gopal@gmail.com
124.	Dr. Jata Shankar	Assistant Professor (Senior Grade), Biotechnology and Bioinformatics, Jaypee University Of Information Technology, Himachal Pradesh (Office: 01792-239363)	jata.shankar@juit.ac.in, jata_s@yahoo.com
125.	Prof. S.V. Rajagopal,	Dept. of Biotechnology, GITAM University, Visakhapatnam, AP	hodbiotechcos@gitam.edu
126.	Dr. M. Rama Rao	Associate Prof., Dept. of Biochemistry, GITAM University Visakhapatnam, AP	rrmalla@gitam.edu
127.	Dr. D. Sundar	Associate Professor, Department of Biochemical Engineering and Biotechnology, Indian Institute of Technology (IIT) Delhi, Hauz Khas, New Delhi - 110016	sundar@dbeb.iitd.ac.in sundar@jhu.edu
128.	Dr. Shree Prakash Pandey	Assistant Professor, Indian Institute of Science Education Research (IISER) Kolkata, Mohanpur Campus, Mohanpur - 741246	sppandey@iiserkol.ac.in
129.	Dr. Pooran Singh Solanki	The Coordinator, Bioinformatics Centre, Birla Institute of Scientific Research, Statue Circle, Jaipur-302001 Rajasthan, INDIA	pooransingh@bisr.res.in , pooransingh@gmail.com
130.	Prof. Manish Shrimali	Professor & Head, Department of Physics, Dean, School of Physical Sciences, Central University of Rajasthan Ajmer.	m.shrimali@gmail.com, shrimali@curaj.ac.in
131.	Dr. Subhash Mohan Agarwal	Institute of Cytology & Preventive Oncology, I - 7, Sector - 39, NOIDA, Distt. Gautam Buddha Nagar, Utter Pradesh - 201 301	smagarwal@yahoo.com
132.	Dr. Manish Kumar	Assistant Professor Department of Biophysics, University of Delhi South Campus, Benito Juarez Road, New Delhi	manish@south.du.ac.in, manish.imt@gmail.com
133.	Dr. Rajeev Mishra	Assistant Professor in Bioinformatics Mahila Maha Vidyalaya, Banaras Hindu University	mishrarajeev@gmail.com
134.	Dr. Sangram Bagh	Assistant Professor Department of Biotechnology, Presidency University 86/1 College Street, Kolkata	sangram.biotechnology@presiur ac.in
135.	Dr. Kamal Rawal	Assistant Professor (Senior Grade), Jaypee Institute of Information Technology, A-10, Sector-62, Noida-201 309, Uttar Pradesh, India.	Kamal.rawal@jiit.ac.in

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136.	Dr. Ragothaman Yennamalli	Assistant Professor (Grade II), Department of Biotechnology and Bioinformatics, Jaypee University of Information Technology, Wagnaghat, P.O. Wagnaghat, Teh Kandaghat, Distt. Solan - PIN-173 234	ym.ragothaman@juit.ac.in
137.	Dr. Alok Srivastava	Assistant Professor, C.R.Rao Advanced Institute of Mathematics, Statistics and Computer Science (AIMSCS) University of Hyderabad Campus, Central University Post Office, Prof.CRRao Road, Hyderabad - 500 046	foralok@gmail.com alok@cr Raoaimscs.res.in
138.	Dr. Sandeep Krishna	National Centre for Biological Sciences Tata Institute of Fundamental Research GKVK, Bellary Road, Bangalore 560065,	Sandeep@ncbs.res.in
139.	Prof. Sudha Bhattacharya	Professor, School of Environmental Sciences, JNU, New Delhi	sb@mail.jnu.ac.in sbjnu110@gmail.com
140.	Prof. Ramakrishna Ramaswamy	Professor, School of Physical Sciences, JNU, New Delhi	r.ramaswamy@mail.jnu.ac.in
141.	Dr. Abhinav Grover	Assistant Professor (UGC), Room No. 98, School of Biotechnology, Jawaharlal Nehru University, New Delhi - 110 067, India. Mobile: +91-8130738032; +91-9891812561 Office Tel: +91-11-26738728 Fax: +91-11-26702040	abhinavgr@gmail.com agrover@jnu.ac.in
142.	Dr. Nand Singh	Assistant Professor, Department of Biotechnology, Moti Lal Nehru National Institute of Technology, Allahabad- 211004, India	singhnand@gmail.com, nksingh@mnnit.ac.in
143.	Dr. Deepak Rajpurohit	Assistant Professor Biotechnology, Department of Post Harvest Engineering and Technology, College of Technology and Engineering, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan- 313001,	deepakrajpurohit2001@yahoo.com
144.	Dr. Vikash Babu	Scientist, Fermentation Technology Division, CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu- 180001, India	vikash@iiim.ac.in
145.	Dr. Kumari Neelam Singh	Assistant Biotechnologist, College of Agriculture, School of Agricultural Biotechnology, Punjab Agricultural University, Ludhiana, Punjab- 141004, India	kneelam@pau.edu
146.	Dr. H.K. Chaudhary	Principal Scientist & Head, Department of Crop Improvement. College of Agriculture, CSK Himachal Pradesh Agricultural University, Palampur, Distt- Kangra, Himachal Pradesh- 176062, India	headci@hillagric.ac.in, ctlhkc@rediffmail.com, mctlhkc@gmail.com
147.	Prof. G. Harold Philip	Head, Department of Biotechnology, Professor, Zoology Sri Krishnadevaraya University, Anantapur, Andhra Pradesh	ghphilip@rediffmail.com
148.	Prof. Allam Appa rao	Director, C.R.Rao Advanced Institute of Mathematics, Statistics and Computer Science, Hyderabad 500 046, India	apparaoallam@gmail.com
149.	Dr. Madhvi Shakya	Associate Professor, Mathematics (Applied Mathematics) Department, MANIT, Bhopal	madhvishakya@gmail.com
150.	Dr. Subhankar Chatterjee	Assistant Professor, Department of Environmental Sciences, Central University of Himachal Pradesh	schatt.cuhp@gmail.com
151.	Dr. Mushtaq Ahmed	Associate Professor, Department of Environmental Sciences, Central University of Himachal Pradesh	mushtaq_bhu@rediffmail.com

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*22/11/2016*

*Dr. Mushtaq Ahmed*

## Centre for Computational Biology and Bioinformatics

School of Life Sciences

Course Code	Name of the Course	Credits	Level	Pre-requisite	Co-requisite
CBB 401	Mathematics in Biology	2	4		
CBB 402	Modern Biology	2	4		
CBB 403	Introduction to Statistics and Probability	2	4		
CBB 404	Introduction to Computer and Programming	2	4		
CBB 405	Basic of Bioinformatics	2	4		
CBB 406	Practical course on Programming	2	4		
CBB 407	Practical course on Bioinformatics	4	4		
CBB 408	Database Management Systems	2	4		
CBB 409	Computational methods in Sequence Analysis	2	4		
CBB 410	Computational methods in Structure Analysis	2	4		
CBB 411	Introduction to PERL Programming	2	4		
CBB 412	Computational statistics for Biology	2	4		
CBB 413	Practical course on PERL	2	4		
CBB 414	Practical course on Bioinformatics Tools	2	4		
CBB 415	Practical Course on Statistical Analysis	2	4		
CBB 416	Machine Learning Methods	2	4		
CBB 499	Major Project	4	4		
CBB 501	Algorithms in computational Biology	4	5		
CBB 502	Programming in BIOPERL and PYTHON	4	5		
CBB 503	Molecular Modelling and Dynamics	4	5		
CBB 504	Genomics and Proteomics	4	5		
CBB 505	Practical course in BIOPERL	4	5		
CBB 506	Practical course in DBMS	2	5		
CBB 507	Seminar	2	5		
CBB 508	Ontology, Networks and pathways	4	5		
CBB 509	Data Mining and knowledge discovery	4	5		
CBB 510	Web Enabling Technologies	4	5		
CBB 511	Software Engineering	4	5		
CBB 512	High Performance Computing	4	5		
CBB 513	Chemo-Informatics	4	5		
CBB 514	Molecular Simulation and Application	4	5		
CBB 515	Computer aided Drug Discovery	4	5		
CBB 516	Molecular Evolution and Biodiversity	4	5		
CBB 517	Probabilistic Methods for Computational Biology	4	5		
CBB 518	Elements of Systems Biology	4	5		
CBB 519	Human Genetics	4	5		
CBB 520	Mathematical Models in Biology	4	5		
CBB 521	Bio-Medical Imaging	4	5		
CBB 599	Dissertation(M.Phil)	20	5		
CBB 699	Thesis (Ph.D)	60	6		
CBB 417	Structural Biology	2	4		
CBB 418	Biomolecules	2	4		

CBB 419	Concepts in Molecular Biology	2	4		
CBB 420	Cell Biology and Genetics	4	4		
CBB 421	Physics in Biology	2	4		
CBB 422	Basics of Microbiology and Immunology	2	4		
CBB 423	Numerical Methods for Computational Biologists	2	4		
CBB 424	Computational Chemistry	2	4		
CBB 425	Basics of Plant Biotechnology	2	4		
CBB 426	Practical course on Molecular Simulations	2	4		
CBB 427	Practical Course on Sequence Analysis	2	4		
CBB 428	Practical Course on CADD	2	4		
CBB 429	Practical Course on Structure Prediction and Modelling	2	4		
CBB 430	Biophysics	2	4		
CBB 431	Bioanalytical Techniques	2	4		
CBB 522	Elements of Synthetic Biology	2	5		
CBB 523	Practical Course on Systems Biology	2	5		
CBB 524	Statistical Physics of Biomolecules	2	5		
CBB 525	Enzyme Kinetics	2	5		
CBB 526	Next Generation Sequencing: methods and data analysis	2	5		
CBB 527	Plant Bioinformatics	4	5		
CBB 528	Drug discovery process	2	5		
CBB 529	Introduction to Dynamical Systems: From Cells to Societies	2	5		
CBB 530	Practical course on Dynamical Systems Modelling	2	5		
CBB601	Research Methodologies in Life Sciences	4	6		
CBB 602	Molecular basis of pathogenesis in Infectious Diseases	4	6		
CBB402A	Elements of Modern Biology	4	4		
CBB17A	Advances in Structural Biology	4	5		
CBB 513A	Introduction to Chemo-Informatics	2	5		
CBB 531	Life: Its Origin, Its Future	2	5		
CBB 532	Elements of Computational Ecology	2	5		
CBB 533	Concepts in Complex Systems Studies	2	5		
CBB 529A	Introduction to Nonlinear Dynamical Systems: From Cells to Societies	4	5		
CBB 534	Fundamentals of Metabolomics	2	5		
CBB 520A	Mathematical Biology	2	5		
CBB 499A	MSc Project	8	5		
<b>New Course suggested</b>					
CBB 535	Basics of Mathematical Ecology	2	4		
CBB 536	Practical course on R programming for Bioinformatics	2	4		
CBB 537	Fundamentals of Genetic Engineering and Transgenics	2	5		

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# Central University of Himachal Pradesh

Centre for Bioinformatics and Computational Biology

School of Life Sciences

## AGENDA



### **FIFTH BOARD OF STUDIES MEETING**

TO BE HELD ON 23<sup>rd</sup> AUGUST, 2018 at TAB SHAHPUR

Venue: Committee Room, Temporary Academic Block,  
CENTRAL UNIVERSITY OF HIMACHAL PRADESH,  
Shahpur, District Kangra (HP)

*F. Apal Singh*  
*23/08/18*

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## AGENDA-INDEX

Agenda Item No.	PARTICULARS	Information
CBB-BOS-5/18-1	Approval of the Minutes of the 4 <sup>th</sup> Board of Studies meeting held on 28.09.2017	
CBB-BOS-5/18-2	Review of Course Catalogue and Insertion of New Courses for the M.Sc. Computational Biology & Bioinformatics and Research Degree Program	
CBB-BOS-5/18-3	Approval of course curriculum for MSc CBB in the CBCS format	
CBB-BOS-5/18-4	Approval of synopsis of Ph.D. Scholars	
CBB-BOS-5/18-5	Approval of List of Experts as Examiners	
CBB-BOS-5/18-6	Request to consider date of Ph.D registration from the date of allotment of supervisor to the first batch of Ph.D students	
CBB-BOS-5/18-7	Modification of the Ph.D. topic of Mr. Gagandeep Singh and extension of the Registration for one year as per his request and recommendations of the respective Supervisor/Guide	
CBB-BOS-5/18-8	Extension of registration for two months in favour of Mr Ashish as per his request and recommendations of the respective Supervisor/Guide	
	Any item with the permission of the Chair	

The details of Agenda items for the 5<sup>th</sup> Board of Studies Meeting of Centre for Bioinformatics and Computational Biology, School of Life Sciences, Central University of Himachal Pradesh (CUHP) to be held on 23<sup>rd</sup> August, 2018 in the Committee Room at Temporary Academic Block (TAB), CUHP, Shahpur are as given under:

### Agenda Item No. – CBB-BOS-5/18-1

Approval of the Minutes of the 4<sup>th</sup> Board of Studies meeting held on 28.09.2017

### Agenda Item No. – CBB-BOS-5/18-2

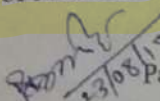
**Review of Course Catalogue and Insertion of New Courses for the M.Sc. Computational Biology & Bioinformatics and Research Degree Program**

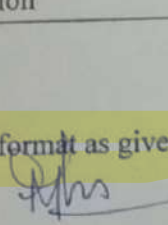

In accordance with the draft ordinances number 4, Section 23 and Statute 16(2) of the Central Universities Act 2009, point number 4(a), the Director of the Centre for Bioinformatics and Computational Biology places before the members of the board for their approval of the additional courses that are to be included in CDC of the masters and research programs. The list of courses, respective course code, credits and level are as follows-

S. No.	Course Code	Course name	Credits
1	CBB 538	Data Science	02
2	CBB539	R for Data Science	02
3	CBB540	High Throughput Sequencing: data analysis and application	04

### Agenda Item No. – CBB-BOS-5/18-3

Approval of course curriculum of MSc CBB in the CBCS format as given in Annexure 1.

  
 23/08/18  
 Page 2 of 4

  
  
 F. Anil  
 23/8/18



Agenda Item No. – CBB-BOS-518-4

Approval of synopsis of following Ph.D. Scholars

Sr. No.	Name of the Student	Roll No.	Name of the Supervisor
1.	Mr. Dixit Sharma	CUHP15RDCBB01	Dr. Shailender Kumar Verma
2.	Mr. Vikram Singh	CUHP15RDCBB06	Dr. Vikram Singh

Agenda Item No. – CBB-BOS-5/18-5

Approval of List of Experts as Examiners

In accordance with the draft ordinances number 4(i), Section 23 and Statute 16(2) of the Central Universities Act 2009, point number 4(b) i and ii, the Director of the Centre for Bioinformatics and Computational Biology places before the members of the board for their approval, the list of examiners for various evaluation of PG course and Ph.D course work

The lists of examiners are as follows-

S. No.	Name	Address	Email
1.	Prof. Bhushan Patwardhan	Director, Interdisciplinary School of Health Sciences, Savitribai Phule Pune University, Ganeshkhind Pune 411 007	bhushan@unipune.ac.in
2.	Prof. Parbati Biswas	Department of Chemistry University of Delhi Delhi-110007	pbiswas@chemistry.du.ac.in
3.	Dr. Avinash Chand Yadav	Department of Physics & Astronomical Sciences, School of Basic & Applied Sciences, Central University of Jammu Samba-181 143, J&K, India	jnu.avinash@gmail.com avinashyadav@ujammu.ac.in
4.	Dr. Awadhesh Prasad	Office Room No. – 177, Multistoried Building, Department of Physics and Astrophysics, University of Delhi, Delhi-110007	awadhesh@physics.du.ac.in, awadhesh.prasad@gmail.com
5.	Dr. Hemant Rituraj Kushwaha	School of Biotechnology, Jawaharlal Nehru University, New Delhi - 110067	hemantkushwaha@jnu.ac.in, ritturajhemant@gmail.com
6.	Dr. Karnati Raja Ram Mohan Roy	Department of Animal Biology, School of Life Sciences, University of Hyderabad Prof. CR Rao Road Hyderabad - 500046	roykarnati@uohyd.ac.in

7.	Prof. Krishnaveni Mishra	Department of Biochemistry School of Life Science University of Hyderabad, Prof. C.R.Rao Road, Gachibowli, Hyderabad, 500046, India	kmsl@uohyd.ernet.in, krishnaveni.mishra@gmail.com
8.	Dr. Poosarla V.Giridhar	Assistant Professor Microbiology and FST (Food Science & Technology) Department Gitam Institute of Science Gandhi Nagar, Rushikonda, Visakhapatnam-530 045	giridhar.poosarla@gitam.edu, pvgdhar@gmail.com
9.	Dr. Debashis Barik	Assistant Professor School of Chemistry University of Hyderabad Gachibowli, Hyderabad, 500046, AP, India	dbariksc@uohyd.ac.in barikdd@gmail.com
10.	Dr. Sairam Swaroop Mallajosyula	Assistant Professor, Chemistry, IIT-Gandhinagar Palaj, Gandhinagar - 382355,	msairam@iitgn.ac.in
11.	Prof. Rajeswari R. Moganty	Department of Biochemistry, All India Institute of Medical Sciences, New Delhi-110029, India	rajeswari3011@hotmail.com

It is proposed that the list will be updated regularly by the faculty members with the consent to the Dean,  
School of Life Sciences

**Agenda Item No. – CBB-BOS-5/18-6**

Request to consider date of Ph.D registration from the date of allotment of supervisor to the first batch of Ph.D students

**Agenda Item No. – CBB-BOS-5/18-5-7**

Modification of the Ph.D. topic & objectives of Synopsis of Mr. Gagandeep Singh and extension of the Registration for one year as per his request and recommendation of his Ph.D. Supervisor.

**Agenda Item No. – CBB-BOS-5/18-8**

Extension of registration for two months in favour of Mr Ashish as per his request and recommendations of the respective Supervisor/Guide

**Any item with the permission of the Chair**

**Prof. Ambrish K. Mahajan**  
(Chairman and Convener)

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 23/08/18  
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 23/08/18  
 23/08/18



हिमाचल प्रदेश केंद्रीय विश्वविद्यालय  
Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

अस्थाई शैक्षणिक खण्ड, शाहपुर, जिला कांगड़ा, हिमाचल प्रदेश - 176206  
Temporary Academic Block, Shahpur, Distt. Kangra (HP) - 176206  
Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

File No: LS/1-5(Vol.II)/CUHP/12/114

Dated: 28.09.2017

Centre for Computational Biology and Bioinformatics

School of Life Sciences

Minutes of the 4<sup>th</sup> Board of Studies meeting held on 28<sup>th</sup> September, 2017

The meeting of the 4<sup>th</sup> Board of Studies of the Centre for Computational Biology and Bioinformatics, School of Life Sciences was held on 28<sup>th</sup> September, 2017 at 11:30 AM in the Committee Room, Central University of Himachal Pradesh, Temporary Academic Block, Shahpur. Prof. Ambrish Kumar Mahajan, Director, Centre for Computational Biology and Bioinformatics and Dean, School of Life Sciences welcomed all the Hon'ble members.

Following members attended the meeting:

1. **Prof. Ambrish Kumar Mahajan – Chairman and Convener**  
Director, Centre for Computational Biology & Bioinformatics and Dean, School of Life Sciences, Central University of Himachal Pradesh.
2. **Prof. Sukesh C. Sharma – Subject Expert**  
Department of Biochemistry, Punjab University, Chandigarh
3. **Prof. Duni Chand – Subject Expert**  
Department of Biotechnology, University of Himachal Pradesh, Shimla.
4. **Dr. Mushtaq Ahmed – Vice Chancellor's Nominee**  
Associate Professor, School of Earth and Environmental Sciences, Central University of Himachal Pradesh.
5. **Dr. Vikram Singh – Member**  
Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences, Central University of Himachal Pradesh.
6. **Dr. Yusuf Akhter – Special Invitee**  
Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences, Central University of Himachal Pradesh.
7. **Dr. Shailender Kumar Verma – Special Invitee**  
Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences, Central University of Himachal Pradesh.

Following Decision were taken in BOS meeting as per the Agenda.

*Yusuf Akhter*  
28/9/17

*Mushtaq Ahmed*

*Shailender Kumar Verma*

*28/9/17*

*Ambrish Kumar Mahajan*

Agenda Item No. – CBB-BOS-4/14-1

**Review of Course Catalogue and Insertion of New Courses for the M.Sc. Computational Biology & Bioinformatics and Research Degree Program**

In accordance with the draft ordinances number 4, Section 23 and Statute 16(2) of the Central Universities Act 2009, point number 4(a), the Director of the Centre for Bioinformatics and Computational Biology places before the members of the board for their approval of the additional courses that are to be included in CDC of the masters and research programs. The list of courses, respective course code, credits and level are as follows-

S. No.	Course Code	Course name	Credits
1.	CBB 433	Biosafety issues	2
2.	CBB 433A	Biosafety and Ethics	2
3.	CBB 434	Skills in agricultural technology	2
4.	CBB 434A	Agricultural Technology	2
5.	CBB403A	Fundamentals of Statistics	4
6.	CBB435	Fundamentals of Genetics	2
7.	CBB 531A	Life: Its Emergence, Evolution and Extent	2
8.	CBB 436	History of Science and Technology in India	2
9.	CBB 437	Principles of Scientific Writing	2

**Decision:**

All members agreed and approved the list of above new courses with minor modifications.

Agenda Item No. – CBB-BOS-4/14-2

**Approval of synopsis of following PhD Students**

Sr. No.	Name of the Student	Roll No.	Title of the Synopsis	Name of the Supervisor
1.	Munawwar Karim	CUHP13RDCBB02	Prophylactic and post-infection therapeutics discovery against Leishmaniasis using computational approaches	Dr. Yusuf Akhter
2.	Neha	CUHP13RDCBB03	Application of Molecular dynamics based free energy calculation methods for identification of novel COX-2 inhibitors	Dr. P Aparoy
3.	Ankita Sharma	CUHP14RDCBB02	Studies on iron, zinc and copper binding proteins from bacterial pathogens of wheat	Dr. Shailender Kumar Verma
4.	Neha Choudhary	CUHP14RDCBB04	Network Pharmacological Evaluation of selected Ayurvedic Medicines	Dr. Vikram Singh

**Decision:**

All members agreed and approved it. Experts also made a suggestion that in future, synopsis of the students shall be approved within the time limit as specified by the UGC regulations during the enrolment of the student. The members also felt that since in Science subjects, title of the synopsis is subject to some modifications depending on the scientific output and that can be under taken before submission of the thesis.

**Agenda Item No. – CBB-BOS-4/14-3**

To appoint the co-supervisor of Mr Dixit Sharma (PhD Scholar).

Sr. No.	Name of the Student	Roll No.	Name of the Supervisor	Name and address of co-supervisor
1	Dixit Sharma	CUHP15RDCBB01	Dr. Shailender Kumar Verma	Dr. Birbal Singh, Principal Scientist Biotechnology Lab, ICAR-IVRI Regional Station, Palampur, H.P. INDIA. 176061 Email: <a href="mailto:bsbpalampur@yahoo.co.in">bsbpalampur@yahoo.co.in</a>

**Decision:**

All members agreed and approved it subject to the condition that Dr. Birbal Singh provides written consent on hard copy along with his CV. The email has been received from the co-supervisor which has been considered at this stage.

**Agenda Item No. – CBB-BOS-4/14-4**

To approve Dr. Shailender Kumar Verma, Assistant Professor, CBB, SoLS, as Co-supervisor in the PhD thesis of Ms. Shilpa, Deenbandhu Chhotu Ram University of Science and Technology (A State Government University), Murthal, Sonapat-131039, Haryana.

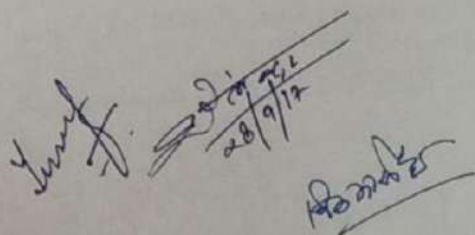
**Decision:**

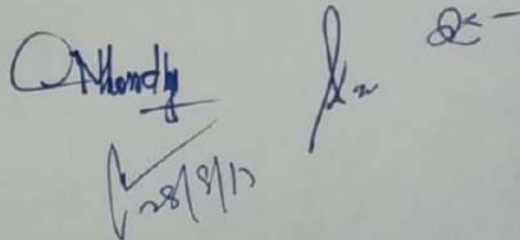
All members agreed to defer this agenda item.

**Agenda Item No. – CBB-BOS-4/14-5**

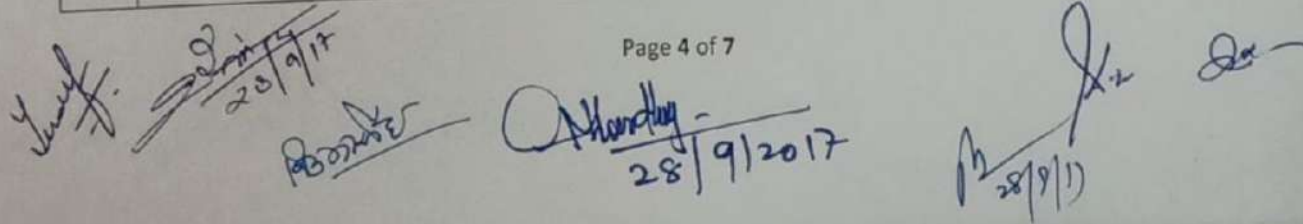
Approval of List of Additional Experts as examiners for viva-voce of dissertations/ practical courses.

In accordance with the draft ordinances number 4(i), Section 23 and Statute 16(2) of the Central Universities Act 2009, point number 4(b) i and ii, the Director of the Centre for Bioinformatics and Computational Biology places before the members of the board for their approval, the list of examiners for various evaluation purposes. The lists of examiners is as follows-

  
28/9/12

  
28/9/12

S. No.	Name	Address	Email
1.	Prof. H.S. Dhaliwal	(Former professor PAU Ludhiana and IIT Roorkee) Professor and Vice Chancellor, Eternal University, Baru Sahib via Rajgarh, Distt. Sirmour-173101, Himachal Pradesh; Phone No.: +91-9805098702.	hsdhaliwal07@gmail.com, hsdhaliwal@eternaluniversity.edu.in;
2.	Dr. Kamalendra Awasthi	Assistant Professor, Department of Physics, Malaviya National Institute of Technology Jaipur-302017, Rajasthan; Phone no.: 0141-2713441.	kawasthi.phy@mnit.ac.in
3.	Dr. Anjali Awasthi	Assistant Professor, Center for Advanced Studies, Department of Zoology, University of Rajasthan, Jaipur-302004, Rajasthan; Phone no.: +91-9461339369.	anjkam.awasthi@gmail.com, anjali.chaturvedi83@gmail.com
4.	Dr. Manoj Kumar	Staff Scientist VI: National Institute of Plant Genome Research, ArunaAsafAlif Marg, New-Delhi-110067; Phone No.: +911126741612,14,17 Ext-160, +91-11-26735160.	manoj_prasad@nipgr.ac.in, manoj_pds@yahoo.com
5.	Dr. T. R. Sharma	Director (A) & Joint Director (Research), ICAR- Indian Institute of Agricultural Biotechnology	
6.	Dr. Sangeeta Saxena	Associate Professor, Department of Biotechnology, School of Bio-sciences & Biotechnology, BabasahebBhimraoAmbedkar University (A Central University), Vidya-Vihar, Rae-Bareilly Road, Lucknow-226025, Uttar-Pradesh; Phone No.: +91-522-2505364, +91-9450645342.	dr_sangeeta_saxena@yahoo.com
7.	Dr. G. Sunil Babu	Assistant Professor, Department of Biotechnology, School of Bio-sciences & Biotechnology, Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae-Bareilly Road, Lucknow-226025, Uttar-Pradesh; Phone No.: +91-9455036926.	sunil_gos@yahoo.com;
8.	Dr. Birbal Singh	Principal Scientist Biotechnology Lab ICAR-IVRI Regional Station, Palampur Himachal Pradesh. 176061 Ph.No.: 9418431715	bsbpalampur@yahoo.co.in
9.	Dr. Rinku Sharma	Senior Scientist Pathology Lab ICAR-IVRI Regional Station, Palampur Himachal Pradesh. 176061 Ph.No.: 9418153235	rinkusharma99@gmail.com
10.	Dr. Gorakh Mal	Principal Scientist Biochemistry Lab ICAR-IVRI Regional Station, Palampur Himachal Pradesh. 176061	gorakh14@yahoo.com
11.	Dr. Rajendra Patil	Associate Professor Department of Veterinary Pathology CSK Himachal Pradesh Agri. University Palampur 176062 Himachal Pradesh,	rdpatil02@rediffmail.com


  
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 28/9/2017  
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		Ph. No.: 94180 53235	
12.	Dr. P.N. Sharma	Professor Department of Plant Pathology CSK Himachal Pradesh Agri. University Palampur 176062 Himachal Pradesh, Phone: 01894-230326 (O), 9418161835 (mobile) Fax: 01894-30511	<a href="mailto:pns1960@gmail.com">pns1960@gmail.com</a> ; <a href="mailto:pns@hillagric.ernet.in">pns@hillagric.ernet.in</a>
13.	Dr. R.S. Chandel	Principal Scientist Department of Agricultural Entomology CSK Himachal Pradesh Agri. University Palampur 176062 Himachal Pradesh, Ph.No.: 9418019747	<a href="mailto:visitrvcandel@yahoo.com">visitrvcandel@yahoo.com</a>
14.	Dr. K. D. Sharma	Professor Department of Agricultural Biotechnology CSK Himachal Pradesh Agri. University Palampur 176062 Himachal Pradesh, Phone: 01894 230314(O); 094184-68896 (mobile) Fax: +91-1894 230511	<a href="mailto:kml1967@rediffmail.com">kml1967@rediffmail.com</a> . <a href="mailto:kmaldev2002@yahoo.co.in">kmaldev2002@yahoo.co.in</a>
15.	Dr. Sudesh Radotra	Principal Scientist Regional Research Centre, ICAR-IVRI campus, Palampur ICAR-Indian Grassland and Fodder Research Institute Himachal Pradesh, 176061 Ph.No.: 9418053231	<a href="mailto:sradotra@rediffmail.com">sradotra@rediffmail.com</a>
16.	Dr. Amit Chawla	Scientist Biotechnology Lab CSIR-IHBT, Palampur, Himachal Pradesh, Ph.No.: 01894-233339	<a href="mailto:amitchawla@ihbt.res.in">amitchawla@ihbt.res.in</a>
17.	Dr. Rakshak Kumar	Scientist Biotechnology Lab CSIR-IHBT, Palampur Himachal Pradesh, 176061 Ph.No.: 9882986355	<a href="mailto:rakshakacharya@gmail.com">rakshakacharya@gmail.com</a>
18.	Dr. Tulika Prakash Srivastava	Assistant Professor School Of Basic Sciences Indian Institute of Technology Mandi Himachal Pradesh, 175001 Ph.No.: 01905 -237922	<a href="mailto:tulika@iitmandi.ac.in">tulika@iitmandi.ac.in</a>
19.	Dr. Shyam Kumar Masakapalli	Assistant Professor School Of Basic Sciences Indian Institute of Technology Mandi Himachal Pradesh, 175001	<a href="mailto:shyam@iitmandi.ac.in">shyam@iitmandi.ac.in</a>
20.	Dr. Tirathraj Singh	Assistant Professor, Department of Biotechnology & Bioinformatics, Jaypee University of Information Technology, Waknaghat	<a href="mailto:tiratharaj@gmail.com">tiratharaj@gmail.com</a>
21.	Dr. Ram Rup Sarkar	Senior Scientist, Chemical Engineering & Process Development Division, NCL, Pune	<a href="mailto:rr.sarkar@ncl.res.in">rr.sarkar@ncl.res.in</a>
22.	Dr. S. Ramachandran	Professor, Biological Sciences Division, Institute of Genomics & Integrative Biology, New Delhi	<a href="mailto:ramu@igib.res.in">ramu@igib.res.in</a>

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23.	Prof. Kuldeep K. Sharma	Dean and Professor, Life Sciences, University of Jammu	prof.ksharma@gmail.com
24.	Dr. Suresh Kumar Sharma	Professor, Department of Statistics, Punjab University, Chandigarh	ssharma643@yahoo.co.in
25.	Dr. Sudhir P. Singh	Scientist, Synthetic Biology, CIAB, Mohali	pratapudhir17@gmail.com
26.	Dr. Chetan Gadgil	Scientist, Chemical Engineering Division, National Chemical Laboratory, Pune	cj.gadgil@ncsl.res.in
27.	Dr. Binay Panda	Scientist, Institute of Bioinformatics and Applied Biotechnology, Bengaluru	binay@ganitlabs.in
28.	Dr. Soumen Roy	Associate Professor, Department of Physics, Bose Institute, Kolkata	rsoumen@gmail.com
29.	Dr. Areejit Samal	Reader, Room 219, New Building, The Institute of Mathematical Sciences (IMSc), 4th Cross Road, CIT Campus, Taramani Chennai 600113	areejit.samal@gmail.com
30.	Dr. Amitabha Nandi	Assistant Professor, Department of Physics, IIT Bombay, Mumbai - 400076	amitabha@phy.iitb.ac.in
31.	Dr. Vijai Singh	Assistant Professor & Group Leader, Institute of Advanced Research, Gandhinagar	vijaisingh15@gmail.com
32.	Dr. A. Krishnamachari	Assistant Professor School of Computational and Integrative Sciences, Jawaharlal Nehru University, New Delhi -110067	akchari@gmail.com
33.	Dr. Harpreet Singh	Head, Department of Bioinformatics, Hans Raj Mahila Maha Vidyalaya, Jalandhar-144008	harpreetsingh05@gmail.com
34.	Dr. Ritushree Kukreti	Biological Sciences Division, Institute of Genomics & Integrative Biology, New Delhi	ritus@igib.res.in
35.	Dr. Ganesh Bagler	B-205, Indraprastha Institute of Technology, Delhi	bagler@iiitd.ac.in
36.	Dr. Sarika Jalan	Complex Systems Lab (SB301), IIT Indore, Khandawa Road, Simrol, Indore 453552	sarika@iiti.ac.in
37.	Dr. Awadhesh Prasad	Office Room No.-- 177, Multistoried Building, Department of Physics & Astrophysics, University of Delhi, Delhi-110007	awadhesh.prasad@gmail.com
38.	Prof. Bibhudhananda Biswal	Cluster Innovation Centre, University of Delhi Delhi - 11007	bibhucic@gmail.com
39.	Dr. Vijai Pal Yadav	Room No: 115A School of Environmental Sciences Jawaharlal Nehru University New Delhi -110067	vpal@mail.jnu.ac.in
40.	Prof. Atul Johari	Room No.: 404 School of Life Sciences Jawaharlal Nehru University New Delhi -110067	ajohri@jnu.ac.in , akjohri14@yahoo.com
41.	Prof. Suman Dhar	Special Centre for Molecular Medicine Jawaharlal Nehru University New Delhi -110067	skdhar@mail.jnu.ac.in , skdhar2002@yahoo.co.in

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**Decision:**

All members agreed with the above list for examiners as proposed. However, course-wise list of external paper-setters for end term examinations as per clause 22 of ordinance no 30 shall be prepared separately and should get approved by circulation by the BOS.

With above observation, all members agreed and approved the above list.

Agenda Item No. – CBB-BOS-4/14-6

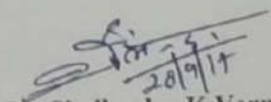
To review the suggestion from 3<sup>rd</sup> School Board meeting.

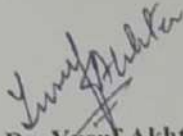
**Decision:**

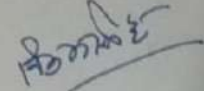
No suggestion was given by 3<sup>rd</sup> school board for approval.

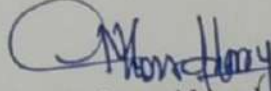
Any item with the permission of the Chair: No item has been taken

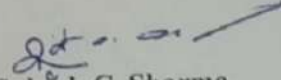
The meeting ended with a vote of thanks by the chair.

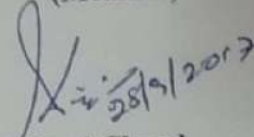
  
28/9/19  
Dr. Shailender K Verma  
(Special Invitee)

  
Dr. Yusuf Akhter  
(Special Invitee)

  
Dr. Vikram Singh  
(Member)

  
28/9/19  
Dr. Mushtaq Ahmed  
(VC's Nominee)

  
Prof. Sukesh C. Sharma  
(Subject Expert)

  
28/9/2019  
Prof. Duni Chand  
(Subject Expert)

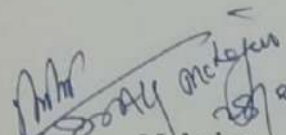
  
28/9/19  
Prof. Ambrish Kumar Mahajan,  
(Chairman and Convener)

TABLE-I: Curricular Framework for Centre for Computational Biology and Bioinformatics based on Choice Based Credit System (CBCS) (Spring 2017)

Semester	Credits	Core- Compulsory	Credits	Credits	Core- Open	Credits	
I	16	CBB 402 – Modern Biology	4				
		CBB 403 – Introduction to Statistics and Probability	2				
		CBB 405 – Basics of Bioinformatics	2				
		CBB 414 – Practical Course on Bioinformatics Tools	2				
		CBB 411 -- Introduction PERL programming	2				
		CBB 413 – Practical Course on PERL	2				
		CBB 431 -- Bioanalytical Techniques	2				
II	12	CBB 410-Computational Methods in Structure Analysis	2	4	CBB 504 -- Genomics and Proteomics	4	
		CBB 429 – Practical Course on Structure Prediction and Modelling	2				
		CBB501 – Algorithms in Computational Biology	4				
		CBB-509 – Data Mining and Knowledge Discovery	4				
III	4	CBB515–Computer Aided Drug Discovery	4	4	CBB 518 – Elements of Systems Biology	4	
IV	8	CBB499A – M.Sc. Project	8	4	CBB 523 – Practical Course on Systems Biology	2	
					CBB 428 – Practical Course on CADD	2	
Semester	Credits	Elective (Specialization)	Credits	Semester	Credits	Elective (Specialization)	Credits
III	8	CBB - High Throughput Sequencing: data analysis and applications	4	IV	8	CBB 522 – Elements of Synthetic Biology	2
		CBB 516 – Molecular Evolution and Biodiversity	4			CBB 516 – Molecular Evolution and Biodiversity	4
						CBB 527 – Plant Bioinformatics	4
						CBB 513- Chemoinformatics	4



हिमाचल प्रदेश केंद्रीय विश्वविद्यालय  
Central University of Himachal Pradesh  
(Established under Central Universities Act 2009)  
अस्यार्ड शैक्षणिक खण्ड, शाहपुर, ज़िला काँगड़ा, हिमाचल प्रदेश - 176206  
Temporary Academic Block, Shahpur, Distt. Kangra (HP) - 176206  
Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

File No: LS/1-5/ CUHP/12/01

Dated: 18/09/2020

MINUTES

The 6<sup>th</sup> Board of Studies (BoS) meeting of Centre for Computational Biology and Bioinformatics was held on 18<sup>th</sup> September, 2020 at 11:00 AM at Central University of Himachal Pradesh, Temporary Academic Block, Shahpur. The following were present:

1.	Dr. Mahesh Kulharia, Director, Centre for Computational Biology and Bioinformatics, School of Life Sciences	CONVERNER & CHAIRMAN	Offline Mode
2.	Prof. Birj Mohan, Ret. Professor, Chaudhary charan kumar Himachal Pradesh Agriculture University	SUBJECT EXPERT	Online Mode
3.	Prof. Desh Deepak Singh, Professor, Department of Biotechnology, Punjab University,	SUBJECT EXPERT	Online Mode
4.	Prof. Pardeep Kumar, Dean, Professor, Department of Plant Sciences, School of Life Sciences	MEMBER (VC NOMINEE)	Offline Mode
5.	Dr. Sunil Kumar, Associate Professor, Department of Animal Sciences, School of Life Sciences	MEMBER (VC NOMINEE)	Online Mode
6.	Dr. Shailender Kumar Verma, Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences	MEMBER	Offline Mode

The Director, Centre for Computational Biology and Bioinformatics (Convener & Chairman), School of Life Sciences welcomed all the members and thanked them for being available for attending this meeting.

*Mahesh Kulharia*

Minutes of the 6<sup>th</sup> BOS meeting of Centre for Computational Biology and Bioinformatics  
Held on 18<sup>th</sup> Sep 2020

**ITEM NO: CBB-BOS-6/20-1:** Approved the Minutes of the 5<sup>th</sup> Meeting of the Board of Studies held on 23<sup>rd</sup> August, 2018.(Annexure-I)

**ITEM NO: CBB-BOS-6/20-2:** Recommended the Change from nomenclature of the Centre for Computational Biology and Bioinformatics to Department of Computational Biology and Bioinformatics.

**ITEM NO: CBB-BOS-6/20-3:** Scrutinized, modified and approved the modified list of courses and syllabi to be taught/offered in the coming academic session (for 2020 Batch onwards) for the M.Sc. Centre for Computational Biology and Bioinformatics Sciences program in the CBCS format. (Annexure-II)

**ITEM NO: CBB-BOS-6/20-4:** Approved the list of courses to be taught/offered and syllabi for the course work of Research Degree students of the Centre for Computational Biology and Bioinformatics Sciences. (Annexure-III)

**ITEM NO: CBB-BOS-6/20-5:** Accredited the Faculty Member i.e. Dr. Mahesh Kulharia, Associate Professor, Centre for Computational Biology and Bioinformatics to become Ph.D. Supervisor/Guide.

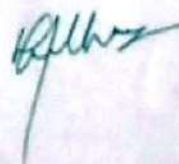
**ITEM NO: CBB-BOS-6/20-6:** Approved of the allotment of Supervisor/Guide for the Ph.D. Scholars.

Sr. No.	Name of Student	Roll. Number	Name of Supervisor
1.	Mr. Ashish Panghalia	CUHP17RDCBB01	Dr. Vikram Singh
2.	Ms. Himisha Dixit	CUHP17RDCBB02	Dr. Shailender Kumar Verma
3.	Ms. Deepanshi Awasthi	CUHP20RDCBB01	Dr. Vikram Singh
4.	Ms. Shilpa Chauhan	CUHP20RDCBB02	Dr. Shailender Kumar Verma
5.	Ms. Varuni Bhardwaj	CUHP20RDCBB03	Dr. Mahesh Kulharia
6.	Mr. Virender Kumar	CUHP20RDCBB04	Dr. Shailender Kumar Verma

**ITEM NO: CBB-BOS-6/20-7:** Approved the RAC of Ms. Himisha Dixit and Mr. Ashish Panghalia.

Sl. No.	Name of the Student	Registration No.	Constitution of RPMC/RAC
1.	Mr. Ashish Panghalia	CUHP17RDCBB01	1. Head of the Department-Ex-Officio Chairman 2. Dr. Vikram Singh-(Research Supervisor)-Convener 3. Dr. Dilbag Singh- Subject Expert
2.	Ms. Himisha Dixit	CUHP17RDCBB02	1. Head of the Department-Ex-Officio Chairman 2. Dr. Shailender Kumar Verma-(Research Supervisor)- Convener 3. Dr. Tarkeshwer- Subject Expert

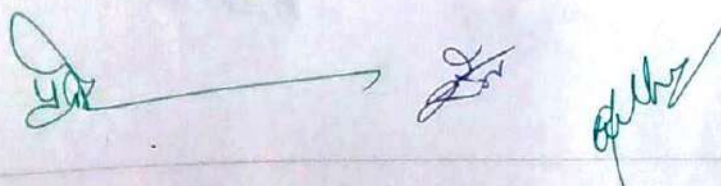
 



ITEM NO: CBB-BOS-6/20-8: Approved (Post facto) the allotment of Dissertation student semester (M.Sc. CBB).

PRIV,  
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Sr. No.	Name of Students	Roll No.	Title of the Thesis	Name of the Supervisor
1.	ASHITA SOOD	CUHP18CBB02	Atomistic structural determination of CALHM2 through in-silico techniques"	Dr. Mahesh Kulharia, Associate Professor
2.	DIKSHA TANTA	CUHP18CBB03	Protein-protein Interactions based study to analyze their importance as an effective drug targets	
3.	ISHIKA	CUHP18CBB04	To Create the drug molecule that can block PfHT1 (Plasmodium Falciparum Hexose Transporter 1) or its Homologs in other Plasmodium species.	
4.	PUSHPENDER SINGH CHANDEL	CUHP18CBB011	MD Simulation of Ebola virus Vp24 protein	
5.	ANKITA CHAUHAN	CUHP18CBB01	Network scale exploration of miRNA mediated regulation in Epilepsy associated COVID-19	Dr. Vikram Singh, Assistant Professor
6.	PUSHPESH DHIMAN	CUHP18CBB12	Comparative flux balance analysis of MERS, SARS and SARS-CoV-2 genomes	
7.	RADHIKA JOSHI	CUHP18CBB13	Aspects of genome scale evolution of SARS-CoV-2 and its protein interaction network with human-miRNAs	
8.	SHILPA PATHANIA	CUHP18CBB14	"Construction and analysis of SARS-CoV-2 protein interaction network with miRNAs associated with Glaucoma and Keratoconus"	
9.	NISHA VERMA	CUHP18CBB08	In silico structural analysis, physiochemical characterization and structure prediction of Triticum aestivum Iron Regulated Transporter 1 (IRT1) Protein	Dr. Shailender Kumar Verma, Assistant Prof
10.	PRATIBHA SHARMA	CUHP18CBB09	Identification and Classification of ABC transporter proteins of Xanthomonas oryzae_BB151-3	



1.	PRIYANKA CHOUDHARY	CUHP18CBB10	Bioinformatics functional characterization of hypothetical proteins of Chlamydia pisttaci strain Ful127 to discover potential drug targets
12.	SHIVALI KASHYAP	CUHP18CBB15	Phylogenetic Analysis of ATP-Binding Cassette Transporter (ABC) Gene in Xanthomonas translucens strain 569

**ITEM NO: CBB-BOS-6/20-9:** Approved the Academic Activity Schedule of the Centre for Computational Biology and Bioinformatics. (Annexure-IV)

**ITEM NO: CBB-BOS-6/20-10:** Approved the updated list of External Examiners for conducting practical /M.Sc. Dissertations Examinations and of the Centre for Computational Biology and Bioinformatics Sciences. (Annexure-V)

**ITEM NO: CBB-BOS-6/ 20-11:** Approved (Post facto) the title, objectives and synopses of the Ph.D thesis of Mr. Gagandeep Singh, CUHP12RDCBB03. (Annexure-VI)

Sr. No.	Name of Students	Roll No.	Title of the Thesis	Name of the Supervisor
1.	Gagandeep Singh	CUHP12RDCBB03	In-silico studies on systems scale characterization of Camellia sinensis (tea) using transcriptomic and genomic data	Dr. Vikram Singh, Assistant Professor

**ITEM NO: CBB-BOS-6/20-12:** Approved the proposal for initiating the Advance Diploma in Bioinformatics as 1 year (2 semester) course by the Centre for Computational Biology and Bioinformatics in self-financing mode. The funds thus generated will be used for the upgradation of the research facilities of Centre for Computational Biology and Bioinformatics.

**ITEM NO: CBB-BOS-6/20-13:** Scrutinized, modified and approved the list of courses and detailed syllabi to be taught/offered in the next academic session (for 2021 Batch onwards) for the Advance Diploma in Bioinformatics. (Annexure-VII).

**ITEM NO: CBB-BOS-6/ 20-11:** Approved (Post facto) the list of courses to be taught/offered and syllabi for the previous batches of M.Sc. Computational Biology and Bioinformatics. (Annexure-VIII)

*approved online*  
**Prof. Desh Deepak Singh**  
 Dept. of Biotechnology  
 Punjab University, Chandigarh

*approved online*  
**Prof. Brijmohan Sharma**  
 CSKHPKV, Palampur

*[Signature]*  
**Prof. Pardeep Kumar**  
 Dean SLS  
 CUHP, Dharamsala

*[Signature]*  
**Dr. Shailender Kumar Verma**  
 Assistant Professor, CCBB  
 CUHP, Dharamsala

*approved online*  
**Dr. Sunil Kumar**  
 HOD, Animal Sciences  
 CUHP, Dharamsala

*[Signature]*  
**Dr. Mahesh Kulharia**  
 Director, CCBB  
 CUHP, Dharamsala

Fwd: regarding the Board of studies CCBB

Inbox

Mahesh Kulharia

to me

11:38 AM (19 minutes ago)

----- Forwarded message -----

From: Prof. Desh Deepak Singh <ddsingh@pu.ac.in>

Date: Wed, Oct 7, 2020 at 11:54 AM

Subject: Re: regarding the Board of studies CCBB

To: Mahesh Kulharia <kulharia@hpcu.ac.in>

Cc: Dr Pardeep Kumar <pardeepsangla@gmail.com>, Dr Sunil Kumar Thakur <sunilbcs@gmail.com>, Brij Sharma <drbrijsharma@gmail.com>, Shailender Kumar Verma <shailenderverma22@gmail.com>

Dear Dr. Mahesh Kulharia,

This is with reference to the BOS meeting and the draft minutes sent by you.

I am approving the minutes you sent and it maybe recorded accordingly.

Best wishes

--

Prof. Desh Deepak Singh  
Professor, Biotechnology Department  
BMS-I, South Campus  
Panjab University,  
Chandigarh-160 014  
www: <http://biotechnology.puchd.ac.in/>  
Email: [ddsingh@pu.ac.in](mailto:ddsingh@pu.ac.in)  
Ph: +91 172 2534091  
+919228379835;

On 2020-10-06 13:38, Mahesh Kulharia wrote:

Dear Sirs,  
Please find the draft minutes of the 6th meeting of Board of studies along with the annexures attached herewith for your kind perusal and approval.  
We would really appreciate if you could find time to give your valuable suggestions/corrections/approval in next two days (i.e. 8 oct 2020).  
Thanking you in anticipation  
yours truly

Mahesh Kulharia

to me

11:38 AM (19 minutes ago)

----- Forwarded message -----

From: Brij Sharma <drbrijsharma@gmail.com>

Date: Wed, Oct 7, 2020 at 11:54 AM

Subject: Re: regarding the Board of studies CCBB

To: Mahesh Kulharia <kulharia@hpcu.ac.in>

Cc: Dr.Pardeep Kumar <pardeepsangla@gmail.com>, Dr Sunil Kumar Thakur <sunilbcs@gmail.com>, <ddsingh@pu.ac.in>, Shailender Kumar Verma <shailenderverma22@gmail.com>

Approved.

Dr. B. M. Sharma

Sr.Professor & Programme Director(Retd.).

Ganesh Vihar(Khilru),P.O.Bindraban,

Near SSB Chowk,Palampur- 176 061

Tel: +91 94184 71501

E-mail- [drbrijsharma@gmail.com](mailto:drbrijsharma@gmail.com)

FAX 01894 230326

**Mahesh Kulharia**

to me

11:39 AM (18 minutes ago)

----- Forwarded message -----

From: **Dr Sunil Kumar Thakur** <[sunilbtes@gmail.com](mailto:sunilbtes@gmail.com)>

Date: Wed, Oct 7, 2020 at 3:14 PM

Subject: Re: regarding the Board of studies CCBB

To: Mahesh Kulharia <[kulharia@hpcu.ac.in](mailto:kulharia@hpcu.ac.in)>

Dear Dr Kulharia

I am approving the minutes of BOS sent by you.

Thanks & Regards

**डॉ सुनील कुमार / Dr Sunil Kumar**

सह-प्रोफेसर और विभागाध्यक्ष / Assoc. Prof. & Head

जंतु विज्ञान विभाग / Department of Animal Sciences

जैविक विज्ञान स्कूल / School of Life Sciences

हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय / Central University of Himachal Pradesh

अस्थायी शैक्षणिक खण्ड, शाहपुर / TAB Shahapur, Kangra HP - 176206

Mob. 9418050067, 7018445774. website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)






# Academic Activity Schedule for Centre for Computational Biology and Bioinformatics

Annexure  

The detailed annual schedule for academic and lab activity for the Centre for Computational Biology.

S.No.	Activity	Date/Schedule
1.	RAC schedule of PhD scholars	1-Jan to 31-Jan
2.	Monthly Lab cleaning Schedule	1 week of every month
3.	Board of studies meeting	1-Feb to 28 Feb
4.	Lab Inspection	1-March to 7-March
5.	Centre's File Auditing	15-May to 22-May
6.	RAC Schedule of PhD scholars	1-July to 30-July
7.	Annual Asset verification Schedule	1-July to 7-July
8.	Board of studies meeting	1-Aug to 31 Aug
9.	Lab Inspection	1-Oct to 7-Oct
10.	Centre's File Auditing	15-Nov to 22-Nov
11.	Report Submission for M.Sc. Dissertation-I (CBB 599A)	7-Nov to 14-Nov
12.	Viva for M.Sc. Dissertation-I (CBB 599A)	22-Nov to 1-Dec
13.	Report Submission for M.Sc. Dissertation-II (CBB 599B)	7-May to 14-May
14.	Viva for M.Sc. Dissertation M.Sc. Dissertation-II (CBB 599B)	22-May to 1-June
15.	G.N. Ramachandran Technology Skill Festival	1 to 15 October
16.	Open Seminar of faculty, research fellows and PhD scholars for research aptitude inculcation	Last working Friday of every month

**List of external experts for M.Sc. Practicals and Dissertation Viva Evaluation**  
**Centre for Computational Biology and Bioinformatics**  
**Central University of Punjab**

Dr. R. K. Chahohta  
Professor  
Department of Agricultural Biotechnology  
CSK Himachal Pradesh Agriculture University Palampur-176062 (HP) INDIA  
Tel: 94183-69800  
Email: rkchahota@gmail.com

Dr Sneh Sharma  
Associate Professor  
Department of Biotechnology  
College of Horticulture and Forestry  
Neri, Hamirpur (HP)-177 001  
Email: snehasharma\_ss@yahoo.co.in  
Mob no : 9805468689

Dr. Vinod Pathania  
Associate Professor  
Head of Department of Pharmaceutical Sciences  
Central University of Punjab  
Bathinda  
Email: vpathania18@gmail.com  
Tel: 7018660635

Dr. Jagmohan Singh  
Principal Scientist  
IMTECH  
Chandigarh  
Contact Number: 9417182983  
Email: jsjagsingh@gmail.com

Dr. Sudhir Kumar  
Professor (Chemistry) & Head  
Bioinformatics Section, College of Basic Sciences & Humanities  
CCS Haryana Agricultural University, Hisar-125004  
Phone Number: 01662-289114  
Mobile: 9466242051  
Email: Sudhir@hau.ernet.in

Prof. Desh Deepak Singh  
Department of Biotechnology  
Panjab University  
Sector 14, Chandigarh, 160014  
Contact No.: +91 9228379835  
Email: ddsingh@pu.ac.in

Dr. Debasisa Mohanty  
National Institute of Immunology New Delhi 110067

Tel 01126703749  
Email: deb@nii.res.in

Dr. Purshottam Kumar  
Chemistry Department  
Punjab University, Chandigarh  
Tel:9855855239  
Email: sonumultip@gmail.com

Dr. Sudip Chakraborty  
Head of the Department  
Computational Sciences  
Central University of Punjab  
Bathinda  
Tel:9902728016  
Email: sudip.hammer@gmail.com

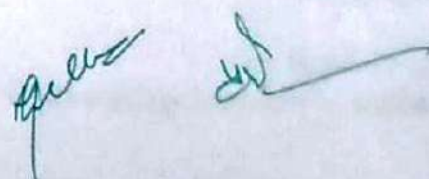
Dr. Kousik Giri  
Former Head of the Department  
Computational Sciences  
Central University of Punjab  
Bathinda  
Tel: 9501586930  
Email: kousik.giri@gmail.com

Er. Surinder Singh Khurana  
Department of Computer Science and Technology  
Central University of Punjab  
Bathinda  
Tel:987837711  
Email: surinder.seeker@gmail.com

Prof. Anjana Munshi  
Department of Human Genetics and Molecular Medicine  
Central University of Punjab  
Bathinda  
Tel: 9872694373  
Email:anjanadurani@yahoo.co.in

Dr. Vishal Goyal  
Designation: Professor  
Department Of Computer Science,  
Punjabi University, Patiala, Punjab, India.  
Mobile: 9501096111  
Email:vishal.pup@gmail.com

Dr. Anil Kumar Verma  
Designation: Professor  
Address: Thapar University  
Patiala, Punjab Contact No. +91-9888-601-667  
Email: akverma@thapar.edu



Dr. Neeraj Dilbaghi  
Professor Incharge Radio Ecology Centre (NanoBio Technology)  
Guru Jambheshwar University of Science & Technology  
Hisar- 125 001, Haryana  
Contact Number: 01662-263500, 01662-263349  
Email: ndnano@gmail.com , ndnano@gjust.org



**TABLE-I: Curricular Framework for M.Sc. CBB based on Choice Based Credit System (CBCS) (Batch: 2020-21 onwards)**

Semester	Semester Credits	Core - Compulsory	Subject Credits	Semester Credits	Core Open	Subject Credits
I	10	CBB 401 - Sequence Analysis	4	6	CBB 405 - Basics of Biochemistry	4
		CBB 402 - Statistical Mechanics	2		CBB 406 - Concepts of Genetics	2
		CBB 403 - Sequence Analysis Lab	2		CBB 407 - Biomolecules	2
		CBB 404 - Programming Lab I	2		CBB 408 - Fundamentals of Molecular Dynamics simulations	2
II	12	CBB 451 - Biomolecular Structure Modelling	4	4	CBB 456 - Cell and Molecular Biology	2
		CBB 452 - Algorithms in Computational Biology	2		CBB 457 - Essentials of Immunology	2
		CBB 453 - Molecular Evolution	2		CBB 458 - Statistical Genetics	4
		CBB 454 - Molecular Simulations Lab	2			
		CBB 455 - Programming Lab II	2			
Semester	Semester Credits	Core - Compulsory	Subject Credits	Semester Credits	Elective Open	Subject Credits
III	10	CBB 501 - Computational Genomics and Proteomics	4	4	CBB 503 - Plant Bioinformatics	4
		CBB 502 - Chemoinformatics	2		CBB 504 - Biological Database Management Systems	2
		CBB 599A - M.Sc. Dissertation I	4		CBB 505 - Database Management Lab	2
IV	16	CBB 551 - Elements of Systems Biology	4	4	CBB 553 - Fundamentals of Metabolomics	2
		CBB 552 - Computer Aided Drug Discovery	4		CBB 554 - Metabolomics Practicals	2
		CBB 599B - M.Sc. Dissertation II	8			

*[Handwritten signatures and marks in blue ink]*

Semester	Semester Credits	Elective Structural Bioinformatics (Specialization)	Credits
III	6	CBB 506 – Computational Methods in Structure Analysis	4
		CBB 507 – Structure Prediction Lab	2
Semester	Semester Credits	Elective Applied Plant Bioinformatics (Specialization)	
III	Semester 6	CBB 508 – Next Generation Sequencing: methods and data analysis	4
		CBB 509 – Practical course on R programming in Bioinformatics	2
Semester	Credits	Elective Network Bioinformatics (Specialization)	
III	Semester 6	CBB 510 – Introduction to Dynamical Systems: From Cells to Societies	4
		CBB 511 – Numerical Methods for Computational Biologists	2

*Amem*

**Human Making and Skill Development Courses to be offered by the Department of Animal Sciences:-**

**SEMESTER-I**

<b>Human Making Courses (Total Credits =02)</b>			<b>Credits</b>
1	CBB 409	Biosafety Issues	2
<b>Skill Development Courses (Total Credits = 02)</b>			
1	CBB 410	Machine Learning - I	2

<b>Foundation Courses (Total Credits =02)</b>			
1	CBB 411	Fundamentals of Computational Techniques & Mathematics	2 Credits
2	CBB 412	Biology for Non-Biologists	2 Credits

Every student will opt for one of the above courses as these will be a customised foundation course for bridging the knowledge gaps.

1. for students with biology background to familiarize them with the IT/Mathematical concepts as required in later semesters – Fundamentals of Computational Techniques & Mathematics; Course Code: 411
2. for students with non-biology background to familiarise them with the biological concepts as required in the later semesters- Biology for Non-Biologists; Course Code 412

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**SEMESTER-II**

<b>Human Making Course (Total Credits = 02)</b>			<b>Credits</b>
1.	CBB 459	History of Sciences and Technology in India	2
<b>Skill Development Course (Total Credits = 02)</b>			
1.	CBB 460	Machine Learning II	2







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## Semester I

Credits	Core - Compulsory	Credits
8	CBB 401 - Sequence Analysis	2
	CBB 402 - Statistical Mechanics	2
	CBB 403 – Sequence Analysis Lab	2
	CBB 404 - Programming Lab I	2

Credits	Core Open	Credits
6	CBB 405 - Basics of Biochemistry	4
	CBB 406 - Concepts of Genetics	2
	CBB 407 - Biomolecules	2
	CBB 408 – Fundamentals of Molecular Dynamics simulations	4

Human Making Courses (Total Credits =02)		
1	CBB 409	Biosafety Issues
Skill Development Courses (Total Credits = 02)		
1	CBB 410	Machine Learning - I

Foundation Courses (Total Credits =02)			
1	CBB 411	Fundamentals of Computational Techniques & Mathematics	2 Credits
2	CBB 412	Biology for Non-Biologists	2 Credits

Every student will opt for one of the above courses as these will be a customised foundation course for bridging the knowledge gaps.

1. for students with biology background to familiarize them with the IT/Mathematical concepts as required in later semesters – Fundamentals of Computational Techniques & Mathematics; Course Code: 411
2. for students with non-biology background to familiarise them with the biological concepts as required in the later semesters- Biology for Non-Biologists; Course Code 412



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Sequence Analysis**

**Course Code: CBB.401**

**Total Hours: 60**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

## Course Content

### Unit 1

**13 Hours**

Basic concepts of sequence similarity, identity and homology, homologues, orthologues, paralogues and xenologues Pairwise sequence alignments: basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties

### Unit 2

**10 Hours**

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series Tools such as BLAST (various versions of it) and FASTA

### Unit 3

**12 Hours**

Multiple sequence alignments (MSA): basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW (including interpretation of results), concept of dendrogram and its interpretation.

### Unit 4

**10 Hours**

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

**Transactional Modes:** Lecture; Problem solving; Self-learning.

## Suggested Reading

1. A.D. Baxevanis *et. al.*, Current Protocols in Bioinformatics, (2005) Wiley Publishers
2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN81-203-2550-8
4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1
5. N.Gautham Bioinformatics Narosa publications. (2006) ISBN-13: 9781842653005

**TABLE-I: Course Work of Advance Diploma in Bioinformatics**

Semester	Semester Credits	Course Title	Subject Credits
I	20	ADB 601 – Sequence Analysis	4
		ADB 602 – Computer Aided Drug Discovery	4
		ADB 603 – Fundamentals of Molecular Dynamics simulations	2
		ADB 604 – Statistical Mechanics	2
		ADB 605 – Programming Lab I	4
		ADB 606 – Sequence Analysis Lab	4
<b>Total</b>			20

Semester	Semester Credits	Course Title	Subject Credits
II	20	ADB 651 - Biomolecular Structure Prediction	4
		ADB 652 – Algorithms in Computational Biology	2
		ADB 653 – Molecular Evolution	2
		ADB 654 - Molecular Simulations Lab	4
		ADB 655 - Programming Lab II	4
		ADB 656 – Biomolecular Structure Prediction Lab	4
<b>Total</b>			20

*[Handwritten signatures]*

Central University of Himachal Pradesh

Centre for Computational Biology and Bioinformatics  
School of Life Sciences



**BOARD OF STUDIES MEETING**

Scrutinised and Approved on 29<sup>th</sup> **DECEMBER, 2020** at TAB SHAHPUR

*Kulharni*  
29/12/2020

Venue: Seminar Hall,  
Central University of Himachal Pradesh  
Temporary Academic Block, Shahpur



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## PROGRAMME OUTCOMES (M.Sc. Bioinformatics)

Student graduating after successful completion of this course shall be able to

- Critically analyse current issues and trends influencing the field of Bioinformatics.
- Competent to carry out understanding complex information from the concurrent scientific literature, identify the knowledge lacunae, shortlist attainable objectives, design comprehensive methodology and carry out the unsupervised research.
- Shall have scientific temperament.
- Establish professional relationships and development of professional competencies
- Develop understanding and reflections on higher education policies and practices.



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## Semester I

Credits	Core - Compulsory	Credits
10	BIN 401 Sequence Analysis	2
	BIN 402 Biomolecular Structure Analysis	2
	BIN 403 Linux and Shell Scripting Lab	2
	BIN 404 Sequence and Structure Analysis Lab	2
	BIN 405 Python Programming Lab I	2

Credits	Core Open	Credits
6	BIN 406 Basics of Biochemistry	2
	BIN 407 Concepts of Genetics	2
	BIN 408 Basic Mathematics for Life Sciences	2
	BIN 409 Statistical Methods	4

Human Making (2)	Credits
BIN 410 History of Science in India	2

Skill Development (2)	Credits
BIN 411 Fundamentals of machine learning	2



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Sequence Analysis**

**Course Code: BIN.401**

**Credits earned: 2**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

## Course Content

### Unit 1

Basic concepts of sequence similarity, identity and homology, homologues, orthologues, paralogues and xenologues Pairwise sequence alignments: basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties

### Unit 2

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series Tools such as BLAST (various versions of it) and FASTA

### Unit 3

Multiple sequence alignments (MSA): basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW (including interpretation of results), concept of dendrogram and its interpretation.

### Unit 4

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

**Transactional Modes:** Lecture; Problem solving; Self-learning.

### Suggested Reading

1. A.D. Baxevanis *et. al.*, Current Protocols in Bioinformatics, (2005) Wiley Publishers
2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN81-203-2550-8
4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1
5. N.Gautham Bioinformatics Narosa publications. (2006) ISBN-13: 9781842653005



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Biomolecular Structure Analysis**

**Course Code: BIN.402**

**Credits earned: 2**

## LEARNING OUTCOMES

The overall goal of this course is to give students advanced knowledge of the relationship between the structure and function of biomolecules and to handle different tools used in structural bioinformatics.

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

explain the basis of biological macromolecules constitution and traits

explain the basis of biological catalysis

explain the constitution of molecular complexes like ribosomes and viruses and aggregates like filaments and tubules

use databases with information of structure and function of macromolecules

use and analyse results from methods used to predict secondary- and tertiary structure of macromolecules

## COURSE CONTENT

### Unit 1

Methods for the determination of macromolecules structure and interaction.

Basic macromolecular structure; DNA, RNA, protein, lipids and carbohydrates.

### Unit 2

The folding process and structural background to the dynamics of macromolecules.

Binding specificity, catalysis and cooperativity in enzymes and receptors.

Macromolecules function described by a few specific examples.

### Unit 3

Biological structure databases.

Structure analysis and classification of proteins in structural families.

Relation between sequence, structure and function.

### Unit 4

Computer modelling of secondary- and tertiary structure of proteins and nucleic acid based on sequence data.

Enzyme/receptor-based drugs-rational drug design.

## Transactional Mode

Lectures, seminars.

## Suggested Reading

1. Liljas, Anders Textbook of structural biology New Jersey: World Scientific, cop. 2009
2. Tooze, Branden An Introduction to Protein Structure. 2014





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Website: [www.euhimachal.ac.in](http://www.euhimachal.ac.in)

**Course Title: Linux and Shell Scripting Lab**

**Course Code: BIN.403**

**Credits earned: 4**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Linux administration
- File / Data management
- Stream processing

## Course Content

### Unit 1

What is Linux, Linux architectures: root, files system, standard directories

general commands for files and directories cd, ls, cp, rm, mkdir, rmdir, pwd, file, more, less

Creating and viewing files using cat file comparisons

Essential Linux commands: Processes in Linux, Process fundamentals, Connecting processes with pipes, Redirecting input, Redirecting output, Background processing

### Unit 2

Managing multiple processes, Process scheduling – (at, batch), nohup command, kill, ps, who

find, sort, touch, file, file processing commands – wc, cut, paste etc.

Mathematical commands – expr, factor etc

Creating files with editors: vi, vim, kate, Kwrite, pico etc

### Unit 3

System administration

Common administrative tasks

identifying administrative files

Configuration and log files

Role of system administrator

Managing user accounts -adding users

Managing user accounts -deleting users

Changing permissions and ownerships

Creating and managing groups

Modifying group attributes

### Unit 4

Simple filter commands & Understanding various Servers.

Filter Commands-pr, head, tail

Filter Commands -cut, sort.

Filter Commands- uniq, tr.

Filter using regular expression grep.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

## Suggested Readings:

1. Cristopher Negus – Red Hat Linux Bible, Wiley Dreamtech India 2005 edition.
2. Yeswant Kanethkar – UNIX Shell Programming, First edition, BPB.

Text Books for Enrichment

## References :

1. Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India
2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education.
3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth edition, Wiley Dreamtech India.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Sequence and Structure Analysis Lab

**Course Code:** BIN.404

**Credits earned:** 4

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

Introduction to Bioinformatics and Sequence Analysis. In addition to lecture material, skills needed for future problem set assignments will be covered. This will include taking screenshots, formatting of text and generation of reports.
Internet Resources focusing on text-based searches of literature, molecular, and medical databases. We will again work on the skills needed for generating reports.
Searching DNA databases with DNA queries: BLASTN. First problem set assignment focused on material from this lecture: 5 grade points maximum.
Searching protein databases with protein queries: BLASTP. Second problem set assignment focused on material from this lecture: 10 grade points maximum.
Cross-molecular searches: BLASTX and TBLASTN. Third problem set assignment focused on material from this lecture: 10 grade points maximum.
Advanced topics in BLAST
Protein Analysis Fourth problem set assignment focused on material from this lecture: 10 grade points maximum.
Analysis problems involving short sequences Fifth problem set assignment focused on material from this lecture: 5 grade points maximum.
MicroRNAs and Pathway Analysis Sixth problem set assignment focused on material from this lecture: 5 grade points maximum.
Multiple Sequence Alignments
Exploring the genome with Genome Browsers
Secondary Structure Prediction Methods – Chou Fasman, GOR, Neural Networks 3D structure visualization: Pymol, Rasmol, VMD

**Suggested Reading:**

“Practical Bioinformatics” by Michael Agostino ISBN 978-0-8153-4456-8



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Python Programming Lab I**

**Course Code: BIN.405**

**Credits earned: 4**

**Learning Outcomes:** Upon successfully completing this course, students will be able to “do something useful with Python”.

- Identify/characterize/define a problem
- Design a program to solve the problem
- Create executable code
- Read most Python code
- Write basic unit tests

## Course Content

1. Working with Data. A detailed tour of how to represent and work with data in Python. Covers tuples, lists, dictionaries, and sets. Students will also learn how to effectively use Python's very powerful list processing primitives such as list comprehensions. Finally, this section covers critical aspects of Python's underlying object model including variables, reference counting, copying, and type checking.
2. Program Organization. Functions, and Modules. More information about how to organize larger programs into functions and modules. A major focus of this section is on how to design functions that are reliable and can be easily reused across files. Also covers exception handling, script writing, and some useful standard library modules.
3. Classes and Objects. An introduction to object-oriented programming in Python. Describes how to create new objects, overload operators, and utilize Python special methods. Also covers basic principles of object oriented programming including inheritance and composition.
4. Inside the Python Object System. A detailed look at how objects are implemented in Python. Major topics include object representation, attribute binding, inheritance, memory management, and special properties of classes including properties, slots, and private attributes.

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- The Python Tutorial (<https://docs.python.org/3/tutorial/>): This is the official tutorial from the Python website. No more authoritative source is available.
  - Code Academy Python Track (<http://www.codecademy.com/tracks/python>): Often cited as a great resource, this site offers an entertaining and engaging approach and in-browser work.
  - Learn Python the Hard Way (<http://learnpythonthehardway.org/book/>): Solid and gradual. This course offers a great foundation for folks who have never programmed in any language before.
- [Python 2]



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Website: [www.euhimachal.ac.in](http://www.euhimachal.ac.in)

**Course Title: Basics of Biochemistry**

**Course Code: BIN.406**

**Credits earned: 2**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student comprehends the following:

- The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- The energy metabolism by cellular components in cells and the process of mitotic cell division.
- Influences of changes or losses in cell function; including the responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

## Course Content

### Unit 1

Principles of biophysical chemistry Thermodynamics, Colligative properties, Stabilizing interactions: Van der Waals, Electrostatic, Hydrogen bonding, Hydrophobic interaction, etc.

### Unit 2

Composition, structure, function and metabolism of Carbohydrates, Lipids.

### Unit 3

Composition, structure, function and metabolism of Amino Acids and Nucleotides.

### Unit 4

Enzymology: Classification, Principles of catalysis. Mechanism of enzyme catalysis, Enzyme kinetics, Enzyme regulation, Isozymes.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry*. W.H. Freeman & Company. USA.
2. Brown, T.A. (2006). *Gene Cloning and DNA analysis: In Introduction*. Blackwell Publishing Professional. USA.
3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.
4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.
5. Nelson, D. and Cox, M.M. (2013). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.
6. Ochiai, E. (2008). *Bioinorganic chemistry: A survey*. Academic Press. Elsevier, India.

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Temporary Academic Block, Shahpur, Distt. Kangra (HP) – 176206

Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)



7. Randall, D. J., Burggren. W. and French, K. (2001). *Eckert animal physiology*. W.H. Freeman & Company. USA.
8. Raven, P.H., Johnson, G.B. and Mason, K.A. (2007). *Biology*. Mcgraw-Hill. USA.
9. Shukla AN (2009). *Elements of enzymology*. Discovery Publishing. New Delhi, India.
10. Voet, D. and Voet, J.G. (2014). *Principles of biochemistry*. CBS Publishers & Distributors. New Delhi, India.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Concepts of Genetics**

**Course Code: BIN.407**

**Credits earned: 2**

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

- gain a deep knowledge about the structures and organisation of nucleic acids
- learn DNA replication, Inheritance patterns

## Course Content

### Unit 1

Introduction and scope of genetics, DNA as genetic material: Double helical structure, Structure of DNA and RNA, Different types of DNA molecules, forces stabilizing nucleic acid structure, super coiled DNA, properties of DNA, denaturation and renaturation of DNA and Cot curves. DNA replication: Basic mechanism of DNA replication.

### Unit 2

Cell division and Cell cycle: Mitosis, Meiosis Concepts of Linkage analysis and gene mapping: Coupling and repulsion phase linkage, Crossing over and recombination. Population genetics: Application of Mendel's laws to populations, Hardy-Weinberg principle, inbreeding depression and heterosis, inheritance of quantitative traits.

### Unit 3

Gene Interaction: Sex determination and Sex linked inheritance, Sex determination in humans, *Drosophila* and other animals, Sex determination in plants, Sex linked genes and dosage compensation.

### Unit 4

Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* Chromosomal aberrations: Types of changes— deletions, duplications, inversions, translocations, Change in chromosome number: trisomy and polyploidy.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Reading

1. Anthony, J.F., Miller, J.A., Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The science of Genetics*. Saundern College publication.
3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Gupta, P.K. (2009). *Genetics*. Rastogi publications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
6. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.



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7. Schaum, W.D. (2000). *Theory & problems in Genetics by Stansfield, out line series McGrahill, USA.*
8. Tamarin, R.H. (1996). *Principles of Genetics, International edn. McGrawhill, USA.*





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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Basic Mathematics for Life Sciences**

**Course Code: BIN.408**

**Credits earned: 2**

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

1. Identify and describe the basic mathematical techniques that are commonly used by chemist.
2. Develop skills in vectors, matrices, differential calculus, integral calculus and probability.
3. Apply the principles to a number of simple problems that have analytical solutions.
4. Design different methods to problems related to chemistry.

## Course Content

### Unit-1

Vectors in 2D, 3D and in general, circles, transformation of coordinates, polar coordinates, parametric equations, and the solid analytic geometry of vectors, lines, planes, spherical coordinate.

### Unit-2

Functions, limits, derivative, physical significance, basic rules of differentiation, maxima and minima, exact and inexact differentials, partial differentiation.

### Unit-3

Using computational tools for: Addition and multiplication; inverse, adjoint and transpose of matrices, matrix equation. Introduction to vector spaces, matrix eigen values and eigen vectors, diagonalization, determinants (examples from Huckel theory).

### Unit-4

Tools for applying Basic rules for integration, integration by parts, partial fraction and substitution, definite integrals, evaluation of definite.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### Suggested readings

The chemistry Mathematics Book, E.Steiner, Oxford University Press (2008).

Mathematical for Physical Chemistry : F. Daniels, Mc. Graw Hill (1959).

Chemical Mathematics D.M. Hirst, Longman (1979).

Basic Mathematics for Chemists, Tebbutt, Wiley (1994).

G. Arfken, H. Weber and F. Harris, *Mathematical Methods for Physicists* (Elsevier Academic Press, Massachusetts, USA) 2012.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Statistical Methods**

**Course Code: BIN.409**

**Credits earned: 4**

## Course Objectives:

This course will introduce the students to the concepts and methods of statistics, covering topics such as data organization and presentation, data analysis, probability, estimation and hypothesis testing and their application to the biological data. Students will be encouraged to use Python or R to gain computational hands-on learning about the topics covered. At the end of the course, students will be able to:

1. Develop an understanding of the fundamental theoretical aspects of methods of statistics and probability.
2. Develop the foundational skills in statistical analysis for Bioinformatics and Data Science.

## Course Contents:

### Unit-I: Introductory concepts

- Big Data in Biology: Need of Statistical measures to analyze it.
- Statistical population and sample: Types of data, Relative and cumulative frequency.
- Organization and presentation of data.
- Descriptive measures:
  - Measures of Central tendency: Mean, Median, Mode: notation and formulae, grouped data, relative merits
  - Measures of Dispersion: Absolute and relative measures.

### Unit-II: Probability concepts

- Basic probability models: Combinatorics based computation, Bayes' rule
- Basics of Monte Carlo simulations
- Discrete random variables: Expected value, Variance, Covariance
- Discrete parametric distributions: (i) One Bernoulli Trail, (ii) Binomial distribution, (iii) Uniform distribution, (iv) Poisson distribution, (v) Power-law distribution
- Continuous probability models: Cumulative distribution function, Density functions
- Continuous probability distributions:
  - (i) Uniform distribution, (ii) Normal distribution: Standard deviation, Variance, Skewness and Kurtosis, z-score (iii) Exponential distribution.

### Unit III: Statistics concepts

- Statistical preliminaries: Sample mean, Sample variance, Standard error
- Continuous models fitting: Method of moments, Method of maximum likelihood, Goodness of fit
- Family of normal distributions: Standard normal distribution. The central limit theorem, Chi-squared distribution
- Statistical inference: Confidence intervals, Student-t distribution, Significance tests, p-values, P-hacking, ANOVA

### Unit IV: Multivariate analysis

*[Handwritten signatures]*



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- Discrete and continuous multivariate distributions
- Covariance and correlation
- Dimensionality reduction: principal component analysis
- Clustering, Classification, Regression
- Model parsimony and over-fitting

## Text Books:

1. Ewens and Grant (2005), Statistical Methods in Bioinformatics, Springer
2. Matloff (2020). Probability and Statistics for Data Science, CRC
3. Prem S. Mann (2018), Introductory Statistics, Wiley
4. Daniel and Cross (2019), Biostatistics, Wiley

## Reference Books:

- Murray Spiegel et al. (2010), Probability and Statistics. McGraw Hill Education.  
Roger E. Kirk (2007), Statistics: An Introduction, Cengage Learning.  
Neil A. Weiss (2012), Introductory Statistics.  
Charles Henry Brase and Corrinne Pellillo Brase (2011), Understandable Statistics: Concepts and Methods.  
J. H. Zar (2019), Biostatistical Analysis, Pearson



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: History of Science in India**

**Course Code: BIN.410**

**Credits earned: 2**

**Course Objectives:** This course is designed to introduce students about the rich scientific culture of India. The course attempts to develop a quest for search and research of scientific concepts embedded in the traditional Indian texts and rituals. For that, each topic covered in the course is taught by integrating two aspects: its modern scientific understanding and its discussion in the Indian literature. Prominent Indian Scientists, the Acharyas and the Rishis associated with a topic under discussion are duly introduced and acknowledged. The semester for offering this course can be altered as per departmental/faculty requirements.

## Course Contents

### Unit 1: Introductory concepts

- Antiquity of Indian civilization
- The archaeological sources
- The literature sources: Vedas and Vedangas, Epics and Puranas, Sastras (Niti, Artha), etc.
- Needham's puzzle

### Unit 2: Mathematics

- The Sulbasutras
- Concept of pi
- Zero, decimal number system, place value system, combinatorics
- Katapyadi system, binary number system
- Fibonacci series and golden ratio

### Unit 3: Physics and Astronomy

- The Vaisheshika: Matter and Universe (Notions of Padarth, Dravya and Guna)
- Measurements of length and mass
- Kaal ganana, calendars and eclipses: Five siddhants
- Laws of motion, concept of gravity and relativity
- Sound, light and energy

### Unit 4: Life Sciences and Medicine

- Plants and agriculture, the Vrikshayurveda
- Microbes, animals and humans
- Origin and evolution of Ayurveda
- Basic concepts; food, drinks and materia-medica; diseases; medicine; surgery; holistic view of life

### UNIT 5: Engineering Sciences and Technology

- Architecture and Vastu Shastra
- Alchemy and metallurgy
- Marine science

**Text Books:**

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- Suresh Soni (2008). India's Glorious Scientific Tradition. Ocean Books
- Bose et al. (2009). A Concise History of Science in India. Universities Press

## Additional Readings:

- BB Datta and AN Singh (1962). History of Hindu Mathematics. Asia Publishing House
- NG Dongre and SG Nene (2016). Physics in Ancient India. National book Trust.
- MS Valiathan. The Legacy of Caraka/ Susruta/ Vagabhata. Universities Press.
- P.C. Ray (1903). A History of Hindu Chemistry. The Bengal chemical and pharmaceutical works ltd.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Fundamentals of Machine Learning**

**Course Code: BIN.411**

**Credits earned: 2**

**Learning Outcomes:** At the end of the course, the students will be able to understand the basics of Machine learning. The semester for offering Foundation courses can be altered as per departmental requirements.

## Course Content

### Unit 1

Class overview: Class organization, topics overview, software etc.  
Introduction: what is ML; Problems, data, and tools; Visualization

### Unit 2

Linear regression; SSE; gradient descent; closed form; normal equations; features  
Overfitting and complexity; training, validation

### Unit 3

Classification problems; decision boundaries; nearest neighbor methods  
Probability and classification

### Unit 4

Naive Bayes and Gaussian class-conditional distribution, Linear classifiers, Bayes' Rule and Naive Bayes Model

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### Suggested Readings:

- Ethem Alpaydin, Introduction to Machine Learning, Second Edition, <http://mitpress.mit.edu/catalog/item/default.asp?tttype=2&tid=12012>.
- Stephen Marsland, Machine Learning: An Algorithmic Perspective. <http://www.amazon.com/Machine-Learning-Algorithmic-PerspectiveRecognition/dp/1420067184>
- Christopher M. Bishop. Pattern Recognition and Machine Learning. <http://research.microsoft.com/en-us/people/cmbishop/prml/>.
- Tom Mitchell, Machine Learning. <http://www.cs.cmu.edu/~tom/mlbook.html>.



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## Semester II

Credits	Core - Compulsory	Credits
10	BIN 451 Algorithms in Bioinformatics	4
	BIN 452 Fundamentals of Molecular Dynamics simulations	2
	BIN 453 Molecular Dynamics Simulation Lab	2
	BIN 454 Python Programming Lab II	2
		2

Credits	Core Open	Credits
6	BIN 455 Cell and Molecular Biology	2
	BIN 456 Essentials of Immunology	2
	BIN 457 Statistical Genetics	2
	BIN 458 Biological Databases and Management System	2
	BIN 459 DBMS Lab	2

	Human Making (2)	Credits
BIN 460 Biosafety Issues		2
	Skill Development (2)	Credits
BIN 461 Elements of Data Science		2

**Course Title: Algorithms in Bioinformatics**

**Course Code: BIN.451**

**Credits earned: 4**

**Course Objectives:** The course is designed to introduce students the algorithmic principles, central to the studies in Computational Biology and Bioinformatics. Concepts from computer science like dynamic programming and graph theory will enable students to understand a variety of concepts that are used in the theoretical studies of life sciences and expose them to the underlying mechanisms of widely used softwares. Students, who are familiar with at least one programming language, will be encouraged to write their own codes for various algorithms discussed in this course.

### Course Content

#### Unit 1: Introduction to algorithms and complexity

Basic Concepts: Algorithmic complexity (spatial and temporal), Biological vs. Computer algorithms, Genetic algorithm.

Standard Notations: Big-Oh, Omega, Theta notations; Hardness of an algorithm.

Linear and non-linear data structures, Stack, Queues, Linked list.

Introduction to algorithm design techniques: Exhaustive search, Greedy Algorithms, Divide and conquer etc.

Searching algorithms: Linear and Binary search; Sorting algorithms: Selection, Bubble, Insertion, Merge, Quick, Heap.

#### Unit 2: Sequence Analysis

6. Models of DNA evolution: Jukes Cantor, Kimura and Tamura models

7. Derivation of protein evolution models: PAM and BLOSUM

8. Elements of dynamic programming: Edit distance, Longest Common Subsequences, Global and Local Sequence Alignment

9. Working of BLAST: Usage of Finite State Machine, E-value, etc.

10. Introduction to Multiple Sequence Alignment

11. Concepts of Joint, Conditional, Marginal probabilities

12. Markov Chains and Hidden Markov Models: CpG islands, Pairwise alignment using HMMs

#### Unit 3: Pattern matching

a) Tandem and Interspersed repeats.

b) Repeat finding: Motifs, consensus, position weight matrices

c) Algorithms for derivation of and searching sequence patterns: MEME, PHI-BLAST, SCanProsite and PRATT

d) Algorithms for generation of sequence profiles: PSIBLAST, HMMer,

#### Unit 4: Phylogenetics

5. Basics of Molecular Evolution,

6. Tree - terminologies, Binary trees, AVL trees.

7. Tree traversal: Pre-order, In-order, post-order; Breadth-first search, Depth-first search.



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8. Evolutionary trees: (I) Distance based methods – UPGMA, NJ, Fitch Margoliash (FM), Minimum Evolution (ME); (II) Character based methods – MP, ML, Bayesian inference algorithm.
9. Tree Evaluation, Bootstrapping.

## Unit 5: RNA and Protein Structure Prediction

- RNA secondary structure: Nussinov algorithm, Energy minimization, Zuker's Algorithm, SCFG.
- RNA tertiary structure: Basics of “minimum free energy” based methods.
- Protein secondary structure: Chou-Fasman, GOR method.
- Protein tertiary structure: Rosetta method, Contact potential method.

## Text Books:

- Jones and Pevzner (2004), An Introduction to Bioinformatics Algorithms. MIT Press.
- Durbin *et al.* (1998), Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press
- Mount (2004), Bioinformatics: Sequence and Genome Analysis, CBS Publishers
- Pevsner (2015), Bioinformatics and Functional Genomics. Wiley.

## Additional Readings:

- Gusfield (2005), Algorithms on Strings, Trees and Sequences. Cambridge University Press.
- Cormen *et al.* (2009), Introduction to Algorithms. MIT Press.
- Sung (2009), Algorithms in Bioinformatics: A Practical Introduction. Chapman & Hall/CRC.
- Neapolitan and Naimipour (2011), Foundations of Algorithms. Jones & bartlett.
- Korf *et al.* (2003), BLAST. O'Reilly
- Junker and Schreiber (2008), Analysis of Biological Networks. Wiley-Interscience, New Jersey.
- Mitchell (1998), An Introduction to Genetic Algorithms. MIT Press.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Fundamentals of Molecular Dynamics Simulation**

**Course Code: BIN.452**

**Credits earned: 2**

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

- learn the modelling of small to large molecular environments
- understand various force field for biomolecular simulation in details
- gain the knowledge about different molecular simulation techniques
- learn different methods for simulating large systems
- understand the dynamics of the structural transitions

## Course Content

### Unit 1

Biomolecular Modeling and Structure - molecular modeling today: overview of problems, tools, and solution analysis, minitutorials in protein and nucleic acid structure. Techniques for Conformational Sampling- Monte Carlo, global optimization, etc.

### Unit 2

Molecular Mechanics: general features, bond stretching, angle bending, improper torsions, out of plane bending, cross terms, non-bonded interactions, Ramachandran diagram point charges, calculation of atomic charges, polarization, van der waals interactions, hydrogen bond interactions, Water models, Force field, all atoms force field and united atom force field.

### Unit 3

Energy minimization: Steepest descent, conjugate gradient – Derivatives, First order steepest decent and conjugate gradients. Second order derivatives Newton-Raphson, Minima, maxima saddle points and convergence criteria.-non derivatives minimization methods, the simplex, sequential univariate, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, Solvent access, Equilibration, cut-offs.

### Unit 4

Simulation methods: algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzmann velocity, time steps, duration of the MD run, Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions. Various methods of MD, Monte Carlo, systematic and random search methods. Differences between MD and MC, Energy, Pressure, Temperature, Temperature dynamics, simulation softwares. Various methods of MD, Monte Carlo, systematic and random search methods.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### Suggested Readings

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
2. Fenniri, H. "Combinatorial Chemistry – A practical approach", (2000) Oxford University Press, UK.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.

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4. Gordon, E.M. and Kerwin, J.F. "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.

**Course Title: Molecular Dynamics Simulation Lab**

**Course Code: BIN.453**

**Credits earned: 4**

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

- learn the modelling of small to large molecular environments
- understand various force field for biomolecular simulation in details
- learn different methods for simulating large systems
- gain the knowledge about different molecular simulation techniques understand the dynamics of the structural transitions

## Course Content

1. Visualization Software and 3D representations with VMD and PYMOL
2. Coordinate generations and inter-conversions.
3. Energy minimizations and optimization.
4. Molecular Dynamics with Gromacs:
  - Protein in water
  - Membrane protein
  - Umbrella Sampling
  - Free Energy of Solvation
  - Protein ligand interaction
  - Free Energy of Solvation

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings:

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
2. Fenniri, H. "Combinatorial Chemistry – A practical approach", (2000) Oxford University Press, UK.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. Gordon, E.M. and Kerwin, J.F. "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Python Programming Lab II**

**Course Code: BIN.454**

**Credits earned: 4**

**Learning Outcomes:** Upon successfully completing this course, students will be able to “do something useful with Python”.

- Identify/characterize/define a numerical problem
- Design a program to solve the data parsing problem
- Create Time series code
- Read most of the advanced Python code

## Course Content

- Introduction to Numpy and Pandas
- Visualizations with Matplotlib and Seaborn
- Statistical analysis to understand our data
- Data cleaning and normalization.
- Advanced Pandas models
- Hierarchical indexing
- Data Wrangling and transformations
- Advanced visualizations
- Introduction to Machine Learning
- Intro to Regressions- Linear and logistic regression using Scikit Learn
- Intro to Classification- Classification with K nearest Neighbours- Decision Trees and Random Forest

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- Core Python Programming (<http://corepython.com/>): Only available as a dead trees version, but if you like to have book to hold in your hands anyway, this is the best textbook style introduction out there. It starts from the beginning, but gets into the full language. Published in 2009, but still in print, with updated appendixes available for new language features. In the third edition, "the contents have been cleaned up and retrofitted w/Python 3 examples paired w/their 2.x friends."
- Dive Into Python 3 (<http://www.diveinto.org/python3/>): This book offers an introduction to Python aimed at the student who has experience programming in another language.
- Python for You and Me (<http://pymbook.readthedocs.org/en/latest/>): Simple and clear. This is a great book for absolute newcomers, or to keep as a quick reference as you get used to the language. The latest version is Python 3.
- Think Python (<http://greenteapress.com/thinkpython/>): Methodical and complete. This book offers a very "computer science"-style introduction to Python. It is really an intro to Python in the service of Computer Science, though, so while helpful for the absolute newcomer, it isn't quite as "pythonic" as it might be.



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- Python 101 (<http://www.blog.pythonlibrary.org/2014/06/03/python-101-book-published-today/>) Available as a reasonably priced ebook. This is a new one from a popular Blogger about Python. Lots of practical examples. Also available as a Kindle book: <http://www.amazon.com/Python-101-Michael-Driscoll-ebook/dp/B00KQTFHNK>
  - Problem Solving with Algorithms and Data Structures (<http://interactivepython.org/runestone/static/pythonds/index.html>) (Links to an external site.) Links to an external site.)
  - Python Course ([http://www.python-course.eu/python3\\_course.php](http://www.python-course.eu/python3_course.php)) (Links to an external site.) Links to an external site.)
- References for getting better, once you know the basics
- Python Essential Reference (<http://www.dabeaz.com/per.html>): The definitive reference for both Python and much of the standard library.
  - Hitchhikers Guide to Python (<http://docs.python-guide.org/en/latest/>): Under active development, and still somewhat incomplete, but there is good stuff.
  - Writing Idiomatic Python (<https://www.jeffknupp.com/writing-idiomatic-python-ebook/>): Focused on not just getting the code to work, but how to write it in a really "Pythonic" way.
  - Fluent Python (<http://shop.oreilly.com/product/0636920032519.do>): All python3, and focused on getting the advanced details right. Good place to go once you've got the basics down.
  - Python 3 Object Oriented Programming (<https://www.packtpub.com/application-development/python-3-object-oriented-programming>) (Links to an external site.) Links to an external site.): Nice book specifically about Object Oriented programming structure, and how to do it in Python. From local Author and founder of the Puget Sound Programming Python (PuPPy) meetup group, Dusty Phillips.

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Name: Cell and Molecular Biology**

**Course Code: BIN.455**

**Total Lectures: 30**

## Learning Outcomes:

On successful completion of the course the student will be able to:

- Conceptualization of basic cellular and molecular mechanisms.
- Understanding structures and functions of various cellular organelles.
- Understanding the molecular processes of DNA replication, transcription, and translation

## Course Content

### Unit – I

Membranes of intracellular organelles, Membrane transport, Structure and functions of intracellular organelles, Intracellular traffic and secretory pathways, endocytosis and exocytosis.

### Unit – II

**The Cytoskeleton:** cell cytoskeleton and its organization including extracellular matrix, adhesions and junctions.

**Cell-cell communication and cell growth:** Overview of cell signaling, cell surface receptors and second messengers.

### Unit – III

**Gene and Genome organization:** Eukaryotic gene organization, transposition, Mechanism of DNA replication, DNA damage and their repair.

### Unit – IV

**Transcription:** transcription and transcription factors, Transcriptional and post-transcriptional gene silencing, mRNA processing: Capping, Polyadenylation, Splicing, editing, mRNA stability.

**Translation:** Genetic code, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, post-translational modifications of proteins.

**Transactional Modes:** Lecture; Demonstration; Tutorial; Lecture cum demonstration; Problem solving; Self-learning.

## Suggested Reading:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). *Molecular cloning: a laboratory manual*. Cold Spring Harbor Laboratory Press New York.
2. Lodish, H., Berk, A. Chris, A.K. & Krieger, M. (2011). *Molecular Cell Biology*. W.H. Freeman, USA.
3. Robertis, (2011). *Cell and Molecular Biology*. Lippincott Williams & Wilkins.
4. Karp, G. (2010). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., & Levine, M. (2003). *Molecular Biology of the Gene* Benjamin Cummings.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2007). *Molecular biology of the cell*. Garland Science. New York, 1392.
8. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.

# Central University of Himachal Pradesh

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Temporary Academic Block, Shahpur, Distt. Kangra (HP) – 176206

Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)



Course Code: : Essentials of Immunology

Course Code: BIN.456

Total Lectures: 30

## Learning Outcomes:

On successful completion of the course the student will be able to:

- Evaluate basic concepts of immune system.
- Gain knowledge about various key processes related to development of immune system.
- Understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
- Apply the knowledge how immune system is involved in diseases caused by internal or external factors.

### Unit: I

**Immune System:** The cells and organs of immune system, humoral immunity-immunoglobulin, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, antibody diversity, class switching, B and T cell development.

### Unit: II

**Immune Effectors:** Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, various effector cells of immune system: DC, NK, Monocytes etc.

### Unit: III

**Mechanisms of Immune System Diversity:** Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions.

### Unit: IV

**Immune System in Health and Diseases:** Inflammation, hypersensitivity and autoimmunity, AIDS and immunodeficiencies, vaccine development.

**Transactional Modes:** Lecture; Demonstration; Tutorial; Lecture cum demonstration; Problem solving; Self-learning.

### Suggested Reading:

- Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2018). *Kuby Immunology*. W.H. Freeman, USA.
- Abbas. (2018). *Cellular and Molecular Immunology*. CBS Publishers & Distributors, India.
- Charles, A. and Janeway, J.R. (2001). *Immunobiology: The immune system in health and disease*. Blackwell Publishing, USA.
- Delves, P.J., Roitt, I.M. and Seamus, J.M. (2016). *Roitt's Essential Immunology (Series- Essentials)*. Blackwell Publishers, USA.
- Elgert, K.D. (2015). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Code : Statistical Genetics**  
**Course Code: BIN.457**  
**Total Lectures: 30**

**Learning Outcomes:** The course is designed to ensure that the students understand the fundamentals, theoretical and practical aspects of statistics which could be applied in wide fields of life sciences.

## Course Contents

### UNIT I

- Mendel's law, Hardy Weinberg equilibrium and overview of linkage and association
- Map function & recombination fraction
- Genetic map construction

### UNIT II

- Multipoint analysis of mendalian loci
- Introduction to quantitative genetics
- Major gene detection and segregation analysis

### UNIT III

- Interval mapping & CIM
- QTL mapping & GWAS
- Statistics for population genetics

### UNIT V

- Statistics for genetic epidemiology and biomedical sciences
- Statistics for evolutionary genetics and epigenetic research
- Statistical genetics for animal and plant breeding

## Text Books:

1. D.J. Balding, M Bishop and C. Cannings. Handbook of Statistical Genetics Vol 1 & 2. *Wiley*
2. Murray R Spiegel and Larry J Stephens: Schaum's outline of statistics. *Tata McGraw Hill*
3. Sheldon M. Ross. Introductory Statistics. *Academic Press*
4. Shizhong Xu. Principles of Statistical Genomics. *Springer*



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

Course Code : BDBMS

Course Code: BIN.458

Total Lectures: 30

**Learning Outcomes:** Upon successfully completing this course, students will be able to apply principles of DBMS to create novel solution in bioinformatics.

- Identify/characterize/define and solve a data collection, sorting and management problem
- Design an approach to create a Relational DBMS
- Create non-redundant databases

## Course Content

### Unit 1

Biological Databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt, Mapping databases, Genomic databases, PDBsum, PDB, SCOP, CATH, Pathway and molecular interaction databases.

### Unit 2

Database planning and Design concepts General Database Planning and Design – Document or forms – preparation and architecture Entity-Relational ship Model- entities, Attributes, keys, tables design, relationships, roles and dependencies.

### Unit 3

Relational DB Introduction to relational DB and transactions. SQL-statements-Data Definition-Manipulation-control-Objects, - Views, sequences and Synonyms. Working with code and forms-Front end development-query sublanguage-modifying relations in SQL.

### Unit 4

Internals of RDBMS Physical data structures, query optimization. Join algorithm statistica and cost base optimization. Transaction processing.concurrency control and recovery management. Transaction model properties, state serizability, lock base protocols, two phase locking.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

- 1 Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
- 2 Elmasri Ramez and Novathe Shamkant, " Fundamentals of Database systems" (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
- 3 P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
- 4 Jim Gray and A.Reuter " Transaction processing : Concepts and Techniques" Morgan Kaufmann Press.(1997) ISBN- 10: 1558601902
- 5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279
- 6 Date C.J. " Introduction to database management" (2009) Vol1, Vol2, Vol3 addison Wesley.
- 7 Ullman, JD " Principles of Database systems" (1992) Galgottia publication
- 8 James Martin Principles of Database Management systems" (1985) PHI.
6. Introduction to NCBI Taxonomic Browser
7. DDL & DML: Creating and working with databases, creating tables, dropping tables, primary and secondary keys, data validation, simple queries using MySQL, cursors, stored procedures.
8. DTD and XML schema- simple DTD and creation of data in XML.



**Course Code: : DBMS Lab**

**Course Code: BIN.459**

**Total Lectures: 30**

**Learning Outcomes:** Upon successfully completing this course, students will be able to apply principles of DBMS to create novel solution in bioinformatics.

- Identify/characterize/define and solve a data collection, sorting and management problem
- Design an approach to create a Relational DBMS
- Create non-redundant databases

### **Course Content**

1. Data Definition, Table Creation, Constraints,
2. Insert, Select Commands, Update & Delete Commands.
3. Nested Queries & Join Queries
4. Views
5. High level programming language extensions (Control structures, Procedures and Functions).
6. Front end tools
7. Forms
8. Triggers
9. Menu Design
10. Reports.

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

### **Suggested Readings**

- 1 Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
- 2 Elmasri Ramez and Novathe Shamkant, " Fundamentals of Database systems" (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
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- 5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279
- 6 Date C.J. " Introduction to database management" (2009) Vol1, Vol2, Vol3 addison Wesley.
- 7 Ullman, JD " Principles of Database systems" (1992) Galgottia publication
- 8 James Martin Principles of Database Management systems" (1985) PHI.

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Biosafety Issues**

**Course Code: BIN.460**

**Credits earned: 2**

**Learning Outcomes:** The course is designed to introduce students to biosafety guidelines of DBT, Ministry of Science & Technology, Government of India and the World Health Organization. The semester for offering Foundation courses can be altered as per departmental requirements.

## Course Contents:

### UNIT-I: Introduction

- Introduction to the biosafety guidelines
- Constitution of institutional biosafety committees (IBSC's) and its functions
- Microbiological risk assessment

### UNIT-II: Biohazards and biosafety levels

- Biosafety level 1
- Biosafety level 2
- Biosafety level 3
- Biosafety level 4

### UNIT-III: Laboratory biosecurity, equipment and good lab practices

- Laboratory biosecurity concepts
- Biological safety cabinets and equipment
- Laboratory techniques
- Disinfection and sterilization
- Introduction to the transport of infectious substances

### UNIT-IV: Scientific Considerations

- Biosafety and recombinant DNA technology
- Chemicals, fire, electrical, noise and ionizing radiation hazards
- Human health and environmental considerations
- Containment facilities

### UNIT-V: National; International frameworks on biosafety

- Guidelines by Ministry of Environment and Forests (MoEF), & DBT Government of India
- International binding and non-binding instruments on Biosafety
- Potential overlaps and conflicts between treaties and trade concerns
- Competent authorities to regulate the biosafety issues
- Safety checklist

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.


**Suggested Readings:**

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1. Guidelines and Handbook for Institutional Biosafety Committees (IBSCs) by Department of Biotechnology, Ministry of Science & Technology, Government of India.
  2. Laboratory biosafety manual (3 rd edition) by the World Health Organization, Geneva.



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:: Elements of Data Science**

**Course Code: 461**

**Credits earned: 2**

**Course Objectives:** This course is designed to introduce students to the underlying concepts about the most demanding job of the 21<sup>st</sup> century – “The Data Scientist”. Data is termed as the “new gold” and the students will learn about the science of extracting knowledge from the Big Data. The applications covered will span Weather predictions, Oil drilling, Seismic activities, Biological data analysis, Social media analytics among many others. Students are encouraged to gain technical know-how about the discussed concepts using Python. The semester for offering Foundation courses can be altered as per departmental requirements.

## **Course Contents:**

### **Unit I: Big Data and Data Science**

- How big is Big Data
- Facets of Data
- The Data Science process
- Data Scientist's Toolkit

### **Unit II: Basics of Python**

- **The Basics:** Getting Python, The Zen of Python, Whitespace formatting, Modules, Arithmetic, Functions, Strings, Exceptions, Lists, Tuples, Dictionaries, Sets, Control Flow, Sorting, List Comprehensions, Generators and Iterators, Randomness, Regular expressions, etc.
- **Visualizing Data:** Matplotlib, Bar charts, Line charts, Scatterplots etc.

### **Unit III: Getting Data and Working with Data**

- Reading files
- Scraping the web
- Using APIs
- Cleaning, Munging and Manipulating Data
- Rescaling the Data

### **Unit IV: Machine Learning**

#### **Supervised Learning:**

- Classification: Naïve Bayes, Support Vector Machines, Decision Trees
- Regression: Linear, Polynomial, Logistic

#### **Unsupervised Learning**


- Clustering: k-means, Hierarchical
- Dimensionality Reduction: Principal Component Analysis

### **Unit V: Enabling technologies for Data Science**

Brief introduction to the NoSQL, Hadoop, MongoDB and Cassandra, Map-Reduce, Hive, Pig

#### **Text Books:**

1. Joel Grus (2019). Data Science from Scratch, O'Reilly
2. Cielen, Meysman, Ali (2015). Introducing Data Science, Manning Publications.



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## Additional Readings:

1. Blum, Hopcroft, Kannan (2020). Foundations of Data Science. Cambridge University Press
2. VanderPlas (2016). Python Data Science Handbook. O'Reilly
3. Kroese et al. (2020). Data Science and Machine Learning: Mathematical and Statistical Methods, CRC Press.





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**Semester III**

Credits	Core - Compulsory	Credits
8	BIN 501 Computer Aided Drug Design Lab	2
	BIN 502 R Programming Lab	2
	BIN 503 M.Sc. Project	4

Credits	Elective Open	Credits
4	BIN 504 Computational Genomics and Proteomics	4

Credits	Elective (Specialization) Structural Bioinformatics	Credits
8	BIN 505 Computer Aided Drug Discovery	4
	BIN 506 Systems Biology and Biological Networks	4

*2/2/20* *[Signature]*

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Computer Aided Drug Design Lab**

**Course Code: BIN.501**

**Credits earned: 4**

## Course Content

- Introduction to Structure based Drug Design and process layout of Docking
- Data mining, literature study and acquisition of target structure
- Comparative modelling of protein (Homology modelling) \*target structure not available
- Server based –PHYRE, RaptorX, SWISSMODEL, I-TASSER, etc.
- Protein structure validation(ProSA)
- Ramachandran plot assessment(RAMPAGE,Pdbsum,Procheck)
- Active site/ Pocket identification –MetaPocket,CastP,Active site identification using PyMol
- Molecular Docking \*using AutoDock vina/AutoDock Tools/PyRx (For docking of multiple ligands)
- Protein and ligand preparation
- Setting grid parameters and Docking parameters
- Docking analysis (based on binding energy, Hydrogen bond interactions, electrostatic interactions, hydrophobic interactions, etc.)
- BINANA (BINDing ANalyser)
- Pdbsum for visualising protein-ligand interactions
- Building protein-ligand complex and visualization(publication standard)
- Report construction





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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: R Programming Lab**

**Course Code: BIN.502**

**Credits earned: 4**

**Course Objectives:** This course deals with the fundamentals and hands-on-experiments on R.

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

- Basics of R programming.
- Hand-on practice on common R commands for statistical analysis
- Learn application of R in bioinformatics and life science research

## Unit I

Introduction and installation of R and R studio; basic syntax; data-types; variables; operators; decision making; loops; functions; strings; vectors; lists; matrices; arrays; factors; data frames; R-packages

## Unit II

Data visualization: pie charts, bar charts, boxplots; histograms, line graphs, scatterplots; mean, median & mode; regression analysis; normal and binomial distribution, analysis of covariance, time series analysis, decision tree, random forest, Chi-square test

## Unit III

Pairwise sequence alignment; SeqinR package; comparing two sequences using dotplots; pairwise DNA sequence alignment; Bioconductor packages, protein sequence alignment by using Needleman-Wunch and Smith-Waterman algorithms; multiple sequence alignments; building phylogenetic tree using R

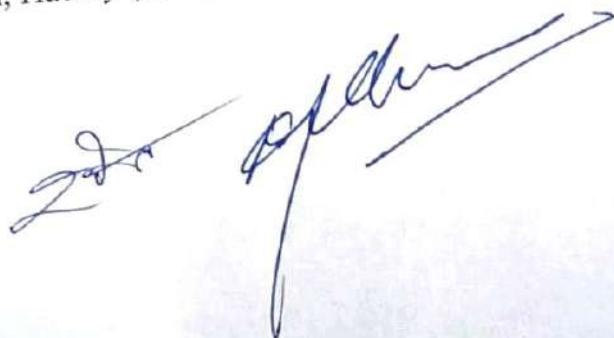
## Unit IV

Finding start and stop codons using R; predicting the protein sequence for an ORF; length of ORF; comparing the number of genes in two species; application of Hidden Markov Models in nucleotide and protein sequence analysis

**Transactional Modes:** Lecture; Tutorial; Hand-on-experiments; Self-learning.

## Suggested Readings

- Michael J. Crawley, The R Book, Wiley. (2012)
- Robert Gentleman, R programming for Bioinformatics, CRC Press, (2009).
- Grolemond, Garret (2014) Hands-on Programming with R
- Wickham, Hadley (2015) Advanced R 1st ed. (Advanced R 2nd ed, 2019.)
- Wickham, Hadley (2015) R Packages.





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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: M.Sc. Project**  
**Course Code: BIN.503**  
**Total Hours: 120**

**Course Objective and Learning Outcomes:** The objective of project would be to ensure that the student learns the fundamentals of the scientific research. Herein the student shall have to carry out the experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analyzed in light of established scientific knowledge to arrive at cogent conclusions.

The Evaluation criteria shall be multifaceted as detailed below:

S.No.	Criteria	Marks allotted
<b>Continuous Assessment</b>		
1.	Research work and Report writing	60
2.	Continuous evaluation of student by guide	20
<b>Research Presentation</b>		
3.	Presentation and defense of research work (Viva)	120
<b>Total</b>		200*

The final presentation shall be evaluated by a two membered committee consisting of  
a. Supervisor  
b. Subject Expert as nominated by honourable VC



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Computational genomics and Proteomics**

**Course Code: BIN.504**

**Credits earned: 4**

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

- learn the importance of DNA-Protein Interactions During Transcription
- gain a deep knowledge about the role of bioinformatics-OMIM database, integrated genomic maps, gene expression profiling
- apply probabilistic modeling techniques for the building of transcriptional regulatory networks which will help them to use the techniques of computational proteomics in their further potential careers in academia and industry.

## Course Content

### Unit 1

The Importance of DNA-Protein Interactions During Transcription, Initiation-Regulation of Transcription, Synthesis and Processing of the Proteome, The Role of tRNA in Protein Synthesis, The Role of the Ribosome in Protein Synthesis, Post-translational Processing of Proteins, Protein Degradation.

### Unit 2

Role of bioinformatics-OMIM database, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP)

### Unit 3

Transcriptomics: database and basic tools, Gene Expression Omnibus (GEO), SAGE databases, detecting differential gene expression,

### Unit 4

Only for yeasts: building predictive models of transcriptional regulatory networks using probabilistic modeling techniques.  
Peptide Mass Finger-printing: database searches

### Extra Reading Topics (Not in evaluatory content)

Genomes, Transcriptomes and Proteomes, The Human Genome and its Importance, Structure of the Eukaryotic and Prokaryotic Genome, the Repetitive DNA Content of Genomes. Mechanism of Genetic Action, Gene-protein relations, Genetic fine structure, Mutational sites Complementation, How Genomes Function, Accessing the Genome, Inside the Nucleus, Chromatin Modifications and Genome Expression, Assembly of the Transcription Initiation Complex, Metagenomics

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.


### Suggested Readings

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1. Sándor Suhai (2002). Genomics and Proteomics. Springer US
  2. CAMPBELL (2007). Discovering Genomics, Proteomics and Bioinformatics. Pearson Education
  3. Richard P. Grant (2004). Computational Genomics: Theory and Application. Horizon Bioscience



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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Computer Aided Drug Discovery**  
**Course Code: BIN.505**  
**Credits earned: 4**

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

- demonstrate various force field for biomolecular modeling
- execute various molecular docking methods
- identify the dynamics of structural transitions which will help them to develop the molecular docking techniques in their further potential careers in academia and industry.

## Course Content

### Unit 1

Introduction to Computer Aided Drug Design (CADD) History, different technique and applications Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters

### Unit 2

Quantitative Structure Activity Relationships: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSAR equations 3D-QSAR approaches and contour map analysis Statistical methods used in QSAR analysis and importance of statistical parameters

### Unit 3

Molecular Modeling and Docking Molecular and Quantum Mechanics in drug design Energetics of bioactive conformation Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AChE & BchE)

### Unit 4

Molecular Properties and Drug Design: Prediction and analysis of ADMET properties of new molecules and its importance in drug design. De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. Homology modeling and generation of 3D-structure of protein

**Transactional Modes:** Lectures; Tutorials; Problem solving; Self-learning.

## Suggested Readings

1. Schneider, Gisbert; Baringhaus, Karl-Heinz; Kubinyi, Hugo Molecular design : concepts and applications Weinheim: Wiley-VCH, c2008
2. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. [http://autodock.scripps.edu/faqs-help/manual/autodock-4-2-user-guide/AutoDock4.2\\_User-Guide.pdf](http://autodock.scripps.edu/faqs-help/manual/autodock-4-2-user-guide/AutoDock4.2_User-Guide.pdf)

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Systems Biology and Biological Networks**

**Course Code: BIN.506**

**Credits earned: 4**

**Course Objectives:** This course will be centered on (i) the theoretical and practical aspects of modelling in systems biology – both deterministic and stochastic and (ii) the study of biological networks. Students will become acquainted with the key concepts and computational approaches to both of these fields.

“Systems Biology” finds its major application in the research field known as “Synthetic Biology” (aiming to design and realize modified or new biological parts). Students will also become familiar with necessary mathematical and computational concepts of Synthetic Biology.

Students having prior knowledge of any programming language will be encouraged to write their own codes for simulating and analysing model biological systems.

## Course Contents

### Unit 1: Introductory interdisciplinary concepts

- Definition and scope of systems and synthetic biology. Introduction to biological complexity
- Self organization, Emergence, Chaos, Robustness.
- First-order systems: Fixed points and stability, Population growth.
- Bifurcations (with examples) in first order systems: Saddle node, Pitch fork, Transcritical.
- Basic notion of bifurcations in second order systems: Period doubling, Hopf.

### Unit 2: Deterministic modelling in systems biology

- Chemical kinetics, Michaelis-Menten kinetics, Hill equations
- Feedback in gene regulation: positive, negative, mutual inhibition
- Deterministic methods of systems modelling (Euler and RK4), with numerical applications
- on
- Simple examples of autocatalysis, linear degradation etc.
- Examples from natural systems: Predator-Prey, p53-mdm2.
- Examples from synthetic systems: Brusselator, Repressilator.

### Unit 3: Stochastic modelling in systems biology

10. Introduction to noise in biological systems. Intrinsic vs. extrinsic noise. System behaviour and role of noise.
11. Stochastic Methods for modelling biological systems (Master equation, Gillespie's stochastic simulation algorithm)
12. Application of Gillespie's SSA on Brusselator, Predator-Prey and other simple examples.

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## Unit 4: Design principles of biological networks

- Introduction to networks: Hamiltonian path vs. Eulerian path; Basic terminology; Topology of genetic, metabolic and ecological networks.
- Network models: Erdős-Renyi, Small-world, Scale-free.
- Global Properties: Average path length, network diameter, centrality measures, clustering coefficients etc. Modular and hierarchical networks.
- Local Properties: Regulatory motifs and graphlets in networks. Motifs in TRNs: discussion on FFL, SIM and other motifs.

## UNIT 5: Analysis of biological networks

- Elementary graph algorithms: Breadth-first search, Depth-first search, Topological sort, Strongly connected components. Growing a minimum spanning tree.
- Finding shortest path: Single source shortest path, All pairs shortest paths
- Network clustering: Clique based clustering, Center based clustering
- Basics of flux balance analysis.

### Text Books:

**Steven H. Strogatz (1994)**, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Perseus Books, Massachusetts.

**Szallasi et al. (2010)**, System Modelling in Cellular Biology. MIT Press.

**Junker and Schreiber (2008)**, Analysis of Biological Networks. Wiley-Interscience, New Jersey.

### Additional Readings:

**Uri Alon (2006)**, An Introduction to the Systems Biology. Chapman and Hall.


**Mark Newman (2010)**, Networks: An Introduction. Oxford University Press.

**Klipp et al. (2009)**, Systems Biology in Practice. Wiley-VCH.

**BO Palsson (2006)**, Systems Biology. Cambridge University Press.

**Press et al. (2007)**, Numerical Recipes in C. Cambridge University Press.

**Singh and Dhar (2015)**, Systems and Synthetic Biology, Springer



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## Semester IV

Credits	Core - Compulsory	Credits
12	BIN 551 Next Generation Sequencing Analysis	4
	BIN 552 Chemoinformatics	2
	BIN 553 M.Sc. Dissertation	6

Credits	Elective Open	Credits
8	BIN 554 Fundamentals of Metabolomics	2
	BIN 555 Advance topics on Machine Learning	2
	BIN 556 Introduction of Synthetic Biology	2
	BIN 557 Systems Biology Lab	2







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Temporary Academic Block, Shahpur, Distt. Kangra (HP) – 176206

Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Next Generation Sequencing: Analysis**  
**Course Code: BIN.551**  
**Credits earned: 4**

**Learning Outcomes:** On completion of the course the student should be able to understand the basics of next generation sequencing and data analysis

### Course Contents:

#### UNIT-I: First generation sequencing technologies: An introduction

Maxam-Gilbert and Sanger sequencing  
Next generation sequencing technologies  
NGS file formats : Preprocessing of raw reads: quality control (FastQC), adapter clipping, quality trimming

#### UNIT-II: Genome sequence assembly

De novo genome sequence assembly  
Use of paired end reads in assembly  
Data preprocessing and sequence read correction methods  
Assembly errors and evaluation of assembly methods

#### UNIT-III: De novo assembly algorithms

The overlap graph approach  
De Bruijn graph approach  
Classification of De Novo assembly algorithms  
Comparison of algorithms

#### Unit IV: Tools and Techniques

Introduction to read mapping (Alignment methods, Mapping heuristics)  
Read mapping (BWA, BWA-MEM, Bowtie2, STAR, segemehl), Mapping output (SAM/BAM format), Usage of important NGS toolkits (samtools), Mapping statistics  
Visualization of mapped reads (IGV, UCSC)  
DNA variant calling

#### UNIT-V: Applications of NGS

- Comparative genomics
- Functional genomics
- Diagnostics and Exom sequencing
- Microbiome studies

#### Suggested Readings


1. Ali-Masoudi-Nejad, Zahra Narimani, Nazanin Hosseinkhan. Next Generation Sequencing and Sequence Assembly: Methodologies and Algorithms, SpringerBriefs in Systems Biology, 2013. ISBN 978-1-4614-7726-6.  
Other references (Review articles)

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1. Rogers, J., and Gibbs, R.A. (2014) Comparative primate genomics: emerging patterns of genome content and dynamics. *Nat Rev Genet*, 15 (5), 347–359.
  2. Werner, T. (2010) Next generation sequencing in functional genomics. *Briefings Bioinforma.* , 11 (5), 499–511.
  3. Bamshad, M.J., Ng, S.B., Bigham, A.W., et al. (2011) Exome sequencing as a tool for Mendelian disease gene discovery. *Nat Rev Genet*, 12 (11), 745–755.
  4. Alkan, C., Coe, B.P., and Eichler, E.E. (2011) Genome structural variation discovery and genotyping. *Nat Rev Genet*, 12 (5), 363–376.
  5. Cooper, G.M., and Shendure, J. (2011) Needles in stacks of needles: finding disease-causal variants in a wealth of genomic data. *Nat Rev Genet*, 12 (9), 628–640.
  6. Kuczynski, J., Lauber, C.L., Walters, W.A., et al. (2012) Experimental and analytical tools for studying the human microbiome. *Nat. Rev. Genet.*, 13 (1), 47–58.





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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Cheminformatics**

**Course Code: BIN.552**

**Credits earned: 2**

**Learning outcomes:** On successful completion of this module, students should be able to: the students will obtain some knowledge and will get training in

- Data organization and search in chemical databases;
- QSAR and pharmacophores modelling;
- Chemical data visualization and analysis
- Virtual screening tools and efficiency assessments

## Course Content

### Unit I:

Cheminformatics as a theoretical chemistry discipline: definition, main concepts and areas of application.

Representing chemical structures on computer. Molecular graphs. Connectivity tables. Adjacency and distance matrices. Linear representations SMILES and SMIRKS.

### Unit 2

Molecular descriptors. Definition and main requirements. Different types of descriptors: constitutional, topological indices, geometry-based, surface-based, substructural fragments, lipophilicity, etc.

### Unit 3

Chemical Space concept. Graph-based chemical space: scaffolds, frameworks and R-groups. Scaffold tree approach. Descriptor-based chemical space: distance and similarity metrics

### Unit 4

Virtual screening workflow. Drug-likeness filters and structural alerts. Parameters of screening efficiency.

**Transactional Modes:** Lectures; Tutorials; Problem solving; Self-learning.

### Suggested Readings

- A. Leach, V. Gillet "An Introduction to Chemoinformatics", Springer, 2007
- "Tutorials in Chemoinformatics", A. Varnek, Ed. , WILEY, 2017

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: M.Sc. Dissertation**  
**Course Code: BIN.599**  
**Total Hours: 240**

**Course Objective and Learning Outcomes:** The objective of dissertation would be to ensure that the student learns the fundamentals of the scientific research. Herein the student shall have to carry out the experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analyzed in light of established scientific knowledge to arrive at cogent conclusions.

The Evaluation criteria shall be multifaceted as detailed below:

S.No.	Criteria	Marks allotted
<b>Continuous Assessment</b>		
1.	Research work and Report writing	50
2.	Continuous evaluation of student by guide	50
<b>Research Presentation</b>		
3.	Presentation and defense of research work (Viva)	300
<b>Total</b>		400*

The final presentation shall be evaluated by a three membered committee consisting of

- External Examiner as approved by Honourable VC
- Dean's Nominee's from allied department
- Supervisor





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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Fundamentals of Metabolomics**  
**Course Code: BIN.553**  
**Credits earned: 2**

**Course Objectives:** This course deals with the fundamentals of metabolomics and its application in life sciences.

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

- Understand the basics of metabolomics
- Learn the overall workflow of metabolomics starting from sample preparation to data analysis
- Understand the application of metabolomics in life sciences research

## Unit I

Introduction to metabolites, metabolism and metabolomics; structural diversity of metabolites, controlling rates and levels; metabolons; metabolites as a part of cellular interactome; sampling and sample preparation for metabolomics; quenching; obtaining metabolites from biological samples; metabolites in the extracellular medium

## Unit II

Introduction to the analytical tools and techniques for metabolome analysis; chromatography techniques; mass spectrometry; GC-MS; LC-MS; ESI-MS; NMR based metabolomics; targeted and untargeted metabolomics

## Unit III

Organizing the metabolomics data: qualitative and quantitative data; data structure; pre-processing of data; deconvolution of spectroscopic data; data normalization and transformations; PCA and Fisher discriminant analysis;

## Unit IV

Hierarchical and *k*-means clustering techniques; decision theory, *k*-nearest neighbour and tree-based classification techniques; application of metabolomics in microbial, plants and biomedical sciences.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

- Silas G. Villas-bôas, Ute Roessner, Michael A. E. Hanse, Jorn Smedsgaard, Jens Nielsen, Metabolome Analysis: An Introduction, Wiley, (2007).

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Advance topics in Machine Learning**  
**Course Code: BIN.554**  
**Credits earned: 2**

## Course Content

### Unit 1

Introduction: Overview of Machine Learning field with intro to statistics Data Cleaning, imputation, cross-validation

### Unit 2

Unsupervised Methods: Clustering: Distance Metrics, K-Means, leader, Jarvis-Patrick, hierarchical clustering;

Clustering: Self-organized maps, EM-algorithm; Dimensionality Reduction: PCA, LDA, Sammon's

### Unit 3

Supervised Methods: Classification: K-NN, naïve Bayes, decision trees, boosting and bagging;

### Unit 4

Classification: Ensemble methods, random Forests; Support vector machines Neural networks; Introduction to Deep learning

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

1. Data Mining: Concepts and Techniques, Third Edition by Han, Kamber, and Pei, 2011.
2. Pattern Recognition and Machine Learning by Christopher Bishop; 2007.
3. Applied Predictive Modeling by Max Kuhn and Kjell Johnson; 2013.
4. An Introduction to Statistical Learning and Applications in R by James, Witten, Hastie, Tibshirani; 2014.
5. Python for Data Analysis by Wes McKinney; 2013.

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Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Introduction of Synthetic Biology**

**Course Code: BIN.555**

**Credits earned: 2**

**Course Objectives:** The course is designed to introduce students the concepts of synthetic biology – a field of study at the interface of (i) complexity of biological systems and (ii) techniques of traditional engineering. This course is designed to acquaint students about the following basic questions:

- Can we study and understand biology as an engineering discipline?
- Why is it necessary to consider stochasticity while modeling biological processes?
- What are the basic parts and devices that have been successfully bioengineered?
- What are the implications of Synthetic Biology on the society?

## Course Contents

### UNIT I: Introductory Interdisciplinary Concepts

- Definition and scope of systems biology and synthetic biology.
- Engineering concepts: parts, devices, circuits -- digital vs. analog, logic gates.
- Biological complexity: Self organization, Emergence, Robustness.

### UNIT II: Modeling methods for Biological Systems

- Review of kinetic chemistry, Aspects of noise in designing biological systems.
- Brief overview of deterministic modeling, master equation and Gillespie's Stochastic Simulation Algorithm.
- Lambda switch and Chemotactic module in *E. coli*.
- Open source programs: CellDesigner, etc

### UNIT III: Standards and parts in Synthetic Biology

- Standards: SBML, SBGN, BioPAX
- MIT Registry of standard biological parts
- Bio-brick and non-biobrick initiatives, iGEM events
- Lac operon, Promoter designing, Quorum sensing
- ZFNs, TALENs, CRISPR/Cas

### UNIT IV: Bio-engineered Synthetic Circuits

- Gates: AND gate, Counters: Pulse generators, Switches: Toggle switch
- Oscillators: Repressilator, mammalian oscillator

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Brief overview of cascades, time delayed circuits, spatial patterning, biosensors, and other logical formula driven circuits.  
Riboswitches and riboregulators  
Four and Six-letter genetic code

## UNIT V: From Modules to Systems

- Integrating gene circuits
- DNA Origami,
- Genome Synthesis, Minimal synthetic cell, Multicellular synthetic systems
- Protocell construction
- Bio-energetics and Bio-fuels
- **Safety and Legal issues:** Bio-security, Bio-safety

### Text Books:

Chris Myers (2009). Engineering Genetic Circuits. Chapman & Hall.  
Edda Klipp *et al.* (2009). Systems Biology: A Textbook. Wiley-VCH.  
Huimin Zhao (2013). Synthetic Biology: Tools and Applications. Academic Press.

### Additional Readings:

- Freemont and Kitney (2012). Synthetic Biology: A Primer. World Scientific
- Fu and Panke (2009). Systems Biology and Synthetic Biology. Wiley, New Jersey.
- Presidential Commission for the Study of Bioethical Issues (2010). NEW DIRECTIONS: Ethics of Synthetic Biology and Emerging Technologies. (<http://bioethics.gov>)
- Singh V., and Dhar, P. K. (2015). Systems and Synthetic Biology, Springer Science, 385. ISBN: 978-94-017-9513-5.

Course Title: Systems Biology Lab

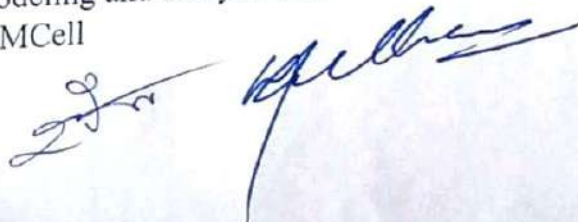
Course Code: BIN.555

Credits earned: 2

**Course Objectives:** The course is designed to give students an opportunity for learning the computational techniques to understand biological complexity at systems level. They will be introduced to the softwares implementing deterministic and stochastic modeling algorithms. At the same time they will also be acquainted with the network visualization and analysis softwares.

Students having working knowledge of any programming language will be encouraged to write their own codes for simulating and analysing model biological systems. Students will be required to learn the following modeling and analysis suites.

- CellDesigner, MCell





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Cytoscape  
• XPPAut  
•

## Contents:

- Standards in Systems Biology -- SBML, SBGN, BioPAX
- Deterministic simulation of a natural biological system.
- Deterministic simulation of a synthetic biological system.
- Implementation of Gillespie's stochastic simulation algorithm to model the given chemical reaction system.
- Introduction to biological network databases – KEGG, STRING, STITCH, DIP, BIND, HPRD, EMP, EcoCyc, MetaCyc, AraCyc etc.
- To construct and visualize simple biological network.
- To analyze a given biological network by calculating the following characteristics
  - Diameter, density
  - Average path length
  - Clustering coefficient
  - Centrality measures (Degree, Closeness, Eccentricity, Betweenness)
  - Degree distribution
  - Community detection Etc.
- To identify motifs and graphlets in a given network.
- Stability analysis of a given 1-dimensional dynamical system.
- Stability analysis of a given 2-dimensional biological system.
- Systems Biology Capstone

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## **Credits Equivalent in terms of real time investment:**

One credit is equivalent to of lectures / organized classroom activity / contact hours; of laboratory work / practical / field work / tutorial / teacher-led activity and of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars with proper record keeping etc.



# Central University of Himachal Pradesh

Centre for Computational Biology and Bioinformatics

School of Life Sciences

## AGENDA



### 7<sup>th</sup> BOARD OF STUDIES MEETING

TO BE HELD ON 29<sup>th</sup> DECEMBER, 2020 at TAB SHAHPUR

**Venue:** Seminar Hall,  
Central University of Himachal Pradesh  
Temporary Academic Block, Shahpur



# हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

अस्थाई शैक्षणिक खण्ड, शाहपुर, जिला काँगड़ा, हिमाचल प्रदेश - 176206

Temporary Academic Block, Shahpur, Distt. Kangra (HP) - 176206

Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

## AGENDA-INDEX

Agenda Item No.	PARTICULARS	Information
CBB-BOS-6/20-1	The Minutes of the 6 <sup>th</sup> Board of Studies meeting held on 18.09.2020.	Annexure –I
CBB-BOS-6/20-2	Change of nomenclature of the M.Sc. Computational Biology and Bioinformatics to M.Sc. Bioinformatics	Annexure- II
CBB-BOS-6/20-3	Restructuring of the Course Curriculum and addition of New Courses for the M.Sc. Binformatics in the CBCS format (for 2020 Batch onwards).	Annexure-III
CBB-BOS-6/20-4	Scrutinising, updation, approval of the detailed syllabus for the M.Sc. Binformatics in the CBCS format (for 2020 Batch onwards).	Annexure-IV
CBB-BOS-6/20-5	Approval of the title, objectives and synopses of the Ph.D thesis of Ms. Himisha Dixit (Regn. Num. CUHP17CBBRD02)	Annexure-V
CBB-BOS-6/20-6	Approval of the title, objectives and synopses of the Ph.D thesis of Ashish Panghalia (Regn. Num. CUHP17RDCBB01 )	Annexure-VI
CBB-BOS-6/20-7	Appointment of Dr. Mahesh Kulharia, Associate Professor, Centre for Computational Biology and Bioinformatics to become Ph.D. Co-Supervisor for Ms. Himisha Dixit's (Regn. Num. CUHP17CBBRD02) doctoral work.	Annexure-VII
CBB-BOS-6/20-8	Any item with the permission of the Chair	

**Dr. Mahesh Kulharia**

Director,

Centre for Computational Biology and Bioinformatics



हिमाचल प्रदेश केंद्रीय विश्वविद्यालय  
Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

अस्थायी शैक्षणिक खण्ड, शाहपुर, जिला कांगड़ा, हिमाचल प्रदेश - 176206

Temporary Academic Block, Shahpur, Distt. Kangra (HP) - 176206

Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

File No: LS/1-5/ CUHP/12/ 75

Dated: 29.12.2020

MINUTES

The 7<sup>th</sup> Board of Studies (BoS) meeting of Centre for Computational Biology and Bioinformatics was held on 29<sup>th</sup> December, 2020 at 11:00 AM at Central University of Himachal Pradesh, Temporary Academic Block, Shahpur. The following were present:

1.	Dr. Mahesh Kulharia, Director, Centre for Computational Biology and Bioinformatics, School of Life Sciences	CONVERNER & CHAIRMAN	Offline Mode
2.	Prof. Brij Mohan, Ret. Professor, Chaudhary charan kumar Himachal Pradesh Agriculture University	SUBJECT EXPERT	Online Mode
3.	Prof. Desh Deepak Singh, Professor, Deapartment of Biotechnology, Punjab University,	SUBJECT EXPERT	Online Mode
4.	Prof. Pardeep Kumar, Dean, Professor, Department of Plant Sciences, School of Life Sciences	MEMBER (VC NOMINEE)	Offline Mode
5.	Dr. Sunil Kumar, Associate Professor, Department of Animal Sciences, School of Life Sciences	MEMBER (VC NOMINEE)	Offline Mode
6.	Dr. Shailender Kumar Verma, Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences	MEMBER	Offline Mode
7.	Dr. Vikram Singh, Assistant Professor, Centre for Computational Biology and Bioinformatics, School of Life Sciences	Special Invite	Offline Mode

The Director, Centre for Computational Biology and Bioinformatics (Convener & Chairman), School of Life Sciences welcomed all the members and thanked them for being available for attending this meeting.

*Signature*  
29/12/2020

Agenda Items:

**ITEM NO: CBB-BOS-7/20-1:** Approved the Minutes of the 6<sup>th</sup> Meeting of the Board of Studies held on 18<sup>th</sup> September, 2020. (Annexure-I)

**ITEM NO: CBB-BOS-7/20-2:** Recommended the Change from nomenclature of the Centre for Computational Biology and Bioinformatics to Department of Computational Biology and Bioinformatics. (Annexure-II)

**ITEM NO: CBB-BOS-7/20-3:** Approved the Re-scrutinizing of the Curriculum and addition of new courses for the M.Sc. Binformatics in the CBCS format. (Annexure-III)

**ITEM NO: CBB-BOS-7/20-4:** Approved the detailed syllabus for the M.Sc. Binformatics in the CBCS format (for 2020 Batch onwards). (Annexure-IV)

**ITEM NO: CBB-BOS-7/20-5:** Approved the appointment of Dr. Mahesh Kulharia, Associate Professor, and Centre for Computational Biology and Bioinformatics to become Ph.D. Co-Supervisor/Guide for Ms. Himisha Dixit (Reg.No.CUHP17RDCBB02) doctoral work. (Annexure-V)

**ITEM NO: CBB-BOS-7/20-6:** Approved the little, objectives and synopses of the Ph.D thesis of Ms. Himisha Dixit (Reg.No. CUHP17RDCBB02). (Annexure-VI)

**ITEM NO: CBB-BOS-7/20-7:** Approved the little, objectives and synopses of the Ph.D thesis of Mr. Ashish Panghalia (Reg.No.CUHP17RDCBB01). (Annexure-VII)

The meeting ended with votes of thanks by the chair:

**Dr. Vikram Singh**  
Assistant Professor,  
Special Invite

*Sharma*  
29/12/2020  
**Dr. Shailender Kumar Verma**  
Assistant Professor, CCBB  
CUHP, Dharamshala

*Sunil Kumar*  
29/12/2020  
**Dr. Sunil Kumar**  
HoD, Animal Sciences,  
(VC Nominee)

*Approved Online*  
**Prof. Desh Deepak Singh**  
(Subject Expert)

*Approved Online*  
**Prof. Brij Mohan Sharma**  
(Subject Expert)

*Pardeep Kumar*  
29/12/2020  
**Prof. Pardeep Kumar**  
HoD, Plant Sciences,  
(VC Nominee)

*Mahesh Kulharia*  
29/12/2020  
**Dr. Mahesh Kulharia**  
Director, CCBB, CUHP,  
Convener & Chairman



mohit lamba <mohitlamba215@gmail.com>

## Regarding the 7th Board of Studies agenda CCBB

3 messages

mohit lamba <mohitlamba215@gmail.com>  
To: ddsingh@pu.ac.in, drbrijsharma@gmail.com  
Cc: Mahesh Kulharia <kulharia@gmail.com>

Mon, Jan 18, 2021 at 9:56 AM

Dear Sirs,

Please find the draft regarding the 7th meeting of Board of Studies along with the annexures attached herewith for your kind perusal and approval. we would really appreciate it if you could find time to give your valuable suggestions/corrections/approval in the next one days.

--

Regards/सादर,

Mohit/मोहित

Lower Division Clerk, अवर श्रेणी लिपिक

School of Life Sciences, जैविक विज्ञान स्कूल

School of Earth and Environmental Sciences, पृथ्वी एवं पर्यावरण विज्ञान स्कूल

Central University of Himachal Pradesh, हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय

TAB-Shahpur: टैब-शाहपुर.

Mobile Number: 9991206122, 9588584463.

7th Board of Studies mintues of the meeting CCBB.pdf  
831K

Prof. Desh Deepak Singh <ddsingh@pu.ac.in>  
To: mohit lamba <mohitlamba215@gmail.com>  
Cc: drbrijsharma@gmail.com, Mahesh Kulharia <kulharia@gmail.com>

Mon, Jan 18, 2021 at 11:23 AM

### Approved

(minutes of 7th meeting of Board of Studies meeting of Center for Computational Biology and bioinformatics of Central University of Himachal Pardesh held on 29th December, 2020 though online mode).

--

Prof. Desh Deepak Singh  
Professor, Biotechnology Department  
BMS-I, South Campus  
Panjab University,  
Chandigarh-160 014  
www. <http://biotechnology.puchd.ac.in/>  
Email: ddsingh@pu.ac.in  
Ph: +91 172 2534091  
+919228379835;

[Quoted text hidden]

7th Board of Studies mintues of the meeting CCBB.pdf  
831K

Brij Sharma <drbrijsharma@gmail.com>

Mon, Jan 18, 2021 at 2:07 PM

**TABLE-I: Curricular Framework for M.Sc. Bioinformatics based on Choice Based Credit System (CBCS) (Batch: 2020-21 onwards)**

**Semester I**

<b>Core - Compulsory (10 Credits)</b>	<b>Credits</b>
BIN 401 Sequence Analysis	2
BIN 402 Biomolecular Structure Analysis	2
BIN 403 Linux and Shell Scripting Lab	2
BIN 404 Sequence and Structure Analysis Lab	2
BIN 405 Python Programming Lab I	2

<b>Core Open (6)</b>	<b>Credits</b>
BIN 406 Basics of Biochemistry	2
BIN 407 Concepts of Genetics	2
BIN 408 Basic Mathematics for Life Sciences	2
BIN 409 Statistical Methods	4

<b>Human Making (2)</b>	<b>Credits</b>
BIN 410 History of Science and in India	2

<b>Skill Development (2)</b>	<b>Credits</b>
BIN 411 Fundamentals of machine learning	2



## Semester II

<b>Core - Compulsory (10)</b>	<b>Credits</b>
BIN 451 Algorithms in Bioinformatics	4
BIN 452 Fundamentals of Molecular Dynamics simulations	2
BIN 453 Molecular Dynamics Simulation Lab	2
BIN 454 Python Programming Lab II	2

<b>Core Open (6)</b>	<b>Credits</b>
BIN 455 Cell and Molecular Biology	2
BIN 456 Essentials of Immunology	2
BIN 457 Statistical Genetics	2
BIN 458 Biological Database and Management System	2
BIN 459 DBMS Lab	2

<b>Human Making (2)</b>	<b>Credits</b>
BIN 460 Biosafety Issues	2

<b>Skill Development (2)</b>	<b>Credits</b>
BIN 461 Elements of Data Science	2

### Semester III

<b>Core Compulsory (8)</b>	<b>Credits</b>
BIN 501 Computer Aided Drug Design Lab	2
BIN 502 R Programming Lab	2
BIN 503 M.Sc. Project	4

<b>Elective Open (4)</b>	<b>Credits</b>
BIN 504 Computational Genomics and Proteomics	4

<b>Elective Specialization (8)</b>	<b>Credits</b>
BIN 505 Computer Aided Drug Discovery	4
BIN 506 Systems Biology and Biological Networks	4

### Semester IV

<b>Core Compulsory (12)</b>	<b>Credits</b>
BIN 551 Next Generation Sequencing: Analysis	4
BIN 552 Chemoinformatics	2
BIN 599 M.Sc. Dissertation	6

<b>Elective Specialization (8)</b>	<b>Credits</b>
BIN 553 Fundamentals of Metabolomics	2
BIN 554 Advance topics on Machine Learning	2
BIN 555 Introduction of Synthetic Biology	2
BIN 556 Systems Biology Lab	2

**Central University of Himachal Pradesh**

**Centre for Computational Biology and Bioinformatics  
School of Life Sciences**

**AGENDA**



**BOARD OF STUDIES MEETING**

Scrutinised and Approved on 29<sup>th</sup> **DECEMBER, 2020** at TAB SHAHPUR

**Venue:** Seminar Hall,  
Central University of Himachal Pradesh  
Temporary Academic Block, Shahpur



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## PROGRAMME OUTCOMES (M.Sc. Bioinformatics)

Student graduating after successful completion of this course shall be able to

- Critically analyse current issues and trends influencing the field of Bioinformatics.
- Competent to carry out understanding complex information from the concurrent scientific literature, identify the knowledge lacunae, shortlist attainable objectives, design comprehensive methodology and carry out the unsupervised research.
- Shall have scientific temperament.
- Establish professional relationships and development of professional competencies
- Develop understanding and reflections on higher education policies and practices.



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## Semester I

Credits	Core - Compulsory	Credits
10	BIN 401 Sequence Analysis	2
	BIN 402 Biomolecular Structure Analysis	2
	BIN 403 Linux and Shell Scripting Lab	2
	BIN 404 Sequence and Structure Analysis Lab	2
	BIN 405 Python Programming Lab I	2

Credits	Core Open	Credits
6	BIN 406 Basics of Biochemistry	2
	BIN 407 Concepts of Genetics	2
	BIN 408 Basic Mathematics for Life Sciences	2
	BIN 409 Statistical Methods	4

Human Making (2)	Credits
BIN 410 History of Science in India	2

Skill Development (2)	Credits
BIN 411 Fundamentals of machine learning	2



# Central University of Himachal Pradesh

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Temporary Academic Block, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Sequence Analysis**

**Course Code: BIN.401**

**Total Hours: 30**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

## Course Content

### Unit 1

**13 Hours**

Basic concepts of sequence similarity, identity and homology, homologues, orthologues, paralogues and xenologues Pairwise sequence alignments: basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties

### Unit 2

**10 Hours**

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series Tools such as BLAST (various versions of it) and FASTA

### Unit 3

**12 Hours**

Multiple sequence alignments (MSA): basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW (including interpretation of results), concept of dendrogram and its interpretation.

### Unit 4

**10 Hours**

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

**Transactional Modes:** Lecture; Problem solving; Self-learning.

## Suggested Reading

1. A.D. Baxevanis *et. al.*, Current Protocols in Bioinformatics, (2005) Wiley Publishers
2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN81-203-2550-8
4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1
5. N.Gautham Bioinformatics Narosa publications. (2006) ISBN-13: 9781842653005



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Biomolecular Structure Analysis**

**Course Code: BIN.402**

**Total Hours: 30**

## LEARNING OUTCOMES

The overall goal of this course is to give students advanced knowledge of the relationship between the structure and function of biomolecules and to handle different tools used in structural bioinformatics.

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

explain the basis of biological macromolecules constitution and traits

explain the basis of biological catalysis

explain the constitution of molecular complexes like ribosomes and viruses and aggregates like filaments and tubules

use databases with information of structure and function of macromolecules

use and analyse results from methods used to predict secondary- and tertiary structure of macromolecules

## COURSE CONTENT

### Unit 1

Methods for the determination of macromolecules structure and interaction.

Basic macromolecular structure; DNA, RNA, protein, lipids and carbohydrates.

### Unit 2

The folding process and structural background to the dynamics of macromolecules.

Binding specificity, catalysis and cooperativity in enzymes and receptors.

Macromolecules function described by a few specific examples.

### Unit 3

Biological structure databases.

Structure analysis and classification of proteins in structural families.

Relation between sequence, structure and function.

### Unit 4

Computer modelling of secondary- and tertiary structure of proteins and nucleic acid based on sequence data.

Enzyme/receptor-based drugs-rational drug design.

## Transactional Mode

Lectures, seminars.

## Suggested Reading

1. Liljas, Anders Textbook of structural biology New Jersey: World Scientific, cop. 2009
2. Tooze, Branden An Introduction to Protein Structure. 2014





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**Course Title: Linux and Shell Scripting Lab**

**Course Code: BIN.403**

**Total Hours: 60**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Linux administration
- File / Data management
- Stream processing

## Course Content

### Unit 1

**7 Hours**

What is Linux, Linux architectures: root, files system, standard directories  
general commands for files and directories cd, ls, cp, rm, mkdir, rmdir, pwd, file, more, less  
Creating and viewing files using cat file comparisons  
Essential Linux commands: Processes in Linux, Process fundamentals, Connecting processes with pipes, Redirecting input, Redirecting output, Background processing

### Unit 2

**7 Hours**

Managing multiple processes, Process scheduling – (at, batch), nohup command, kill, ps, who  
find, sort, touch, file, file processing commands – wc, cut, paste etc,  
Mathematical commands – expr, factor etc  
Creating files with editors: vi, vim, kate, Kwrite, pico etc

### Unit 3

**8 Hours**

System administration  
Common administrative tasks  
identifying administrative files  
Configuration and log files  
Role of system administrator  
Managing user accounts -adding users  
Managing user accounts -deleting users  
Changing permissions and ownerships  
Creating and managing groups  
Modifying group attributes

### Unit 4

**8 Hours**

Simple filter commands & Understanding various Servers.  
Filter Commands-pr, head, tail  
Filter Commands -cut, sort.  
Filter Commands- uniq, tr.  
Filter using regular expression grep.  
Filter using regular expression egrep, sed Basics, Variables, Substitution & Quoting  
Flow Control, Loops and Documentation



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## **Suggested Readings:**

1. Cristopher Negus – Red Hat Linux Bible, Wiley Dreamtech India 2005 edition.
2. YeswantKanethkar – UNIX Shell Programming, First edition, BPB.

Text Books for Enrichment

References :

1. Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India
2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education.
3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth edition, Wiley Dreamtech India.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Sequence and Structure Analysis Lab**

**Course Code: BIN.404**

**Total Hours: 60**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

Introduction to Bioinformatics and Sequence Analysis. In addition to lecture material, skills needed for future problem set assignments will be covered. This will include taking screenshots, formatting of text and generation of reports.
Internet Resources focusing on text-based searches of literature, molecular, and medical databases. We will again work on the skills needed for generating reports.
Searching DNA databases with DNA queries: BLASTN. First problem set assignment focused on material from this lecture: 5 grade points maximum.
Searching protein databases with protein queries: BLASTP. Second problem set assignment focused on material from this lecture: 10 grade points maximum.
Cross-molecular searches: BLASTX and TBLASTN. Third problem set assignment focused on material from this lecture: 10 grade points maximum.
Advanced topics in BLAST
Protein Analysis Fourth problem set assignment focused on material from this lecture: 10 grade points maximum.
Analysis problems involving short sequences Fifth problem set assignment focused on material from this lecture: 5 grade points maximum.
MicroRNAs and Pathway Analysis Sixth problem set assignment focused on material from this lecture: 5 grade points maximum.
Multiple Sequence Alignments
Exploring the genome with Genome Browsers
Secondary Structure Prediction Methods – Chou Fasman, GOR, Neural Networks 3D structure visualization: Pymol, Rasmol, VMD

**Suggested Reading:**

“Practical Bioinformatics” by Michael Agostino ISBN 978-0-8153-4456-8



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**Course Title: Python Programming Lab I**

**Course Code: BIN.405**

**Total Hours: 60**

**Learning Outcomes:** Upon successfully completing this course, students will be able to “do something useful with Python”.

- Identify/characterize/define a problem
- Design a program to solve the problem
- Create executable code
- Read most Python code
- Write basic unit tests

## Course Content

1. Working with Data. A detailed tour of how to represent and work with data in Python. Covers tuples, lists, dictionaries, and sets. Students will also learn how to effectively use Python's very powerful list processing primitives such as list comprehensions. Finally, this section covers critical aspects of Python's underlying object model including variables, reference counting, copying, and type checking.
2. Program Organization, Functions, and Modules. More information about how to organize larger programs into functions and modules. A major focus of this section is on how to design functions that are reliable and can be easily reused across files. Also covers exception handling, script writing, and some useful standard library modules.
3. Classes and Objects. An introduction to object-oriented programming in Python. Describes how to create new objects, overload operators, and utilize Python special methods. Also covers basic principles of object oriented programming including inheritance and composition.
4. Inside the Python Object System. A detailed look at how objects are implemented in Python. Major topics include object representation, attribute binding, inheritance, memory management, and special properties of classes including properties, slots, and private attributes.

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- The Python Tutorial (<https://docs.python.org/3/tutorial/>): This is the official tutorial from the Python website. No more authoritative source is available.
- Code Academy Python Track (<http://www.codecademy.com/tracks/python>): Often cited as a great resource, this site offers an entertaining and engaging approach and in-browser work.
- Learn Python the Hard Way (<http://learnpythonthehardway.org/book/>): Solid and gradual. This course offers a great foundation for folks who have never programmed in any language before. [Python 2]



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**Course Title: Basics of Biochemistry**

**Course Code: BIN.406**

**Total Hours: 30**

**Learning Outcomes:** The outcomes of the subject is to ensure that a student comprehends the following:

- The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- The energy metabolism by cellular components in cells and the process of mitotic cell division.
- Influences of changes or losses in cell function; including the responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

## Course Content

### Unit 1

**16 Hours**

Principles of biophysical chemistry Thermodynamics, Colligative properties, Stabilizing interactions: Van der Waals, Electrostatic, Hydrogen bonding, Hydrophobic interaction, etc.

### Unit 2

**14 Hours**

Composition, structure, function and metabolism of Carbohydrates, Lipids.

### Unit 3

**14 Hours**

Composition, structure, function and metabolism of Amino Acids and Nucleotides.

### Unit 4

**16 Hours**

Enzymology: Classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics, Enzyme regulation, Isozymes.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry*. W.H. Freeman & Company. USA.
2. Brown, T.A. (2006). *Gene Cloning and DNA analysis: In Introduction*. Blackwell Publishing Professional. USA.
3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.
4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.
5. Nelson, D. and Cox, M.M. (2013). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.
6. Ochiai, E. (2008). *Bioinorganic chemistry: A survey*. Academic Press. Elsevier, India.
7. Randall, D. J., Burggren, W. and French, K. (2001). *Eckert animal physiology*. W.H. Freeman & Company. USA.



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8. Raven, P.H., Johnson, G.B. and Mason, K.A. (2007). *Biology*. McGraw-Hill. USA.
9. Shukla AN (2009). *Elements of enzymology*. Discovery Publishing. New Delhi, India.
10. Voet, D. and Voet, J.G. (2014). *Principles of biochemistry*. CBS Publishers & Distributors. New Delhi, India.



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**Course Title: Concepts of Genetics**

**Course Code: BIN.407**

**Total Hours: 30**

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

- gain a deep knowledge about the structures and organisation of nucleic acids
- learn DNA replication, Inheritance patterns

## Course Content

### Unit 1

**8 Hours**

Introduction and scope of genetics, DNA as genetic material: Double helical structure, Structure of DNA and RNA, Different types of DNA molecules, forces stabilizing nucleic acid structure, super coiled DNA, properties of DNA, denaturation and renaturation of DNA and Cot curves. DNA replication: Basic mechanism of DNA replication.

### Unit 2

**7 Hours**

Cell division and Cell cycle: Mitosis, Meiosis Concepts of Linkage analysis and gene mapping: Coupling and repulsion phase linkage, Crossing over and recombination. Population genetics: Application of Mendel's laws to populations, Hardy-Weinberg principle, inbreeding depression and heterosis, inheritance of quantitative traits.

### Unit 3

**7 Hours**

Gene Interaction: Sex determination and Sex linked inheritance, Sex determination in humans, *Drosophila* and other animals, Sex determination in plants, Sex linked genes and dosage compensation.

### Unit 4

**8 Hours**

Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* Chromosomal aberrations: Types of changes– deletions, duplications, inversions, translocations, Change in chromosome number: trisomy and polyploidy.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Reading

1. Anthony, J.F., Miller, J.A., Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., McDonald, J.F. (1999). *The science of Genetics*. Saundern College publication.
3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Gupta, P.K. (2009). *Genetics*. Rastogi publications, Meerut, India.
5. Gupta, P.K (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
6. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
7. Schaum, W.D. (2000). *Theory & problems in Genetics by Stansfield, out line series McGrahill*, USA.
8. Tamarin, R.H. (1996). *Principles of Genetics, International edtn*. McGrawhill, USA.



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**Course Title: Basic Mathematics for Life Sciences**

**Course Code: BIN.408**

**Total Hours: 30**

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

1. Identify and describe the basic mathematical techniques that are commonly used by chemist.
2. Develop skills in vectors, matrices, differential calculus, integral calculus and probability.
3. Apply the principles to a number of simple problems that have analytical solutions.
4. Design different methods to problems related to chemistry.

## Course Content

### Unit-1

**15 Hours**

Vectors in 2D, 3D and in general, circles, transformation of coordinates, polar coordinates, parametric equations, and the solid analytic geometry of vectors, lines, planes, spherical coordinate.

### Unit-2

**15 Hours**

Functions, limits, derivative, physical significance, basic rules of differentiation, maxima and minima, exact and inexact differentials, partial differentiation.

### Unit-3

**15 Hours**

Using computational tools for: Addition and multiplication; inverse, adjoint and transpose of matrices, matrix equation, Introduction to vector spaces, matrix eigen values and eigen vectors, diagonalization, determinants (examples from Huckel theory).

### Unit-4

**15 Hours**

Tools for applying Basic rules for integration, integration by parts, partial fraction and substitution, definite integrals, evaluation of definite.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested readings

The chemistry Mathematics Book, E.Steiner, Oxford University Press (2008).

Mathematical for Physical Chemistry : F. Daniels, Mc. Graw Hill (1959).

Chemical Mathematics D.M. Hirst, Longman (1979).

Basic Mathematics for Chemists, Tebbutt, Wiley (1994).

G. Arfken, H. Weber and F. Harris, *Mathematical Methods for Physicists* (Elsevier Academic Press, Massachusetts, USA) 2012.





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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Statistical Methods**

**Course Code: BIN.409**

**Total Hours: 60**

**Credits Equivalent: 4 Credits**

(One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

**Course Objectives:**

This course will introduce the students to the concepts and methods of statistics, covering topics such as data organization and presentation, data analysis, probability, estimation and hypothesis testing and their application to the biological data. Students will be encouraged to use Python or R to gain computational hands-on learning about the topics covered. At the end of the course, students will be able to:

1. Develop an understanding of the fundamental theoretical aspects of methods of statistics and probability.
2. Develop the foundational skills in statistical analysis for Bioinformatics and Data Science.

**Course Contents:**

**Unit-I: Introductory concepts**

**(10 Hours)**

- Big Data in Biology: Need of Statistical measures to analyze it.
- Statistical population and sample: Types of data, Relative and cumulative frequency.
- Organization and presentation of data.
- Descriptive measures:
  - Measures of Central tendency: Mean, Median, Mode: notation and formulae, grouped data, relative merits
  - Measures of Dispersion: Absolute and relative measures.

**Unit-II: Probability concepts**

**(10 Hours)**

- Basic probability models: Combinatorics based computation, Bayes' rule
- Basics of Monte Carlo simulations
- Discrete random variables: Expected value, Variance, Covariance
- Discrete parametric distributions: (i) One Bernoulli Trail, (ii) Binomial distribution, (iii) Uniform distribution, (iv) Poisson distribution, (v) Power-law distribution
- Continuous probability models: Cumulative distribution function, Density functions  
Continuous probability distributions:
  - (i) Uniform distribution, (ii) Normal distribution: Standard deviation, Variance, Skewness and Kurtosis, z-score (iii) Exponential distribution.



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## Unit III: Statistics concepts

(10 Hours)

- Statistical preliminaries: Sample mean, Sample variance, Standard error
- Continuous models fitting: Method of moments, Method of maximum likelihood, Goodness of fit
- Family of normal distributions: Standard normal distribution, The central limit theorem, Chi-squared distribution
- Statistical inference: Confidence intervals, Student-t distribution, Significance tests, p-values, P-hacking, ANOVA

## Unit IV: Multivariate analysis

(10 Hours)

- Discrete and continuous multivariate distributions
- Covariance and correlation
- Dimensionality reduction: principal component analysis
- Clustering, Classification, Regression
- Model parsimony and over-fitting

### Text Books:

1. Ewens and Grant (2005), Statistical Methods in Bioinformatics, Springer
2. Matloff (2020). Probability and Statistics for Data Science, CRC
3. Prem S. Mann (2018), Introductory Statistics, Wiley
4. Daniel and Cross (2019), Biostatistics, Wiley

### Reference Books:

- Murray Spiegel et al. (2010), Probability and Statistics. McGraw Hill Education.  
Roger E. Kirk (2007), Statistics: An Introduction, Cengage Learning.  
Neil A. Weiss (2012), Introductory Statistics.  
Charles Henry Brase and Corrinne Pellillo Brase (2011), Understandable Statistics: Concepts and Methods.  
J. H. Zar (2019), Biostatistical Analysis, Pearson



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**Course Title: History of Science in India**

**Course Code: BIN.410**

**Total Hours: 30**

**Course Objectives:** This course is designed to introduce students about the rich scientific culture of India. The course attempts to develop a quest for search and research of scientific concepts embedded in the traditional Indian texts and rituals. For that, each topic covered in the course is taught by integrating two aspects: its modern scientific understanding and its discussion in the Indian literature. Prominent Indian Scientists, the Acharyas and the Rishis associated with a topic under discussion are duly introduced and acknowledged.

## Course Contents

### Unit 1: Introductory concepts

**(6 hours)**

- Antiquity of Indian civilization
- The archaeological sources
- The literature sources: Vedas and Vedangas, Epics and Puranas, Sastras (Niti, Artha), etc.
- Needham's puzzle

### Unit 2: Mathematics

**(6 hours)**

- The Sulbasutras
- Concept of pi
- Zero, decimal number system, place value system, combinatorics
- Katapyadi system, binary number system
- Fibonacci series and golden ratio

### Unit 3: Physics and Astronomy

**(6 hours)**

- The Vaisheshika: Matter and Universe (Notions of Padarth, Dravya and Guna)
- Measurements of length and mass
- Kaal ganana, calendars and eclipses: Five siddhants
- Laws of motion, concept of gravity and relativity
- Sound, light and energy

### Unit 4: Life Sciences and Medicine

**(6 hours)**

- Plants and agriculture, the Vrikshayurveda
- Microbes, animals and humans
- Origin and evolution of Ayurveda
  - Basic concepts; food, drinks and materia-medica; diseases; medicine; surgery; holistic view of life



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- Brief discussions on Rasachikitsa, Nadi vijnana, Yoga, Siddha, Homeopathy, Sowa-Rigpa

## UNIT 5: Engineering Sciences and Technology

(6 Hours)

- Architecture and Vastu Shastra
- Alchemy and metallurgy
- Marine science

### Text Books:

- **Suresh Soni (2008).** India's Glorious Scientific Tradition. Ocean Books
- **Bose et al. (2009).** A Concise History of Science in India. Universities Press

### Additional Readings:

- **BB Datta and AN Singh (1962).** History of Hindu Mathematics. Asia Publishing House
- **NG Dongre and SG Nene (2016).** Physics in Ancient India. National book Trust.
- **MS Valiathan.** The Legacy of Caraka/ Susruta/ Vagabhata. Universities Press.
- **P.C. Ray (1903).** A History of Hindu Chemistry. The Bengal chemical and pharmaceutical works ltd.



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**Course Title: Fundamentals of Machine Learning**

**Course Code: BIN.411**

**Total Hours: 30**

**Learning Outcomes:** At the end of the course, the students will be able to understand the basics of Machine learning

## Course Content

### Unit 1

**8 hours**

Class overview: Class organization, topics overview, software etc.

Introduction: what is ML; Problems, data, and tools; Visualization

### Unit 2

**6 hours**

Linear regression; SSE; gradient descent; closed form; normal equations; features

Overfitting and complexity; training, validation

### Unit 3

**6 hours**

Classification problems; decision boundaries; nearest neighbor methods

Probability and classification

### Unit 4

**8 hours**

Naive Bayes and Gaussian class-conditional distribution, Linear classifiers, Bayes' Rule and Naive Bayes Model

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings:

- Ethem Alpaydin, Introduction to Machine Learning, Second Edition , <http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012>.
- Stephen Marsland, Machine Learning: An Algorithmic Perspective. <http://www.amazon.com/Machine-Learning-Algorithmic-PerspectiveRecognition/dp/1420067184>
- Christopher M. Bishop, Pattern Recognition and Machine Learning. <http://research.microsoft.com/en-us/um/people/cmbishop/prml/>.
- Tom Mitchell, Machine Learning, <http://www.cs.cmu.edu/~tom/mlbook.html>.



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## Semester II

Credits	Core - Compulsory	Credits
10	BIN 451 Algorithms in Bioinformatics	4
	BIN 452 Fundamentals of Molecular Dynamics simulations	2
	BIN 453 Molecular Dynamics Simulation Lab	2
	BIN 454 Python Programming Lab II	2
		2

Credits	Core Open	Credits
6	BIN 455 Cell and Molecular Biology	2
	BIN 456 Essentials of Immunology	2
	BIN 457 Statistical Genetics	2
	BIN 458 Biological Databases and Management System	2
	BIN 459 DBMS Lab	2

Human Making (2)	Credits
BIN 460 Biosafety Issues	2

Skill Development (2)	Credits
BIN 461 Elements of Data Science	2



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Algorithms in Bioinformatics**

**Course Code: BIN.451**

**Total Hours: 60**

**Course Objectives:** The course is designed to introduce students the algorithmic principles, central to the studies in Computational Biology and Bioinformatics. Concepts from computer science like dynamic programming and graph theory will enable students to understand a variety of concepts that are used in the theoretical studies of life sciences and expose them to the underlying mechanisms of widely used softwares. Students, who are familiar with at least one programming language, will be encouraged to write their own codes for various algorithms discussed in this course.

## Course Content

### Unit 1: Introduction to algorithms and complexity

**8 Hours**

Basic Concepts: Algorithmic complexity (spatial and temporal), Biological vs. Computer algorithms, Genetic algorithm.

Standard Notations: Big-Oh, Omega, Theta notations; Hardness of an algorithm.

Linear and non-linear data structures, Stack, Queues, Linked list.

Introduction to algorithm design techniques: Exhaustive search, Greedy Algorithms, Divide and conquer etc.

Searching algorithms: Linear and Binary search; Sorting algorithms: Selection, Bubble, Insertion, Merge, Quick, Heap.

### Unit 2: Sequence Analysis

**10 Hours**

6. Models of DNA evolution: Jukes Cantor, Kimura and Tamura models

7. Derivation of protein evolution models: PAM and BLOSUM

8. Elements of dynamic programming: Edit distance, Longest Common Subsequences, Global and Local Sequence Alignment

9. Working of BLAST: Usage of Finite State Machine, E-value, etc.

10. Introduction to Multiple Sequence Alignment

11. Concepts of Joint, Conditional, Marginal probabilities

12. Markov Chains and Hidden Markov Models: CpG islands, Pairwise alignment using HMMs

### Unit 3: Pattern matching

**6 Hours**

a) Tandem and Interspersed repeats.

b) Repeat finding: Motifs, consensus, position weight matrices



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- c) Algorithms for derivation of and searching sequence patterns: MEME, PHI-BLAST, SCanProsite and PRATT
- d) Algorithms for generation of sequence profiles: PSIBLAST, HMMer,

## Unit 4: Phylogenetics

8 Hours

5. Basics of Molecular Evolution,
6. Tree - terminologies, Binary trees, AVL trees.
7. Tree traversal: Pre-order, In-order, post-order; Breadth-first search, Depth-first search.
8. Evolutionary trees: (I) Distance based methods – UPGMA, NJ, Fitch Margoliash (FM), Minimum Evolution (ME); (II) Character based methods – MP, ML, Bayesian inference algorithm.
9. Tree Evaluation, Bootstrapping.

## Unit 5: RNA and Protein Structure Prediction

8 Hours

- RNA secondary structure: Nussinov algorithm, Energy minimization, Zuker's Algorithm, SCFG.
- RNA tertiary structure: Basics of “minimum free energy” based methods.
- Protein secondary structure: Chou-Fasman, GOR method.
- Protein tertiary structure: Rosetta method, Contact potential method.

### Text Books:

- **Jones and Pevzner (2004)**, An Introduction to Bioinformatics Algorithms. MIT Press.
- **Durbin *et al.* (1998)**, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press
- **Mount (2004)**, Bioinformatics: Sequence and Genome Analysis, CBS Publishers
- **Pevsner (2015)**, Bioinformatics and Functional Genomics. Wiley.

### Additional Readings:

**Gusfield (2005)**, Algorithms on Strings, Trees and Sequences. Cambridge University Press.





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**Cormen *et al.* (2009)**, Introduction to Algorithms. MIT Press.

**Sung (2009)**, Algorithms in Bioinformatics: A Practical Introduction. Chapman & Hall/CRC.

**Neapolitan and Naimipour (2011)**, Foundations of Algorithms. Jones & bartlett.

**Korf *et al.* (2003)**, BLAST. O'Reilly

**Junker and Schreiber (2008)**, Analysis of Biological Networks. Wiley-Interscience, New Jersey.

**Mitchell (1998)**, An Introduction to Genetic Algorithms. MIT Press.



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**Course Title: Fundamentals of Molecular Dynamics Simulation**

**Course Code: BIN.452**

**Total Hours: 30**

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

- learn the modelling of small to large molecular environments
- understand various force field for biomolecular simulation in details
- gain the knowledge about different molecular simulation techniques
- learn different methods for simulating large systems
- understand the dynamics of the structural transitions

## Course Content

### Unit 1

**15 Hours**

Biomolecular Modeling and Structure - molecular modeling today: overview of problems, tools, and solution analysis, minitutorials in protein and nucleic acid structure. Techniques for Conformational Sampling- Monte Carlo, global optimization, etc.

### Unit 2

**15 Hours**

Molecular Mechanics: general features, bond stretching, angle bending, improper torsions, out of plane bending, cross terms, non-bonded interactions, Ramachandran diagram point charges, calculation of atomic charges, polarization, van der waals interactions, hydrogen bond interactions, Water models, Force field, all atoms force field and united atom force field.

### Unit 3

**15 Hours**

Energy minimization: Steepest descent, conjugate gradient – Derivatives, First order steepest decent and conjugate gradients. Second order derivatives Newton-Raphson, Minima, maxima saddle points and convergence criteria.-non derivatives minimization methods, the simplex, sequential univariate, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, Solvent access, Equilibration, cut-offs.

### Unit 4

**15 Hours**

Simulation methods: algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzmann velocity, time steps, duration of the MD run, Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions. Various methods of MD, Monte Carlo, systematic and random search methods. Differences between MD and MC, Energy, Pressure, Temperature, Temperature dynamics, simulation softwares. Various methods of MD, Monte Carlo, systematic and random search methods.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
2. Fenniri, H. "Combinatorial Chemistry – A practical approach", (2000) Oxford University Press, UK.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. Gordon, E.M. and Kerwin, J.F "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.



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**Course Title: Molecular Dynamics Simulation Lab**

**Course Code: BIN.453**

**Total Hours: 60**

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

- learn the modelling of small to large molecular environments
- understand various force field for biomolecular simulation in details
- learn different methods for simulating large systems
- gain the knowledge about different molecular simulation techniques understand the dynamics of the structural transitions

## Course Content

1. Visualization Software and 3D representations with VMD and PYMOL
2. Coordinate generations and inter-conversions.
3. Energy minimizations and optimization.
4. Molecular Dynamics with Gromacs:
  - Protein in water
  - Membrane protein
  - Umbrella Sampling
  - Free Energy of Solvation
  - Protein ligand interaction
  - Free Energy of Solvation

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings:

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
2. Fenniri, H. “Combinatorial Chemistry – A practical approach”,(2000) Oxford University Press, UK.
3. Lednicer, D. “Strategies for Organic Drug Discovery Synthesis and Design”; (1998) Wiley International Publishers.
4. Gordon, E.M. and Kerwin, J.F “Combinatorial chemistry and molecular diversity in drug discovery” (1998) Wiley-Liss Publishers.



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**Course Title: Python Programming Lab II**

**Course Code: BIN.454**

**Total Lecture: 60**

**Learning Outcomes:** Upon successfully completing this course, students will be able to “do something useful with Python”.

- Identify/characterize/define a numerical problem
- Design a program to solve the data parsing problem
- Create Time series code
- Read most of the advanced Python code

## Course Content

- Introduction to Numpy and Pandas
- Visualizations with Matplotlib and Seaborn
- Statistical analysis to understand our data
- Data cleaning and normalization.
- Advanced Pandas models
- Hierarchical indexing
- Data Wrangling and transformations
- Advanced visualizations
- Introduction to Machine Learning
- Intro to Regressions- Linear and logistic regression using Scikit Learn
- Intro to Classification- Classification with K nearest Neighbours- Decision Trees and Random Forest

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- Core Python Programming (<http://corepython.com/>): Only available as a dead trees version, but if you like to have book to hold in your hands anyway, this is the best textbook style introduction out there. It starts from the beginning, but gets into the full language. Published in 2009, but still in print, with updated appendixes available for new language features. In the third edition, "the contents have been cleaned up and retrofitted w/Python 3 examples paired w/their 2.x friends."
- Dive Into Python 3 (<http://www.diveinto.org/python3/>): This book offers an introduction to Python aimed at the student who has experience programming in another language.
- Python for You and Me (<http://pymbook.readthedocs.org/en/latest/>): Simple and clear. This is a great book for absolute newcomers, or to keep as a quick reference as you get used to the language. The latest version is Python 3.
- Think Python (<http://greenteapress.com/thinkpython/>): Methodical and complete. This book offers a very "computer science"-style introduction to Python. It is really an intro to Python in the service of Computer Science, though, so while helpful for the absolute newcomer, it isn't quite as "pythonic" as it might be.
- Python 101 (<http://www.blog.pythonlibrary.org/2014/06/03/python-101-book-published-today/>) Available as a reasonably priced ebook. This is a new one from a popular Blogger about Python.



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Lots of practical examples. Also available as a Kindle book: <http://www.amazon.com/Python-101-Michael-Driscoll-ebook/dp/B00KQTFHNK>

- Problem Solving with Algorithms and Data Structures (<http://interactivepython.org/runestone/static/pythonds/index.html>) (Links to an external site.) Links to an external site.)

- Python Course ([http://www.python-course.eu/python3\\_course.php](http://www.python-course.eu/python3_course.php)) (Links to an external site.) Links to an external site.)

References for getting better, once you know the basics

- Python Essential Reference (<http://www.dabeaz.com/per.html>): The definitive reference for both Python and much of the standard library.

- Hitchhikers Guide to Python (<http://docs.python-guide.org/en/latest>): Under active development, and still somewhat incomplete, but there is good stuff.

- Writing Idiomatic Python (<https://www.jeffknupp.com/writing-idiomatic-python-ebook>): Focused on not just getting the code to work, but how to write it in a really "Pythonic" way.

- Fluent Python (<http://shop.oreilly.com/product/0636920032519.do>): All python3, and focused on getting the advanced details right. Good place to go once you've got the basics down.

- Python 3 Object Oriented Programming (<https://www.packtpub.com/application-development/python-3-object-oriented-programming>) (Links to an external site.) Links to an external site.): Nice book specifically about Object Oriented programming structure, and how to do it in Python. From local Author and founder of the Puget Sound Programming Python (PuPPy) meetup group, Dusty Phillips.



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**Course Name: Cell and Molecular Biology**

**Course Code: BIN.455**

**Total Lectures: 30**

## Learning Outcomes:

On successful completion of the course the student will be able to:

- Conceptualization of basic cellular and molecular mechanisms.
- Understanding structures and functions of various cellular organelles.
- Understanding the molecular processes of DNA replication, transcription, and translation

## Course Content

### Unit – I

**8 Lectures**

Membranes of intracellular organelles, Membrane transport, Structure and functions of intracellular organelles, Intracellular traffic and secretory pathways, endocytosis and exocytosis.

### Unit – II

**8 Lectures**

**The Cytoskeleton:** cell cytoskeleton and its organization including extracellular matrix, adhesions and junctions.

**Cell-cell communication and cell growth:** Overview of cell signaling, cell surface receptors and second messengers.

### Unit – III

**6 Lectures**

**Gene and Genome organization:** Eukaryotic gene organization, transposition, Mechanism of DNA replication, DNA damage and their repair.

### Unit – IV

**6 Lectures**

**Transcription:** transcription and transcription factors, Transcriptional and post-transcriptional gene silencing, mRNA processing: Capping, Polyadenylation, Splicing, editing, mRNA stability.

**Translation:** Genetic code, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, post-translational modifications of proteins.

**Transactional Modes:** Lecture; Demonstration; Tutorial; Lecture cum demonstration; Problem solving; Self-learning.

## Suggested Reading:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). *Molecular cloning: a laboratory manual*. Cold Spring Harbor Laboratory Press New York.
2. Lodish, H., Berk, A. Chris, A.K. & Krieger, M. (2011). *Molecular Cell Biology*. W.H. Freeman, USA.
3. Robertis, (2011). *Cell and Molecular Biology*. Lippincott Williams & Wilkins.
4. Karp, G. (2010). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., & Levine, M. (2003). *Molecular Biology of the Gene* Benjamin Cummings.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2007). *Molecular biology of the cell*. Garland Science. *New York, 1392*.
8. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.



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Course Code: : **Essentials of Immunology**

**Course Code: BIN.456**

**Total Lectures: 30**

## Learning Outcomes:

On successful completion of the course the student will be able to:

- Evaluate basic concepts of immune system.
- Gain knowledge about various key processes related to development of immune system.
- Understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
- Apply the knowledge how immune system is involved in diseases caused by internal or external factors.

### Unit: I

**12 Lectures**

**Immune System:** The cells and organs of immune system, humoral immunity-immunoglobulin, basic structure, classes and subclasses, structural and functional relationships, nature of antigen, antigen-antibody reaction, antibody diversity, class switching, B and T cell development.

### Unit: II

**7 Lectures**

**Immune Effectors:** Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, various effector cells of immune system: DC, NK, Monocytes etc.

### Unit: III

**6 Lectures**

**Mechanisms of Immune System Diversity:** Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions.

### Unit: IV

**5 Lectures**

**Immune System in Health and Diseases:** Inflammation, hypersensitivity and autoimmunity, AIDS and immunodeficiencies, vaccine development.

**Transactional Modes:** Lecture; Demonstration; Tutorial; Lecture cum demonstration; Problem solving; Self-learning.

## Suggested Reading:

- Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2018). *Kuby Immunology*. W.H. Freeman, USA.
- Abbas. (2018). *Cellular and Molecular Immunology*. CBS Publishers & Distributors, India.
- Charles, A. and Janeway, J.R. (2001). *Immunobiology: The immune system in health and disease*. Blackwell Publishing, USA.
- Delves, P.J., Roitt, I.M. and Seamus, J.M. (2016). *Roitt's Essential Immunology (Series–Essentials)*. Blackwell Publishers, USA.
- Elgert, K.D. (2015). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.



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**Course Code: : Statistical Genetics**

**Course Code: BIN.457**

**Total Lectures: 30**

**Learning Outcomes:** The course is designed to ensure that the students understand the fundamentals, theoretical and practical aspects of statistics which could be applied in wide fields of life sciences.

## Course Contents

### UNIT I

**7 Hours**

- Mendel's law, Hardy Weinberg equilibrium and overview of linkage and association
- Map function & recombination fraction
- Genetic map construction

### UNIT II

**8 Hours**

- Multipoint analysis of mendalian loci
- Introduction to quantitative genetics
- Major gene detection and segregation analysis

### UNIT III

**8 Hours**

- Interval mapping & CIM
- QTL mapping & GWAS
- Statistics for population genetics

### UNIT V

**7 Hours**

- Statistics for genetic epidemiology and biomedical sciences
- Statistics for evolutionary genetics and epigenetic research
- Statistical genetics for animal and plant breeding

## Text Books:

1. D.J. Balding, M Bishop and C. Cannings. Handbook of Statistical Genetics Vol 1 & 2. *Wiley*
2. Murray R Spielgel and Larry J Stephens: Schaum's outline of statistics. *Tata McGraw Hill*
3. Sheldon M. Ross. Introductory Statistics. *Academic Press*
4. Shizhong Xu. Principles of Statistical Genomics. *Springer*





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**Course Code: : BDBMS**

**Course Code: BIN.458**

**Total Lectures: 30**

**Learning Outcomes:** Upon successfully completing this course, students will be able to apply principles of DBMS to create novel solution in bioinformatics.

- Identify/characterize/define and solve a data collection, sorting and management problem
- Design an approach to create a Relational DBMS
- Create non-redundant databases

## Course Content

### Unit1

**15 Hours**

Biological Databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt, Mapping databases, Genomic databases, PDBsum, PDB, SCOP, CATH, Pathway and molecular interaction databases.

### Unit 2

**15 Hours**

Database planning and Design concepts General Database Planning and Design – Document or forms – preparation and architecture Entity-Relational ship Model- entities, Attributes, keys, tables design, relationships, roles and dependencies.

### Unit 3

**15 Hours**

Relational DB Introduction to relational DB and transactions. SQL-statements-Data Definition-Manipulation-control-Objects, - Views, sequences and Synonyms. Working with code and forms-Front end development-query sublanguage-modifying relations in SQL.

### Unit 4

**15 Hours**

Internals of RDBMS Physical data structures, query optimization. Join algorithm statisca and cost base optimization. Transaction processing.concurrency control and recovery management. Transaction model properties, state serizability, lock base protocols, two phase locking.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

1 Abraham Silberschatz, Henry F.Korth and S.Sudhasan (2005) Database system concepts. 5 Ed McGraw Hill Publications.

2 Elmasri Ramez and Novathe Shamkant, “ Fundamentals of Database systems” (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.

3 P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575

4 Jim Gray and A.Reuter “ Transaction processing : Concepts and Techniques” Morgan Kaufmann Press.(1997) ISBN- 10: 1558601902

5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279

6 Date C.J. “ Introduction to database management” (2009) Vol1, Vol2, Vol3 addison Wesley.

7 Ullman, JD “ Principles of Database systems” (1992) Galgottia publication

8 James Martin Principles of Database Management systems” (1985) PHI.

6. Introduction to NCBI Taxonomic Browser

7. DDL & DML: Creating and working with databases, creating tables, dropping tables, primary and secondary keys, data validation, simple queries using MySQL, cursors, stored procedures.

8. DTD and XML schema- simple DTD and creation of data in XML.



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**Course Code: : DBMS Lab**

**Course Code: BIN.459**

**Total Lectures: 30**

**Learning Outcomes:** Upon successfully completing this course, students will be able to apply principles of DBMS to create novel solution in bioinformatics.

- Identify/characterize/define and solve a data collection, sorting and management problem
- Design an approach to create a Relational DBMS
- Create non-redundant databases

## Course Content

1. Data Definition, Table Creation, Constraints,
2. Insert, Select Commands, Update & Delete Commands.
3. Nested Queries & Join Queries
4. Views
5. High level programming language extensions (Control structures, Procedures and Functions).
6. Front end tools
7. Forms
8. Triggers
9. Menu Design
10. Reports.

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- 1 Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
- 2 Elmasri Ramez and Novathe Shamkant, “ Fundamentals of Database systems” (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
- 3 P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
- 4 Jim Gray and A.Reuter “ Transaction processing : Concepts and Techniques” Morgan Kaufmann Press.(1997) ISBN- 10: 1558601902
- 5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279
- 6 Date C.J. “ Introduction to database management” (2009) Vol1, Vol2, Vol3 addison Wesley.
- 7 Ullman, JD “ Principles of Database systems” (1992) Galgottia publication
- 8 James Martin Principles of Database Management systems” (1985) PHI.



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**Course Title: Biosafety Issues**

**Course Code: BIN.460**

**Total Hours: 30**

**Learning Outcomes:** The course is designed to introduce students to biosafety guidelines of DBT, Ministry of Science & Technology, Government of India and the World Health Organization.

**Course Contents:**

## **UNIT-I: Introduction**

**6 hours**

- Introduction to the biosafety guidelines
- Constitution of institutional biosafety committees (IBSCs) and its functions
- Microbiological risk assessment

## **UNIT-II: Biohazards and biosafety levels**

**6 hours**

- Biosafety level 1
- Biosafety level 2
- Biosafety level 3
- Biosafety level 4

## **UNIT-III: Laboratory biosecurity, equipment and good lab practices**

**6 hours**

- Laboratory biosecurity concepts
- Biological safety cabinets and equipment
- Laboratory techniques
- Disinfection and sterilization
- Introduction to the transport of infectious substances

## **UNIT-IV: Scientific Considerations**

**6 hours**

- Biosafety and recombinant DNA technology
- Chemicals, fire, electrical, noise and ionizing radiation hazards
- Human health and environmental considerations
- Containment facilities

## **UNIT-V: National; International frameworks on biosafety**

**6 hours**

- Guidelines by Ministry of Environment and Forests (MoEF), & DBT Government of India
- International binding and non-binding instruments on Biosafety
- Potential overlaps and conflicts between treaties and trade concerns
- Competent authorities to regulate the biosafety issues
- Safety checklist

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### **Suggested Readings:**

1. Guidelines and Handbook for Institutional Biosafety Committees (IBSCs) by Department of Biotechnology, Ministry of Science & Technology, Government of India.
2. Laboratory biosafety manual (3<sup>rd</sup> edition) by the World Health Organization, Geneva.



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**Course Title:: Elements of Data Science**

**Course Code: 461**

**Total Hours: 30**

## Course Objectives:

This course is designed to introduce students to the underlying concepts about the most demanding job of the 21<sup>st</sup> century – “The Data Scientist”. Data is termed as the “new gold” and the students will learn about the science of extracting knowledge from the Big Data. The applications covered will span Weather predictions, Oil drilling, Seismic activities, Biological data analysis, Social media analytics among many others. Students are encouraged to gain technical know-how about the discussed concepts using Python.

## Course Contents:

### Unit I: Big Data and Data Science (3 Hours)

- How big is Big Data
- Facets of Data
- The Data Science process
- Data Scientist's Toolkit

### Unit II: Basics of Python (5 Hours)

- **The Basics:** Getting Python, The Zen of Python, Whitespace formatting, Modules, Arithmetic, Functions, Strings, Exceptions, Lists, Tuples, Dictionaries, Sets, Control Flow, Sorting, List Comprehensions, Generators and Iterators, Randomness, Regular expressions, etc.
- **Visualizing Data:** Matplotlib, Bar charts, Line charts, Scatterplots etc.

### Unit III: Getting Data and Working with Data (3 Hours)

- Reading files
- Scraping the web
- Using APIs
- Cleaning, Munging and Manipulating Data
- Rescaling the Data

### Unit IV: Machine Learning (5 Hours)

#### Supervised Learning:

- Classification: Naïve Bayes, Support Vector Machines, Decision Trees



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- Regression: Linear, Polynomial, Logistic

## Unsupervised Learning

- Clustering: k-means, Hierarchical
- Dimensionality Reduction: Principal Component Analysis

## Unit V: Enabling technologies for Data Science

(4 Hours)

Brief introduction to the NoSQL, Hadoop, MongoDB and Cassandra, Map-Reduce, Hive, Pig

### Text Books:

1. Joel Grus (2019). Data Science from Scratch, O'Reilly
2. Cielien, Meysman, Ali (2015). Introducing Data Science, Manning Publications.

### Additional Readings:

1. Blum, Hopcroft, Kannan (2020). Foundations of Data Science, Cambridge University Press
2. VanderPlas (2016). Python Data Science Handbook, O'Reilly
3. Kroese et al. (2020). Data Science and Machine Learning: Mathematical and Statistical Methods, CRC Press.



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## Semester III

Credits	Core - Compulsory	Credits
8	BIN 501 Computer Aided Drug Design Lab	2
	BIN 502 R Programming Lab	2
	BIN 503 M.Sc. Project	4

Credits	Elective Open	Credits
4	BIN 504 Computational Genomics and Proteomics	4

Credits	Elective (Specialization) Structural Bioinformatics	Credits
8	BIN 505 Computer Aided Drug Discovery	4
	BIN 506 Systems Biology and Biological Networks	4



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**Course Title: Computer Aided Drug Design Lab**

**Course Code: BIN.501**

**Total Hours: 60**

## Course Content

- Introduction to Structure based Drug Design and process layout of Docking
- Data mining, literature study and acquisition of target structure
- Comparative modelling of protein (Homology modelling) \*target structure not available
- Server based –PHYRE, RaptorX, SWISSMODEL, I-TASSER, etc.
- Protein structure validation(ProSA)
- Ramachandran plot assessment(RAMPAGE,Pdbsum,Procheck)
- Active site/ Pocket identification –MetaPocket,CastP,Active site identification using PyMol
- Molecular Docking \*using AutoDock vina/AutoDock Tools/PyRx (For docking of multiple ligands)
- Protein and ligand preparation
- Setting grid parameters and Docking parameters
- Docking analysis (based on binding energy, Hydrogen bond interactions, electrostatic interactions, hydrophobic interactions, etc.)
- BINANA (BINDing ANAlyser)
- Pdbsum for visualising protein-ligand interactions
- Building protein-ligand complex and visualization(publication standard)
- Report construction



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**Course Title: R Programming Lab**

**Course Code: BIN.502**

**Total Hours: 60**

**Course Objectives:** This course deals with the fundamentals and hands-on-experiments on R.

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

- Basics of R programming.
- Hand-on practice on common R commands for statistical analysis
- Learn application of R in bioinformatics and life science research

## **Unit I**

**16 Hours**

Introduction and installation of R and R studio; basic syntax; data-types; variables; operators; decision making; loops; functions; strings; vectors; lists; matrices; arrays; factors; data frames; R-packages

## **Unit II**

**16 Hours**

Data visualization: pie charts, bar charts, boxplots; histograms, line graphs, scatterplots; mean, median & mode; regression analysis; normal and binomial distribution, analysis of covariance, time series analysis, decision tree, random forest, Chi-square test

## **Unit III**

**14 Hours**

Pairwise sequence alignment; SeqinR package; comparing two sequences using dotplots; pairwise DNA sequence alignment; Bioconductor packages, protein sequence alignment by using Needleman-Wunch and Smith-Waterman algorithms; multiple sequence alignments; building phylogenetic tree using R

## **Unit IV**

**14 Hours**

Finding start and stop codons using R; predicting the protein sequence for an ORF; length of ORF; comparing the number of genes in two species; application of Hidden Markov Models in nucleotide and protein sequence analysis

**Transactional Modes:** Lecture; Tutorial; Hand-on-experiments; Self-learning.

## **Suggested Readings**

- Michael J. Crawley, The R Book, Wiley, (2012)
- Robert Gentleman, R programming for Bioinformatics, CRC Press, (2009).
- Golemund, Garret (2014) Hands-on Programming with R
- Wickham, Hadley (2015) Advanced R 1st ed. (Advanced R 2nd ed, 2019.)
- Wickham, Hadley (2015) R Packages.





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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: M.Sc. Project**

**Course Code: BIN.503**

**Total Hours: 120**

**Course Objective and Learning Outcomes:** The objective of project would be to ensure that the student learns the fundamentals of the scientific research. Herein the student shall have to carry out the experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analyzed in light of established scientific knowledge to arrive at cogent conclusions.

The Evaluation criteria shall be multifaceted as detailed below:

S.No.	Criteria	Marks allotted
<b>Continuous Assessment</b>		
1.	Research work and Report writing	60
2.	Continuous evaluation of student by guide	20
<b>Research Presentation</b>		
3.	Presentation and defense of research work (Viva)	120
<b>Total</b>		<b>200*</b>

The final presentation shall be evaluated by a two membered committee consisting of

- Supervisor
- Subject Expert as nominated by honourable VC



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Computational genomics and Proteomics**

**Course Code: BIN.504**

**Total Hours: 60**

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

- learn the importance of DNA-Protein Interactions During Transcription
- gain a deep knowledge about the role of bioinformatics-OMIM database, integrated genomic maps, gene expression profiling
- apply probabilistic modeling techniques for the building of transcriptional regulatory networks which will help them to use the techniques of computational proteomics in their further potential careers in academia and industry.

## Course Content

### Unit I

**14 Hours**

The Importance of DNA-Protein Interactions During Transcription. Initiation-Regulation of Transcription, Synthesis and Processing of the Proteome, The Role of tRNA in Protein Synthesis, The Role of the Ribosome in Protein Synthesis, Post-translational Processing of Proteins, Protein Degradation.

### Unit 2

**16 Hours**

Role of bioinformatics-OMIM database, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP)

### Unit 3

**16 Hours**

Transcriptomics: database and basic tools, Gene Expression Omnibus (GEO), SAGE databases, detecting differential gene expression,

### Unit 4

**14 Hours**

Only for yeasts: building predictive models of transcriptional regulatory networks using probabilistic modeling techniques.

Peptide Mass Finger-printing: database searches

### Extra Reading Topics (Not in evaluatory content)

Genomes, Transcriptomes and Proteomes, The Human Genome and its Importance, Structure of the Eukaryotic and Prokaryotic Genome, the Repetitive DNA Content of Genomes. Mechanism of Genetic Action, Gene-protein relations, Genetic fine structure, Mutational sites Complementation, How Genomes Function, Accessing the Genome, Inside the Nucleus, Chromatin Modifications and Genome Expression, Assembly of the Transcription Initiation Complex, Metagenomics

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### Suggested Readings

1. Sándor Suhai (2002). Genomics and Proteomics. Springer US



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2. CAMPBELL (2007). Discovering Genomics, Proteomics and Bioinformatics. Pearson Education
3. Richard P. Grant (2004). Computational Genomics: Theory and Application. Horizon Bioscience



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Computer Aided Drug Discovery**

**Course Code: BIN.505**

**Total Hours: 60**

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

- demonstrate various force field for biomolecular modeling
- execute various molecular docking methods
- identify the dynamics of structural transitions which will help them to develop the molecular docking techniques in their further potential careers in academia and industry.

## Course Content

### Unit 1

**15 Hours**

Introduction to Computer Aided Drug Design (CADD) History, different technique sand applications Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters ( $\sigma$ ), lipophilicity effects and parameters ( $\log P$ ,  $\pi$  substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters

### Unit 2

**15 Hours**

Quantitative Structure Activity Relationships: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSAR equations 3D-QSAR approaches and contour map analysis Statistical methods used in QSAR analysis and importance of statistical parameters

### Unit 3

**15 Hours**

Molecular Modeling and Docking Molecular and Quantum Mechanics in drug design Energetics of bioactive conformation Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AChE & BchE)

### Unit 4

**15 Hours**

Molecular Properties and Drug Design: Prediction and analysis of ADMET properties of new molecules and its importance in drug design. De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. Homology modeling and generation of 3D-structure of protein

**Transactional Modes:** Lectures; Tutorials; Problem solving; Self-learning.

## Suggested Readings

1. Schneider, Gisbert; Baringhaus, Karl-Heinz; Kubinyi, Hugo Molecular design : concepts and applications Weinheim: Wiley-VCH, c2008
2. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. [http://autodock.scripps.edu/faqs-help/manual/autodock-4-2-user-guide/AutoDock4.2\\_User-Guide.pdf](http://autodock.scripps.edu/faqs-help/manual/autodock-4-2-user-guide/AutoDock4.2_User-Guide.pdf)



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Systems Biology and Biological Networks**

**Course Code: BIN.506**

**Total Hours: 60**

**Course Objectives:** This course will be centered on (i) the theoretical and practical aspects of modelling in systems biology – both deterministic and stochastic and (ii) the study of biological networks. Students will become acquainted with the key concepts and computational approaches to both of these fields.

“Systems Biology” finds its major application in the research field known as “Synthetic Biology” (aiming to design and realize modified or new biological parts). Students will also become familiar with necessary mathematical and computational concepts of Synthetic Biology.

Students having prior knowledge of any programming language will be encouraged to write their own codes for simulating and analysing model biological systems.

## Course Contents

### Unit 1: Introductory interdisciplinary concepts

**(8 hours)**

- Definition and scope of systems and synthetic biology. Introduction to biological complexity -- Self organization, Emergence, Chaos, Robustness.
- First-order systems: Fixed points and stability, Population growth.
- Bifurcations (with examples) in first order systems: Saddle node, Pitch fork, Transcritical.
- Basic notion of bifurcations in second order systems: Period doubling, Hopf.

### Unit 2: Deterministic modelling in systems biology

**(8 hours)**

- Chemical kinetics, Michaelis-Menten kinetics, Hill equations
- Feedback in gene regulation: positive, negative, mutual inhibition
- Deterministic methods of systems modelling (Euler and RK4), with numerical applications on
  - Simple examples of autocatalysis, linear degradation etc.
  - Examples from natural systems: Predator-Prey, p53-mdm2.
  - Examples from synthetic systems: Brusselator, Repressilator.

### Unit 3: Stochastic modelling in systems biology

**(8 hours)**

10. Introduction to noise in biological systems. Intrinsic vs. extrinsic noise. System behaviour and role of noise.



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11. Stochastic Methods for modelling biological systems (Master equation, Gillespie's stochastic simulation algorithm)
12. Application of Gillespie's SSA on Brusselator, Predator-Prey and other simple examples.

## Unit 4: Design principles of biological networks

(8 hours)

- Introduction to networks: Hamiltonian path vs. Eulerian path; Basic terminology; Topology of genetic, metabolic and ecological networks.
- Network models: Erdős-Renyi, Small-world, Scale-free.
- Global Properties: Average path length, network diameter, centrality measures, clustering coefficients etc. Modular and hierarchical networks.
- Local Properties: Regulatory motifs and graphlets in networks. Motifs in TRNs: discussion on FFL, SIM and other motifs.

## UNIT 5: Analysis of biological networks

(8 Hours)

- Elementary graph algorithms: Breadth-first search, Depth-first search, Topological sort, Strongly connected components. Growing a minimum spanning tree.
- Finding shortest path: Single source shortest path, All pairs shortest paths
- Network clustering: Clique based clustering, Center based clustering
- Basics of flux balance analysis.

### Text Books:

**Steven H. Strogatz (1994)**, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Perseus Books, Massachusetts.

**Szallasi *et al.* (2010)**, System Modelling in Cellular Biology. MIT Press.

**Junker and Schreiber (2008)**, Analysis of Biological Networks. Wiley-Interscience, New Jersey.

### Additional Readings:

**Uri Alon (2006)**, An Introduction to the Systems Biology. Chapman and Hall.

**Mark Newman (2010)**, Networks: An Introduction. Oxford University Press.

**Klipp *et al.* (2009)**, Systems Biology in Practice. Wiley-VCH.

**BO Palsson (2006)**, Systems Biology. Cambridge University Press.

**Press *et al.* (2007)**, Numerical Recipes in C. Cambridge University Press.

**Singh and Dhar (2015)**, Systems and Synthetic Biology, Springer



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## Semester IV

Credits	Core - Compulsory	Credits
12	BIN 551 Next Generation Sequencing Analysis	4
	BIN 552 Chemoinformatics	2
	BIN 553 M.Sc. Dissertation	6

Credits	Elective Open	Credits
8	BIN 554 Fundamentals of Metabolomics	2
	BIN 555 Advance topics on Machine Learning	2
	BIN 556 Introduction of Synthetic Biology	2
	BIN 557 Systems Biology Lab	2



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Next Generation Sequencing: Analysis**

**Course Code: BIN.551**

**Total Lecture: 60**

**Learning Outcomes:** On completion of the course the student should be able to understand the basics of next generation sequencing and data analysis

## **Course Contents:**

### **UNIT-I: First generation sequencing technologies: An introduction (12 hours)**

Maxam-Gilbert and Sanger sequencing

Next generation sequencing technologies

NGS file formats : Preprocessing of raw reads: quality control (FastQC), adapter clipping, quality trimming

### **UNIT-II: Genome sequence assembly (12 hours)**

De novo genome sequence assembly

Use of paired end reads in assembly

Data preprocessing and sequence read correction methods

Assembly errors and evaluation of assembly methods

### **UNIT-III: De novo assembly algorithms (12 hours)**

The overlap graph approach

De Bruijn graph approach

Classification of De Novo assembly algorithms

Comparison of algorithms

### **Unit IV: Tools and Techniques (12 hours)**

Introduction to read mapping (Alignment methods, Mapping heuristics)

Read mapping (BWA, BWA-MEM, Bowtie2, STAR, segemehl), Mapping output (SAM/BAM format), Usage of important NGS toolkits (samtools), Mapping statistics

Visualization of mapped reads (IGV, UCSC)

DNA variant calling

### **UNIT-V: Applications of NGS (12 hours)**

- Comparative genomics
- Functional genomics
- Diagnostics and Exom sequencing
- Microbiome studies

## **Suggested Readings**

1. Ali-Masoudi-Nejad, Zahra Narimani, Nazanin Hosseinkhan. Next Generation Sequencing and Sequence Assembly: Methodologies and Algorithms, SpringerBriefs in Systems Biology, 2013. ISBN 978-1-4614-7726-6.

Other references (Review articles)

1. Rogers, J., and Gibbs, R.A. (2014) Comparative primate genomics: emerging patterns of genome content and dynamics. Nat Rev Genet, 15 (5), 347–359.





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2. Werner, T. (2010) Next generation sequencing in functional genomics. *Briefings Bioinforma.* , 11 (5), 499–511.
3. Bamshad, M.J., Ng, S.B., Bigham, A.W., et al. (2011) Exome sequencing as a tool for Mendelian disease gene discovery. *Nat Rev Genet*, 12 (11), 745–755.
4. Alkan, C., Coe, B.P., and Eichler, E.E. (2011) Genome structural variation discovery and genotyping. *Nat Rev Genet*, 12 (5), 363–376.
5. Cooper, G.M., and Shendure, J. (2011) Needles in stacks of needles: finding disease-causal variants in a wealth of genomic data. *Nat Rev Genet*, 12 (9), 628–640.
6. Kuczynski, J., Lauber, C.L., Walters, W.A., et al. (2012) Experimental and analytical tools for studying the human microbiome. *Nat. Rev. Genet.*, 13 (1), 47–58.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Cheminformatics**

**Course Code: BIN.552**

**Total Hours: 30**

**Learning outcomes:** On successful completion of this module, students should be able to: the students will obtain some knowledge and will get training in

- Data organization and search in chemical databases;
- QSAR and pharmacophores modelling;
- Chemical data visualization and analysis
- Virtual screening tools and efficiency assessments

## Course Content

### Unit I:

**8 Hours**

Cheminformatics as a theoretical chemistry discipline: definition, main concepts and areas of application.

Representing chemical structures on computer. Molecular graphs. Connectivity tables. Adjacency and distance matrices. Linear representations SMILES and SMIRKS.

### Unit 2

**7 Hours**

Molecular descriptors. Definition and main requirements. Different types of descriptors: constitutional, topological indices, geometry-based, surface-based, substructural fragments, lipophilicity, etc.

### Unit 3

**7 Hours**

Chemical Space concept. Graph-based chemical space: scaffolds, frameworks and R-groups. Scaffold tree approach. Descriptor-based chemical space: distance and similarity metrics

### Unit 4

**8 Hours**

Virtual screening workflow. Drug-likeness filters and structural alerts. Parameters of screening efficiency.

**Transactional Modes:** Lectures; Tutorials; Problem solving; Self-learning.

### Suggested Readings

- A. Leach, V. Gillet “An Introduction to Chemoinformatics”, Springer, 2007
- “Tutorials in Chemoinformatics”, A. Varnek, Ed. , WILEY, 2017



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: M.Sc. Dissertation**

**Course Code: BIN.599**

**Total Hours: 240**

**Course Objective and Learning Outcomes:** The objective of dissertation would be to ensure that the student learns the fundamentals of the scientific research. Herein the student shall have to carry out the experiments to achieve the objectives as mentioned in the synopsis. The data collected as a result of experiments must be meticulously analyzed in light of established scientific knowledge to arrive at cogent conclusions.

The Evaluation criteria shall be multifaceted as detailed below:

S.No.	Criteria	Marks allotted
<b>Continuous Assessment</b>		
1.	Research work and Report writing	50
2.	Continuous evaluation of student by guide	50
<b>Research Presentation</b>		
3.	Presentation and defense of research work (Viva)	300
<b>Total</b>		<b>400*</b>

The final presentation shall be evaluated by a three membered committee consisting of

- External Examiner as approved by Honourable VC
- Dean's Nominee's from allied department
- Supervisor



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Fundamentals of Metabolomics**

**Course Code: BIN.553**

**Total Hours: 30**

**Course Objectives:** This course deals with the fundamentals of metabolomics and its application in life sciences.

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

- Understand the basics of metabolomics
- Learn the overall workflow of metabolomics starting from sample preparation to data analysis
- Understand the application of metabolomics in life sciences research

## **Unit I**

**8 Hours**

Introduction to metabolites, metabolism and metabolomics; structural diversity of metabolites, controlling rates and levels; metabolons; metabolites as a part of cellular interactome; sampling and sample preparation for metabolomics; quenching; obtaining metabolites from biological samples; metabolites in the extracellular medium

## **Unit II**

**8 Hours**

Introduction to the analytical tools and techniques for metabolome analysis; chromatography techniques; mass spectrometry; GC-MS; LC-MS; ESI-MS; NMR based metabolomics; targeted and untargeted metabolomics

## **Unit III**

**7 Hours**

Organizing the metabolomics data; qualitative and quantitative data; data structure; pre-processing of data; deconvolution of spectroscopic data; data normalization and transformations; PCA and Fisher discriminant analysis;

## **Unit IV**

**7 Hours**

Hierarchical and *k*-means clustering techniques; decision theory, *k*-nearest neighbour and tree-based classification techniques; application of metabolomics in microbial, plants and biomedical sciences.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## **Suggested Readings**

- Silas G. Villas-bôas, Ute Roessner, Michael A. E. Hanse, Jorn Smedsgaard, Jens Nielsen, Metabolome Analysis: An Introduction, Wiley, (2007).



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Advance topics in Machine Learning**

**Course Code: BIN.554**

**Total Hours: 30**

## Course Content

### Unit 1

**4 Hours**

Introduction: Overview of Machine Learning field with intro to statistics Data Cleaning, imputation, cross-validation

### Unit 2

**8 Hours**

Unsupervised Methods: Clustering: Distance Metrics, K-Means, leader, Jarvis-Patrick, hierarchical clustering;

Clustering: Self-organized maps, EM-algorithm; Dimensionality Reduction: PCA, LDA, Sammon's

### Unit 3

**8 Hours**

Supervised Methods: Classification: K-NN, naïve Bayes, decision trees, boosting and bagging;

### Unit 4

**10 Hours**

Classification: Ensemble methods, random Forests; Support vector machines Neural networks; Introduction to Deep learning

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested Readings

1. Data Mining: Concepts and Techniques, Third Edition by Han, Kamber, and Pei, 2011.
2. Pattern Recognition and Machine Learning by Christopher Bishop; 2007.
3. Applied Predictive Modeling by Max Kuhn and Kjell Johnson; 2013.
4. An Introduction to Statistical Learning and Applications in R by James, Witten, Hastie, Tibshirani; 2014.
5. Python for Data Analysis by Wes McKinney; 2013.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Introduction of Synthetic Biology**

**Course Code: BIN.555**

**Total Hours: 30**

**Course Objectives:** The course is designed to introduce students the concepts of synthetic biology – a field of study at the interface of (i) complexity of biological systems and (ii) techniques of traditional engineering. This course is designed to acquaint students about the following basic questions:

- Can we study and understand biology as an engineering discipline?
- Why is it necessary to consider stochasticity while modeling biological processes?
- What are the basic parts and devices that have been successfully bioengineered?
- What are the implications of Synthetic Biology on the society?

## Course Contents

### UNIT I: Introductory Interdisciplinary Concepts (3 Hours)

- Definition and scope of systems biology and synthetic biology.
- Engineering concepts: parts, devices, circuits -- digital vs. analog, logic gates.
- Biological complexity: Self organization, Emergence, Robustness.

### UNIT II: Modeling methods for Biological Systems (5 Hours)

- Review of kinetic chemistry, Aspects of noise in designing biological systems.
- Brief overview of deterministic modeling, master equation and Gillespie's Stochastic Simulation Algorithm.
- Lambda switch and Chemotactic module in *E coli*.
- Open source programs: CellDesigner, etc

### UNIT III: Standards and parts in Synthetic Biology (4 Hours)

- Standards: SBML, SBGN, BioPAX
- MIT Registry of standard biological parts
- Bio-brick and non-biobrick initiatives, iGEM events
- Lac operon, Promoter designing, Quorum sensing
- ZFNs, TALENs, CRISPR/Cas



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## UNIT IV: Bio-engineered Synthetic Circuits

(4 Hours)

- Gates: AND gate, Counters: Pulse generators, Switches: Toggle switch
- Oscillators: Repressilator, mammalian oscillator
- Brief overview of cascades, time delayed circuits, spatial patterning, biosensors, and other logical formula driven circuits.  
Riboswitches and riboregulators  
Four and Six-letter genetic code

## UNIT V: From Modules to Systems

(4 Hours)

- Integrating gene circuits
- DNA Origami,
- Genome Synthesis, Minimal synthetic cell, Multicellular synthetic systems
- Protocell construction
- Bio-energetics and Bio-fuels
- **Safety and Legal issues:** Bio-security, Bio-safety

### Text Books:

**Chris Myers (2009).** Engineering Genetic Circuits. Chapman & Hall.

**Edda Klipp *et al.* (2009).** Systems Biology: A Textbook. Wiley-VCH.

**Huimin Zhao (2013).** Synthetic Biology: Tools and Applications. Academic Press.

### Additional Readings:

- **Freemont and Kitney (2012).** Synthetic Biology: A Primer. World Scientific
- **Fu and Panke (2009).** Systems Biology and Synthetic Biology. Wiley, New Jersey.
- Presidential Commission for the Study of Bioethical Issues (2010). NEW DIRECTIONS: Ethics of Synthetic Biology and Emerging Technologies. (<http://bioethics.gov>)
- **Singh V., and Dhar, P. K. (2015).** Systems and Synthetic Biology, Springer Science, 385. ISBN: 978-94- 017-9513- 5.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Systems Biology Lab**

**Course Code: BIN.555**

**Total Hours: 30**

**Course Objectives:** The course is designed to give students an opportunity for learning the computational techniques to understand biological complexity at systems level. They will be introduced to the softwares implementing deterministic and stochastic modeling algorithms. At the same time they will also be acquainted with the network visualization and analysis softwares.

Students having working knowledge of any programming language will be encouraged to write their own codes for simulating and analysing model biological systems. Students will be required to learn the following modeling and analysis suites.

- CellDesigner, MCell
- Cytoscape
- XPPAut

## **Contents:**

Standards in Systems Biology -- SBML, SBGN, BioPAX

Deterministic simulation of a natural biological system.

Deterministic simulation of a synthetic biological system.

Implementation of Gillespie's stochastic simulation algorithm to model the given chemical reaction system.

Introduction to biological network databases –

KEGG, STRING, STITCH, DIP, BIND, HPRD, EMP, EcoCyc, MetaCyc, AraCyc etc.

To construct and visualize simple biological network.

To analyze a given biological network by calculating the following characteristics

Diameter, density

Average path length

Clustering coefficient

Centrality measures (Degree, Closeness, Eccentricity, Betweenness)

Degree distribution

Community detection Etc.

To identify motifs and graphlets in a given network.

Stability analysis of a given 1-dimensional dynamical system.

Stability analysis of a given 2-dimensional biological system.

Systems Biology Capstone



# Central University of Himachal Pradesh

Centre for Computational Biology and Bioinformatics

School of Life Sciences

## AGENDA



### 9<sup>th</sup> BOARD OF STUDIES MEETING

TO BE HELD ON 27<sup>th</sup> SEPTEMBER, 2021 SHAHPUR CAMPUS

**Venue:** Seminar Hall,  
Central University of Himachal Pradesh  
Shahpur Campus



# हिमाचल प्रदेश केन्द्रीय विश्वविद्यालय

## Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

शैक्षणिक खण्ड, शाहपुर, ज़िला काँगड़ा, हिमाचल प्रदेश -176206

Academic Block, Shahpur, Distt. Kangra (HP) - 176206

Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

### कार्यसूची-अनुक्रमणिका

Agenda Item No.	PARTICULARS	Information
मद CBB-BOS-9/21-1	23.03.2021 को आयोजित हुई संगणकीय जीव विज्ञान एवं जैव सूचना केंद्र की आठवीं पाठ्य समिति (8th BOS) के कार्यवृत्त अनुमोदन हेतु प्रस्तुत है।	अनुलग्नक - I
मद CBB-BOS-9/21-2	राष्ट्रीय शिक्षा नीति (एनईपी-2020) के अनुसार M.Sc. Bioinformatics के लिए नए पाठ्यक्रमों में संशोधन के हेतु प्रस्ताव प्रस्तुत है।	अनुलग्नक - II
मद CBB-BOS-9/21-3	पी-एच.डी. (CBB) कार्यक्रम के नामांकन में परिवर्तन का प्रस्ताव प्रस्तुत है।	अनुलग्नक - III
मद CBB-BOS-9/21-4	पी-एच.डी. (Bioinformatics) कार्यक्रम के पाठ्यक्रम कार्य के लिए नए पाठ्यक्रम आरम्भ करने की स्वीकृति हेतु प्रस्ताव प्रस्तुत है। 1. IKS - 02 क्रेडिट 2. Pedagogy of Teaching Learning Process - 02 क्रेडिट	अनुलग्नक - IV
मद CBB-BOS-9/21-5	विभिन्न एंटी-एग्जिट सिस्टम को अपनाने के हेतु प्रस्ताव प्रस्तुत है।	अनुलग्नक - V
मद CBB-BOS-9/21-6	संगणकीय जीव विज्ञान एवं जैव सूचना केंद्र में प्रायोगिक (Practical) एवं मौखिक (Viva-Voce) परीक्षा हेतु बाह्य परीक्षकों की सूची के अनुमोदन हेतु प्रस्ताव प्रस्तुत है।	अनुलग्नक - VI
मद CBB-BOS-9/21-7	संगणकीय जीव विज्ञान एवं जैव सूचना केंद्र में पी-एच.डी. शोधार्थियों के लिए पर्यवेक्षक आबंटन का प्रस्ताव प्रस्तुत है।	अनुलग्नक - VII
मद CBB-BOS-9/21-8	कोई अन्य मामले जो कि अध्यक्ष की अनुमति से विचार- विमर्श किए जाएंगे।	

डॉ. महेश कुल्हारिया

निदेशक,

संगणकीय जीव विज्ञान एवं जैव सूचना केंद्र



हिमाचल प्रदेश केंद्रीय विश्वविद्यालय  
Central University of Himachal Pradesh  
(Established under Central Universities Act 2009)  
अस्थाई शैक्षणिक खण्ड, शाहपुर, जिला कांगड़ा, हिमाचल प्रदेश - 176206  
Temporary Academic Block, Shahpur, Distt. Kangra (HP) - 176206  
Website: [www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

File No: LS/1-5(Vol.II)/CUHP/12/173

Dated: 23.03.21

Centre for Computational Biology and Bioinformatics  
School of Life Sciences

Minutes of the 8th Board of Studies meeting held on 23rd March, 2021

The meeting of the 8<sup>th</sup> Board of Studies of the Centre for Computational Biology and Bioinformatics, School of Life Sciences was held on 23<sup>rd</sup> March, 2021 by circulation (Through Online Mode).

Following Decision were taken in BOS meeting as per the Agenda.

**Agenda Item-No:** CBB-BOS-8/21-1: Minutes of the 7<sup>th</sup> BoS Meeting held on 29th Dec 2020. (Annexure I)

**Decision:**

All members agreed and approved the Minutes of the 7<sup>th</sup> BoS Meeting held on 29th Dec 2020. (Annexure I).

**Agenda Item-No:** CBB-BOS-8/21-2: Change of the title of the PhD thesis of Smt. Neha. CUHP13RDCBB03 report attached (Annexure II)

**Decision:**

All members agreed and approved the change of the title of the PhD thesis of Smt. Neha. CUHP13RDCBB03 report attached (Annexure II)

The meeting ended with a vote of thanks by the chair.

  
Dr. Shalender Kumar Verma  
Member

  
Dr. Sunil Kumar  
VC's Nominee

  
Prof. Pardeep Kumar  
VC's Nominee

Prof. BrijMohan  
Subject Expert

Dr. Deshdeepak Singh  
Subject Expert

  
Dr. Mahesh Kutharia  
Chairman & Convenor



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File No: LS/1-5(Vol.II)/CUHP/12/

Dated:

Centre for Computational Biology and Bioinformatics

School of Life Sciences

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Member

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VC's Nominee

**Prof. Pardeep Kumar**  
VC's Nominee

**Prof. Brij Mohan**  
Subject Expert

**Dr. Deshdeepak Singh**  
Subject Expert

**Dr. Mahesh Kulharia**  
Chairman & Convenor

File No: LS/1-5(Vol.II)/CU HP/12/

Dated:

**Centre for Computational Biology and Bioinformatics**  
**School of Life Sciences**

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Subject Expert

**Dr. Deshdeepak Singh**  
Subject Expert

**Dr. Mahesh Kulharia**  
Chairman & Convenor



# Central University of Himachal Pradesh

(ESTABLISHED UNDER CENTRAL UNIVERSITIES ACT 2009)

PO Box: 21, Dharamshala, Himachal Pradesh-176215

## Research Progress Monitoring Committee

Date: 14/10/2020

1. Name of the Candidate: Neha
2. Registration No.: CUHP13RDCBB03
3. Date of Joining: 06/01/2014
4. Place of work: School of Life Sciences,  
Central University of Himachal Pradesh
5. Members of the Research Progress Monitoring Committee:
  1. Dr. Mahesh Kulharia (Director)
  2. Dr. P. Aparoy (Supervisor)
  3. Dr. Sunil Kumar (Dean's Nominee)
6. Dates of previous Research Progress Monitoring Committee: 27/06/2018

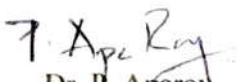
### The following to be filled by the members of the Committee

#### Member

- a) Has the candidate presented her/his work well? **Yes**
- b) Has the candidate put in enough work in the given period? **Yes**
- c) Do you recommend the candidate to go through the pre-Ph.D. viva ( for candidates in their last Research Progress Monitoring Committee): **Yes**
- d) Comments of the Research Progress Monitoring Committee members on the progress of research work during the period under the report.

***The work progressed well and the candidate can give Pre-Ph.D. presentation. The title of the work can be changed as proposed by the student.***

  
Dr. Sunil Kumar  
(Dean's Nominee)

  
Dr. P. Aparoy  
(Supervisor)  
(D. POLANARASETTY APARROY)

  
Dr. Mahesh Kulharia  
(Director)



# Central University of Himachal Pradesh

(ESTABLISHED UNDER CENTRAL UNIVERSITIES ACT 2009)

PO Box: 21, Dharamshala, Himachal Pradesh-176215

## Research Progress Committee Report- IV

1. Name of the candidate:	Neha
2. Enrolment/Registration number:	CUHPI3RDCBB03
3. School:	School of Life Sciences
4. Department/Centre:	Centre for Computational Biology and Bioinformatics
5. Name of the Supervisor	Dr. Polamarasetty Aparoy
6. Title of Thesis:	<p><b>Proposed Title:</b>  <b>Hints for COX-2 inhibitor design: Molecular dynamics based SAR characterization and ligand based analysis.</b></p> <p>Previous Title:          Application of Molecular dynamics based free energy calculation methods for identification of novel COX-2 inhibitors</p>
7. Research activities: a) Work done so far	<p><b>Work done since 2018</b></p> <ul style="list-style-type: none"> <li>• Identification of novel drug like candidates against COX-2.</li> <li>• Structure and ligand based virtual screening using a pool of small molecule databases containing compounds of natural products, primary and secondary metabolites and FDA approved database.</li> <li>• A cluster of amino acids i.e., Gln178, Ser339, Tyr341, Arg499, Phe504, Val509 and Ala513 were found consistence in making interactions with different inhibitors.</li> <li>• MD based studies to characterize the SAR of different classes of COX-2 inhibitors.</li> <li>• Structural insights into the dual inhibition of COX-2/5-LOX.</li> </ul> <p><b>Work done earlier</b></p> <ul style="list-style-type: none"> <li>• Ligand based Virtual Screening to identify potential dual</li> </ul>



## Central University of Himachal Pradesh

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b) Future plan	<p>inhibitors of COX-2 /5-LOX.</p> <ul style="list-style-type: none"><li>• Ligand based pharmacophore modelling using CLOXIBs</li><li>• Molecular descriptor profiling against COX-2 inhibitors</li><li>• MD based studies to characterize the SAR of diaryl heterocyclic COX-2 inhibitors</li><li>• Role of Ser516 in interactions with heterocyclic ring of COXIBs was shown.</li><li>• Calculation of energetic contribution of identified amino acids</li><li>• Molecular dynamics simulation based free energy calculations for COX-2 inhibitors.</li><li>• Interaction based analysis of COX-2 inhibitors.</li><li>• Docking studies of COX-2 inhibitors using AutoDock.</li><li>• Docking of mPGES-1 inhibitors using AutoDock Vina, Dock and AutoDock.</li><li>• Review of Literature.</li></ul> <hr/> <ul style="list-style-type: none"><li>• Pre-PhD presentation</li><li>• Thesis submission</li><li>• Manuscript preparation</li></ul>
<p>8. Conferences/Seminars/workshops attended and the posters, talks presented:</p> <ul style="list-style-type: none"><li>• Poster presentation at <b>“Accelerating Biology 2016: Decoding the deluge”</b> held during January 19-21, 2016 organized by Bioinformatics Group, C-DAC Pune.</li><li>• <b>“International workshop on Cancer Drug Discovery and Development”</b> held during June 22-28, 2016 at University of Hyderabad, Hyderabad.</li><li>• <b>“National Symposium on Bioinformatics &amp; Computational Systems Biology”</b> held during November 12-14, 2016 at Central University of Himachal Pradesh, Himachal Pradesh.</li></ul>	





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## 9. Research work published in conference proceedings/ peer-reviewed journal:

[1] Gupta A, Chaudhary N, Kakularam KR, Pallu R, Polamarasetty A. The Augmenting Effects of Desolvation and Conformational Energy Terms on the Predictions of Docking Programs against mPGES-PLoS One. 2015;10 (8):e0134472. doi: 10.1371/journal.pone.0134472.

[2] Chaudhary N, Aparoy P. Deciphering the mechanism behind the varied binding activities of COXIBs through Molecular Dynamic Simulations, MM-PBSA binding energy calculations and per residue energy decomposition studies. J Biomol Struct Dyn. 2016 Mar 16:1-27.

[3] Gupta A, Chaudhary N, Aparoy P. MM-PBSA and per-residue decomposition energy studies on 7-Phenyl-imidazoquinolin-4(5H)-one derivatives: Identification of crucial site points at microsomal prostaglandin E synthase-1 (mPGES-1) active site. Int J Biol Macromol. 2018 Nov;119:352-359.

[4] Chaudhary N, Aparoy P. Application of per-residue energy decomposition to identify the set of amino acids critical for in silico prediction of COX-2 inhibitory activity. Heliyon. 2020 Oct; 6 (10): e04944

[5] Chaudhary N, Gupta A, Aparoy P. Molecular descriptor based profiling of COX-2 inhibitors to identify features directing COX-2 inhibition. (Under preparation)

[6] Chaudhary N, Choudhary A, Aparoy P. Development of a ligand-based pharmacophore model using PHASE and database searching: An approach for dual inhibition against COX-2 and 5-LOX. (Under preparation)

### To be filled in by the candidate

1. Have you submitted your work report? Yes
2. Are there any specific problems ?
  - i. Thesis title change
  - ii. Allotment of Administrative supervisor
3. Would you like to suggest / modify any objectives: None

Date: 31-Oct-2020

*Neha*  
Signature of the Candidate

*P. Aparoy*  
Signature of the Supervisor

(Dr. POLAMARASETTY APAROY)

*Alhami*  
Signature of Director of the Centre

## Scheme of curriculum to be considered by the Board of Studies

<b>Semester – I</b>		
Major	BIN 415 Basics of Biochemistry	2
	BIN 416 Cell and Molecular Biology	2
	BIN 417 Statistical Methods	4
	BIN 418 Linux and Shell Scripting Lab	2
Minor	BIN 419 Sequence Analysis	2
	BIN 420 Biomolecular Structure Analysis	2
Vocational	BIN 421 Python Programming Lab I	2
	BIN 422 Sequence and Structure Analysis Lab	2
IKS	University wide	2
<b>Semester – II</b>		
Major	BIN 465 Computer Aided Drug Discovery	4
	BIN 465 Computational Genomics and Proteomics	4
	BIN 467 Algorithms in Bioinformatics	4
Minor	BIN 468 Fundamentals of Machine Learning	2
	BIN 469 Fundamentals of Molecular Dynamics simulations	2
Vocational	BIN 470 Python Programming Lab II	2
IKS	BIN 471 History of Science in India	2
<b>Semester – III</b>		
Major (Any for credits equivalent to 4)	BIN 515 Biological Databases and Management System	2
	BIN 516 Systems Biology and Biological Networks	4
	BIN 517 Essentials of Immunology	2
Minor	BIN 518 Research Methodology	4
Vocational	BIN 519 Computer Aided Drug Design Lab	2
	BIN 520 Systems Biology Lab	2
Review	BIN 521 Review of Literature and research proposal	8
<b>Semester – IV</b>		
Major (Any for credits equivalent to 4)	BIN 565 Statistical Genetics	2
	BIN 566 Molecular Evolution	4
	BIN 567 Introduction of Synthetic Biology	2
Minor	BIN 568 Academic Writings	2
	BIN 569 Paper publication/ seminar/ conference	2
Vocational	BIN 570 Molecular Dynamics Simulation Lab	2
	BIN 571 Data Analysis Lab	2
Dissertation	BIN 595 Dissertation	8
<b>Total</b>		<b>80</b>

## **Selection Criteria / Exam Pattern for M.Sc. Bioinformaticsto be considered by the Board of Studies**

The students will be admitted on the basis of entrance examination which will have the two sections in the following pattern:

### **Section A (Non-Optional)**

80% questions will be from Biology / Life Sciences background (20% Genetics, 20% Cell and Molecular Biology, 20% Microbiology, 20% Biochemistry and 20% Biotechnology)

### **Section B (With options)**

There will be 4 sets of questions (each 20%)

A: Physics 20%

B: Chemistry 20%

C: Computer Sciences 20%

D: Mathematics 20%

out of which a student will have to **compulsorily** opt for any one.

### **Eligibility of the prospective students to be considered by the Board of Studies**

A student with more than 55% marks or equivalent in Bachelor's degree from any University / institution (National or International) duly recognised by UGC, in any stream of biology / life sciences, physical sciences, chemical sciences, mathematical sciences, Computer sciences, computer applications, IT, environmental sciences, technology, engineering, agricultural sciences or medicine or any allied field of sciences.

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## Annexure II

<b>Semester – I</b>		
Major	BIN 415 Basics of Biochemistry	2
	BIN 416 Cell and Molecular Biology	2
	BIN 417 Statistical Methods	4
	BIN 418 Linux and Shell Scripting Lab	2
Minor	BIN 419 Sequence Analysis	2
	BIN 420 Biomolecular Structure Analysis	2
Vocational	BIN 421 Python Programming Lab I	2
	BIN 422 Sequence and Structure Analysis Lab	2
IKS	University wide	2
<b>Semester – II</b>		
Major	BIN 465 Computer Aided Drug Discovery	4
	BIN 465 Computational Genomics and Proteomics	4
	BIN 467 Algorithms in Bioinformatics	4
Minor	BIN 468 Fundamentals of Machine Learning	2
	BIN 469 Fundamentals of Molecular Dynamics simulations	2
Vocational	BIN 470 Python Programming Lab II	2
IKS	BIN 471 History of Science in India	2
<b>Semester – III</b>		
Major (Any for credits equivalent to 4)	BIN 515 Biological Databases and Management System	2
	BIN 516 Systems Biology and Biological Networks	4
	BIN 517 Essentials of Immunology	2
Minor	BIN 518 Research Methodology	4
Vocational	BIN 519 Computer Aided Drug Design Lab	2
	BIN 520 Systems Biology Lab	2
Review	BIN 521 Review of Literature and research proposal	8
<b>Semester – IV</b>		
Major (Any for credits equivalent to 4)	BIN 565 Statistical Genetics	2
	BIN 566 Molecular Evolution	4
	BIN 567 Introduction of Synthetic Biology	2
Minor	BIN 568 Academic Writings	2
	BIN 569 Paper publication/ seminar/ conference	2
Vocational	BIN 570 Molecular Dynamics Simulation Lab	2
	BIN 571 Data Analysis Lab	2
Dissertation	BIN 595 Dissertation	8
<b>Total</b>		<b>80</b>

## Semester – I



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**Course Title: Basics of Biochemistry**

**Course Code: BIN.415**

**Total Hours: 20**

L	T	P	Cr
2	0	0	2

**Learning Outcomes:** The outcomes of the subject is to ensure that a student comprehends the following:

- The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- The energy metabolism by cellular components in cells and the process of mitotic cell division.
- Influences of changes or losses in cell function; including the responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

### Course Content

#### Unit 1

Principles of biophysical chemistry Thermodynamics, Colligative properties, Stabilizing interactions: Van der Waals, Electrostatic, Hydrogen bonding, Hydrophobic interaction, etc.

#### Unit 2

Composition, structure, function and metabolism of Carbohydrates, Lipids.

#### Unit 3

Composition, structure, function and metabolism of Amino Acids and Nucleotides.

#### Unit 4

Enzymology: Classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics, Enzyme regulation, Isozymes.

#### Unit 5

Bioenergetics and oxidative phosphorylation, Carbohydrates, metabolism and glycolysis, tricarboxylic acid cycle and pyruvate dehydrogenase complex, gluconeogenesis, glycogen metabolism, monosaccharide and disaccharide metabolism, pentose phosphate pathway

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

#### Suggested Readings

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry*. W.H. Freeman & Company. USA.
2. Brown, T.A. (2006). *Gene Cloning and DNA analysis: In Introduction*. Blackwell

Publishing Professional. USA.

3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.

4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.

5. Nelson, D. and Cox, M.M. (2013). *Lehninger Principles of Biochemistry*. BI publications Pvt. Ltd. Chennai, India.

6. Ochiai, E. (2008). *Bioinorganic chemistry: A survey*. Academic Press. Elsevier, India.

7. Randall, D. J., Burggren, W. and French, K. (2001). *Eckert animal physiology*. W.H. Freeman & Company. USA.



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**Course Title:** Cell and Molecular Biology

**Course Code:** BIN 416

**Total Hours:** 20

L	T	P	Cr
2	0	0	2

## Learning Outcomes:

On successful completion of the course the student will be able to:

- Conceptualization of basic cellular and molecular mechanisms.
- Understanding structures and functions of various cellular organelles.
- Understanding the molecular processes of DNA replication, transcription, and translation

## Course Content

### Unit – I

Membranes of intracellular organelles, Membrane transport, Structure and functions of intracellular organelles, Intracellular traffic and secretory pathways, endocytosis and exocytosis.

### Unit – II

**The Cytoskeleton:** cell cytoskeleton and its organization including extracellular matrix, adhesions and junctions.

**Cell-cell communication and cell growth:** Overview of cell signaling, cell surface receptors and second messengers.

### Unit – III

**Gene and Genome organization:** Eukaryotic gene organization, transposition, Mechanism of DNA replication, DNA damage and their repair.

### Unit – IV

**Transcription:** transcription and transcription factors, Transcriptional and post-transcriptional gene silencing, mRNA processing: Capping, Polyadenylation, Splicing, editing, mRNA stability.

### Unit – V

**Translation:** Genetic code, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, post-translational modifications of proteins.

## Transactional Modes:

Lecture; Demonstration; Tutorial; Lecture cum demonstration; Problem solving; Self-learning.

## Suggested Reading:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2015). *Molecular cloning: a laboratory manual*. Cold Spring Harbor Laboratory Press New York.
2. Lodish, H., Berk, A. Chris, A.K. & Krieger, M. (2011). *Molecular Cell Biology*. W.H. Freeman, USA.
3. Robertis, (2011). *Cell and Molecular Biology*. Lippincott Williams & Wilkins.
4. Karp, G. (2010). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). *Lewin's Genes XII*. Jones & Bartlett Learning.
6. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., & Levine, M. (2003). *Molecular Biology of the Gene* Benjamin Cummings.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2007). *Molecular biology of the cell*. Garland Science. *New York, 1392*.
8. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.





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**Course Title: Statistical Methods**

**Course Code: BIN.417**

**Total Hours: 40**

**Credits Equivalent: 4 Credits**

L	T	P	Cr
4	0	0	4

(One credit is equivalent to of lectures / organized classroom activity / contact hours; of laboratory work / practical / field work / tutorial / teacher-led activity and 1 of other work-load such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

## Course Objectives:

This course will introduce the students to the concepts and methods of statistics, covering topics such as data organization and presentation, data analysis, probability, estimation and hypothesis testing and their application to the biological data. Students will be encouraged to use Python or R to gain computational hands-on learning about the topics covered. At the end of the course, students will be able to:

1. Develop an understanding of the fundamental theoretical aspects of methods of statistics and probability.
2. Develop the foundational skills in statistical analysis for Bioinformatics and Data Science.

## Course Contents:

### Unit-I: Introductory concepts

- Big Data in Biology: Need of Statistical measures to analyze it.
- Statistical population and sample: Types of data, Relative and cumulative frequency.
- Organization and presentation of data.
- Descriptive measures:
- Measures of Central tendency: Mean, Median, Mode: notation and formulae, grouped data, relative merits
- Measures of Dispersion: Absolute and relative measures.

### Unit-II: Probability concepts ()

- Basic probability models: Combinatorics based computation, Bayes' rule
- Basics of Monte Carlo simulations
- Discrete random variables: Expected value, Variance, Covariance
- Discrete parametric distributions: (i) One Bernoulli Trail, (ii) Binomial distribution, (iii) Uniform distribution, (iv) Poisson distribution, (v) Power-law distribution
- Continuous probability models: Cumulative distribution function, Density functions
- Continuous probability distributions:
- Uniform distribution, (ii) Normal distribution: Standard deviation, Variance, Skewness and Kurtosis, z-score (iii) Exponential distribution.

### **Unit III: Statistics concepts I**

- Statistical preliminaries: Sample mean, Sample variance, Standard error
- Continuous models fitting: Method of moments, Method of maximum likelihood, Goodness of fit

### **Unit IV: Statistics concepts II**

- Family of normal distributions: Standard normal distribution, The central limit theorem, Chi-squared distribution
- Statistical inference: Confidence intervals, Student-t distribution, Significance tests, p-values, P-hacking, ANOVA

### **Unit V: Multivariate analysis**

- Discrete and continuous multivariate distributions
- Covariance and correlation
- Dimensionality reduction: principal component analysis
- Clustering, Classification, Regression
- Model parsimony and over-fitting

### **Text Books:**

1. Ewens and Grant (2005), Statistical Methods in Bioinformatics, Springer
2. Matloff (2020). Probability and Statistics for Data Science, CRC
3. Prem S. Mann (2018), Introductory Statistics, Wiley
4. Daniel and Cross (2019), Biostatistics, Wiley

### **Reference Books:**

Murray Spiegel et al. (2010), Probability and Statistics. McGraw Hill Education.  
Roger E. Kirk (2007), Statistics: An Introduction, Cengage Learning.  
Neil A. Weiss (2012), Introductory Statistics.  
Charles Henry Brase and Corrinne Pellillo Brase (2011), Understandable Statistics: Concepts and Methods.  
J. H. Zar (2019), Biostatistical Analysis, Pearson



# Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

Academic Campus, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Linux and Shell Scripting Lab**

**Course Code: BIN.418**

**Total Hours: 20**

L	T	P	Cr
0	0	4	2

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

Linux administration

File / Data management

Stream processing

## **Course Content**

What is Linux, Linux architectures: root, files system, standard directories general commands for files and directories cd, ls, cp, rm, mkdir, rmdir, pwd, file, more, less

Creating and viewing files using cat file comparisons

Essential Linux commands: Processes in Linux, Process fundamentals, Connecting processes with pipes, Redirecting input, Redirecting output, Background processing

Managing multiple processes, Process scheduling – (at,batch), nohup command,, kill, ps, who find, sort, touch, file, file processing commands – wc, cut, paste etc,

Mathematical commands – expr, factor etc

Creating files with editors: vi, vim, kate. Kwrite, pico etc

System administration

Common administrative tasks

Identifying administrative files

Configuration and log files

Role of system administrator

Managing user accounts -adding users

Managing user accounts -deleting users

Changing permissions and ownerships

Creating and managing groups

Modifying group attributes

Simple filter commands & Understanding various Servers.

Filter Commands-pr, head, tail

Filter Commands -cut, sort.

Filter Commands- uniq, tr.

Filter using regular expression grep.

Filter using regular expression egrep, sed Basics, Variables, Substitution & Quoting

Flow Control, Loops and Documentation

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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Sequence Analysis**

**Course Code: BIN 419**

**Total Hours: 20**

L	T	P	Cr
2	0	0	2

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

## Course Content

### Unit 1

Basic concepts of sequence similarity, identity and homology, homologues, orthologues, paralogues and xenologues

### Unit 2

Pairwise sequence alignments: basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties

### Unit 3

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series Tools such as BLAST (various versions of it) and FASTA

### Unit 4

Multiple sequence alignments (MSA): basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW (including interpretation of results), concept of dendrogram and its interpretation.

### Unit 5

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and profiles, profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

**Transactional Modes:** Lecture; Problem solving; Self-learning.

## Suggested Reading

1. A.D. Baxevanis *et. al.*, Current Protocols in Bioinformatics, (2005) Wiley Publishers
2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN81-203-2550-8
4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1
5. N.Gautham Bioinformatics Narosa publications. (2006) ISBN-13: 9781842653005



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Biomolecular Structure Analysis**

**Course Code: BIN 420**

**Total Hours: 20**

L	T	P	Cr
2	0	0	2

## LEARNING OUTCOMES

The overall goal of this course is to give students advanced knowledge of the relationship between the structure and function of biomolecules and to handle different tools used in structural bioinformatics.

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

Explain the basis of biological macromolecules constitution and traits

Explain the basis of biological catalysis

Explain the constitution of molecular complexes like ribosomes and viruses and aggregates like filaments and tubules

Use databases with information of structure and function of macromolecules

Use and analyse results from methods used to predict secondary- and tertiary structure of macromolecules

## COURSE CONTENT

### Unit 1

Methods for the determination of macromolecules structure and interaction.

Basic macromolecular structure; DNA, RNA, protein, lipids.

### Unit 2

The folding process and structural background to the dynamics of macromolecules.

Binding specificity, catalysis and cooperativity in enzymes and receptors.

Macromolecules function described by a few specific examples.

### Unit 3

Biological structure databases.

Structure analysis and classification of proteins in structural families.

Relation between sequence, structure and function.

### Unit 4

Computer modelling of secondary- and tertiary structure of proteins and nucleic acid based on sequence data. Enzyme/receptor-based drugs-rational drug design.

### Unit 5

Applications of Structure Analysis in Life Sciences, Land mark studies and success stories

## Transactional Mode

Lectures, seminars.

## Suggested Reading

1. Liljas, Anders Textbook of structural biology New Jersey: World Scientific, cop. 2009
2. Tooze, Branden An Introduction to Protein Structure. 2014



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Python Programming Lab-I**

**Course Code: BIN 421**

**Total Hours: 40**

L	T	P	Cr
0	0	4	2

**Learning Outcomes:** Upon successfully completing this course, students will be able to “do something useful with Python”.

- Identify/characterize/define a problem
- Design a program to solve the problem
- Create executable code
- Read most Python code
- Write basic unit tests

## Course Content

Working with Data. A detailed tour of how to represent and work with data in Python. Covers tuples, lists, dictionaries, and sets. Students will also learn how to effectively use Python's very powerful list processing primitives such as list comprehensions. Finally, this section covers critical aspects of Python's underlying object model including variables, reference counting, copying, and type checking.

Program Organization, Functions, and Modules. More information about how to organize larger programs into functions and modules. A major focus of this section is on how to design functions that are reliable and can be easily reused across files. Also covers exception handling, script writing, and some useful standard library modules.

Classes and Objects. An introduction to object-oriented programming in Python. Describes how to create new objects, overload operators, and utilize Python special methods. Also covers basic principles of object oriented programming including inheritance and composition.

Inside the Python Object System. A detailed look at how objects are implemented in Python. Major topics include object representation, attribute binding, inheritance, memory management, and special properties of classes including properties, slots, and private attributes.

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- The Python Tutorial (<https://docs.python.org/3/tutorial/>): This is the official tutorial from the Python website. No more authoritative source is available.
- Code Academy Python Track (<http://www.codecademy.com/tracks/python>): Often cited as a great resource, this site offers an entertaining and engaging approach and in-browser work.

Learn Python the Hard Way (<http://learnpythonthehardway.org/book/>): Solid and gradual. This course offers a great foundation for folks who have never programmed in any language before. [Python 2]



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Sequence and Structure Analysis Lab**

**Course Code: BIN 422**

**Total Hours: 40**

L	T	P	Cr
0	0	4	2

**Learning Outcomes:** The outcomes of the subject is to ensure that a student can apply the knowledge of the following

- Data storage formats
- Pairwise alignments
- Sequence patterns and profiling
- Multiple sequence alignment

Introduction to Bioinformatics and Sequence Analysis. In addition to lecture material, skills needed for future problem set assignments will be covered. This will include taking screenshots, formatting of text and generation of reports.
Internet Resources focusing on text-based searches of literature, molecular, and medical databases. We will again work on the skills needed for generating reports.
Searching DNA databases with DNA queries: BLASTN. First problem set assignment focused on material from this lecture: 5 grade points maximum.
Searching protein databases with protein queries: BLASTP. Second problem set assignment focused on material from this lecture: 10 grade points maximum.
Cross-molecular searches: BLASTX and TBLASTN. Third problem set assignment focused on material from this lecture: 10 grade points maximum.
Advanced topics in BLAST
Protein Analysis Fourth problem set assignment focused on material from this lecture: 10 grade points maximum.
Analysis problems involving short sequences Fifth problem set assignment focused on material from this lecture: 5 grade points maximum.
MicroRNAs and Pathway Analysis Sixth problem set assignment focused on material from this lecture: 5 grade points maximum.
Multiple Sequence Alignments
Exploring the genome with Genome Browsers
Prediction of Protein-membrane, Protein-ligand, Protein-nucleic acid and Protein-protein interaction sites
Protein Ligand Docking using (i) Autodock (ii) Vina and (iii) Dock
Protein-protein docking by HADDOCK or other similar methods Modelling macromolecular structure 1. Homology modelling 2. <i>ab-initio</i> structure modeling

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

### **Suggested Readings**

1. *Grant, Guy H.; Richards, W. Graham* Computational chemistry Oxford: Oxford Univ. Press, 1995
2. Schneider, Gisbert; Baringhaus, Karl-Heinz; Kubinyi, Hugo Molecular design: concepts and applications Weinheim: Wiley-VCH, c2008
3. Practical Bioinformatics by Michael Agostino ISBN 978-0-8153-4456-8



# Semester – II



## Central University of Himachal Pradesh

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Academic Campus, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Computer Aided Drug Discovery

**Course Code:** BIN 465

**Total Hours:** 40

L	T	P	Cr
4	0	0	4

### Learning Outcomes:

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

- demonstrate various force field for biomolecular modeling
- execute various molecular docking methods
- Identify the dynamics of structural transitions which will help them to develop the molecular docking techniques in their further potential careers in academia and industry.

### Course Content

#### Unit 1

Introduction to Computer Aided Drug Design (CADD) History, different technique sand applications Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters ( $\sigma$ ), lipophilicity effects and parameters ( $\log P$ ,  $\pi$  substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters

#### Unit 2

Quantitative Structure Activity Relationships: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSAR equations 3D-QSAR approaches and contour map analysis Statistical methods used in QSAR analysis and importance of statistical parameters

#### Unit 3

Molecular Modeling and Docking Molecular and Quantum Mechanics in drug design Energetics of bioactive conformation Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AChE & BchE)

#### Unit 4

Molecular Properties and Drug Design: Prediction and analysis of ADMET properties of new molecules and its importance in drug design.

#### Unit 5

De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. Homology modeling and generation of 3D-structure of protein

**Transactional Modes:** Lectures; Tutorials; Problem solving; Self-learning.

### **Suggested Readings**

1. Schneider, Gisbert; Baringhaus, Karl-Heinz; Kubinyi, Hugo Molecular design : concepts and applications Weinheim: Wiley-VCH, c2008
2. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. [http://autodock.scripps.edu/faqs-help/manual/autodock-4-2-user-guide/AutoDock4.2\\_UserGuide.pdf](http://autodock.scripps.edu/faqs-help/manual/autodock-4-2-user-guide/AutoDock4.2_UserGuide.pdf)



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Computational Genomics and Proteomics

**Course Code:** BIN 466

**Total Hours:** 40

L	T	P	Cr
4	0	0	4

## Learning Outcomes:

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

- learn the importance of DNA-Protein Interactions During Transcription
- gain a deep knowledge about the role of bioinformatics-OMIM database, integrated genomic maps, gene expression profiling
- apply probabilistic modeling techniques for the building of transcriptional regulatory networks which will help them to use the techniques of computational proteomics in their further potential careers in academia and industry.

## Course Content

### Unit I

The Importance of DNA-Protein Interactions During Transcription. Initiation-Regulation of Transcription, Synthesis and Processing of the Proteome

### Unit 2

The Role of tRNA in Protein Synthesis, The Role of the Ribosome in Protein Synthesis, Post-translational Processing of Proteins, Protein Degradation.

### Unit 3

Role of bioinformatics-OMIM database, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP)

### Unit 4

Transcriptomics: database and basic tools, Gene Expression Omnibus (GEO), SAGE databases, detecting differential gene expression,

### Unit 5

Only for yeasts: building predictive models of transcriptional regulatory networks using probabilistic modeling techniques.

Peptide Mass Finger-printing: database searches

1

## Extra Reading Topics (Not in evaluatory content)

Genomes, Transcriptomes and Proteomes, The Human Genome and its Importance, Structure of the Eukaryotic and Prokaryotic Genome, the Repetitive DNA Content of Genomes. Mechanism of Genetic Action, Gene-protein relations, Genetic fine structure, Mutational sites Complementation, How Genomes Function, Accessing the Genome, Inside the Nucleus, Chromatin Modifications and Genome Expression, Assembly of the Transcription Initiation Complex, Metagenomics

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

**Suggested Readings**

1. Sándor Suhai (2002). Genomics and Proteomics. Springer US
2. CAMPBELL (2007). Discovering Genomics, Proteomics and Bioinformatics. Pearson Education
3. Richard P. Grant (2004). Computational Genomics: Theory and Application. Horizon Bioscience



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Algorithms in Bioinformatics**

**Course Code: BIN467**

**Total Hours: 40**

L	T	P	Cr
4	0	0	4

**Learning Outcomes:** On completion of the course the student should be able to :

- Understand the issues involved in dealing with large amount of data
- Gain a deep knowledge about the principles of a number of optimization algorithms

## Course Content

### Unit 1: Introduction to algorithms and complexity

1. Basic Concepts: efficiency, analysis and order of an algorithm. Biological vs. Computer algorithms
2. Standard Notations: Big-O notation, NP-hard problems. Few examples: Sorting, Finding optimal change, Traveling salesman problem etc.

### Unit 2: Algorithm Design

3. Introduction to algorithm design techniques: Exhaustive search, Greedy Algorithms, Divide and conquer etc.
4. Motif finding problem: Brute force algorithm, Greedy algorithm

### Unit 3: Dynamic Programming and Finite State Machines

1. Elements of Dynamic Programming: Edit distance, Longest Common Subsequences.
2. Global and Local Sequence Alignment
3. Markov Chains and Hidden Markov Models
4. Pairwise alignment using HMMs

### Unit 4: Pattern matching, trees and clustering

1. Introduction to hash table, keyword tree, suffix tree
2. Ukkonen's linear time suffix tree algorithm
3. Constant time lowest common ancestor retrieval
4. Hierarchical and k-means clustering
5. Evolutionary trees: distance based construction
6. Evolutionary trees: character based construction

### Unit 5: Genetic Algorithms

1. Elements of genetic algorithms
2. Cellular automata
3. Systems modeling using genetic algorithms: examples from biological and ecosystems
4. Implementing a genetic algorithm.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### Suggested Readings:

1. Aho, Alfred V., John E. Hopcroft, and Jeffrey D. Ullman. The Design and Analysis of Computer Algorithms. Reading, MA: Addison-Wesley, 1974. ISBN: 0201000296.

2. Data Structures and Algorithms. Reading, MA: Addison-Wesley, 1983. ISBN: 0201000237.
3. Baase, Sara. Computer Algorithms: Introduction to Design and Analysis. 2nd ed. Reading, MA: Addison-Wesley, 1988. ISBN: 0201060353.
4. Bentley, Jon Louis. Programming Pearls. Reading, MA: Addison-Wesley, 1986. ISBN: 0201103311.
5. More Programming Pearls: Confessions of a Coder. Reading, MA: Addison-Wesley, 1988. ISBN: 0201118890.
6. Brassard, Gilles, and Paul Bratley. Algorithmics: Theory and Practice. Englewood Cliffs, NJ: Prentice-Hall, 1988. ISBN: 0130232432.
7. Even, Shimon. Graph Algorithms. Rockville, MD: Computer Science Press, 1979. ISBN: 0914894218.
8. Garey, Michael R., and David S. Johnson. Computers and Intractability: A Guide to the Theory of NP-Completeness. San Francisco, CA: W. H. Freeman & Co., 1979. ISBN: 0716710447.
9. Gusfield, Dan. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology. Cambridge, UK: Cambridge University Press, 1997. ISBN: 0521585198.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Fundamentals Machine Learning**

**Course Code: BIN 468**

**Total Hours: 20**

L	T	P	Cr
2	0	0	2

**Learning Outcomes:** At the end of the course, the students will be able to understand the fundamentals of Machine learning

## Course Content

### Unit 1

Class overview: Class organization, topics overview, software etc.

Introduction: what is ML; Problems, data, and tools; Visualization

### Unit 2

Linear regression; SSE; gradient descent; closed form; normal equations; features

### Unit 3

Overfitting and complexity; training, validation, test data, and introduction to Python Libraries

### Unit 4

Classification problems; decision boundaries; nearest neighbor methods

Probability and classification

### Unit 5

Naive Bayes and Gaussian class-conditional distribution, Linear classifiers, Bayes' Rule and Naive Bayes Model

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggestged Readings:

- Ethem Alpaydin, Introduction to Machine Learning, Second Edition , <http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012>.
- Stephen Marsland, Machine Learning: An Algorithmic Perspective. <http://www.amazon.com/Machine-Learning-Algorithmic-PerspectiveRecognition/dp/1420067184>
- Christopher M. Bishop, Pattern Recognition and Machine Learning. <http://research.microsoft.com/en-us/um/people/cmbishop/prml/>.
- Tom Mitchell, Machine Learning, <http://www.cs.cmu.edu/~tom/mlbook.html>.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Fundamentals of Molecular Dynamics simulations

**Course Code:** BIN 469

**Total Hours:** 20

L	T	P	Cr
2	0	0	2

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

- learn the modelling of small to large molecular environments
- understand various force field for biomolecular simulation in details
- gain the knowledge about different molecular simulation techniques
- learn different methods for simulating large systems
- understand the dynamics of the structural transitions

## Course Content

### Unit 1

Biomolecular Modeling and Structure - molecular modeling today: overview of problems, tools, and solution analysis, minitutorials in protein and nucleic acid structure. Techniques for Conformational Sampling- Monte Carlo, global optimization, etc.

### Unit 2

Molecular Mechanics: general features, bond stretching, angle bending, improper torsions, out of plane bending, cross terms, non-bonded interactions, Ramachandran diagram point charges, calculation of atomic charges, polarization, van der waals interactions, hydrogen bond interactions, Water models, Force field, all atoms force field and united atom force field.

### Unit 3

Energy minimization: Steepest descent, conjugate gradient – Derivatives, First order steepest descent and conjugate gradients. Second order derivatives Newton-Raphson, Minima, maxima saddle points and convergence criteria.-non derivatives minimization methods, the simplex, sequential univariate, Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, Solvent access, Equilibration, cut-offs.

### Unit 4

Simulation methods: algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzmann velocity, time steps, duration of the MD run,

### Unit 5

Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions. Various methods of MD, Monte Carlo, systematic and random search methods.



**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

### **Suggested Readings**

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
2. Fenniri, H. "Combinatorial Chemistry – A practical approach", (2000) Oxford University Press, UK.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. Gordon, E.M. and Kerwin, J.F "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Python Programming Lab-II**

**Course Code: BIN 470**

**Total Hours: 40**

L	T	P	Cr
0	0	4	2

**Learning Outcomes:** Upon successfully completing this course, students will be able to “do something useful with Python”.

- Identify/characterize/define a numerical problem
- Design a program to solve the data parsing problem
- Create Time series code
- Read most of the advanced Python code

## Course Content

- Introduction to Numpy and Pandas
- Visualizations with Matplotlib and Seaborn
- Statistical analysis to understand our data
- Data cleaning and normalization.
- Advanced Pandas models
- Hierarchical indexing
- Data Wrangling and transformations
- Advanced visualizations
- Introduction to Machine Learning
- Intro to Regressions- Linear and logistic regression using Scikit Learn
- Intro to Classification- Classification with K nearest Neighbours- Decision Trees and Random Forest

## Transactional Modes:

Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings

- Core Python Programming (<http://corepython.com/>): Only available as a dead trees version, but if you like to have book to hold in your hands anyway, this is the best textbook style introduction out there. It starts from the beginning, but gets into the full language. Published in 2009, but still in print, with updated appendixes available for new language features. In the third edition, "the contents have been cleaned up and retrofitted w/Python 3 examples paired w/their 2.x friends."
- Dive Into Python 3 (<http://www.diveinto.org/python3/>): This book offers an introduction to Python aimed at the student who has experience programming in another language.
- Python for You and Me (<http://pymbook.readthedocs.org/en/latest/>): Simple and clear. This is a great book for absolute newcomers, or to keep as a quick reference as you get used to the language.
- The latest version is Python 3.
- Think Python (<http://greenteapress.com/thinkpython/>): Methodical and complete. This book offers a very "computer science"-style introduction to Python. It is really an intro to Python in the service of Computer Science, though, so while helpful for the absolute newcomer, it isn't quite as "pythonic" as it might be.

- Python 101 (<http://www.blog.pythonlibrary.org/2014/06/03/python-101-book-published-today/>) Available as a reasonably priced ebook. This is a new one from a popular Blogger about Python.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** History of Science in India

**Course Code:** BIN 471

**Total Lectures:** 20

L	T	P	Cr
2	0	0	2

**Course Objectives:** This course is designed to introduce students about the rich scientific culture of India. The course attempts to develop a quest for search and research of scientific concepts embedded in the traditional Indian texts and rituals. For that, each topic covered in the course is taught by integrating two aspects: its modern scientific understanding and its discussion in the Indian literature. Prominent Indian Scientists, the Acharyas and the Rishis associated with a topic under discussion are duly introduced and acknowledged.

## Course Contents

### Unit 1: Introductory concepts

- Antiquity of Indian civilization
- The archaeological sources
- The literature sources: Vedas and Vedangas, Epics and Puranas, Sastras (Niti, Artha), etc.
- Needham's puzzle

### Unit 2: Mathematics

- The Sulbasutras
- Concept of pi
- Zero, decimal number system, place value system, combinatorics
- Katapyadi system, binary number system
- Fibonacci series and golden ratio

### Unit 3: Physics and Astronomy

- The Vaisheshika: Matter and Universe (Notions of Padarth, Dravya and Guna)
- Measurements of length and mass
- Kaal ganana, calendars and eclipses: Five siddhants
- Laws of motion, concept of gravity and relativity
- Sound, light and energy

### Unit 4: Life Sciences and Medicine

- Plants and agriculture, the Vrikshayurveda
- Microbes, animals and humans
- Origin and evolution of Ayurveda
  - Basic concepts; food, drinks and materia-medica; diseases; medicine; surgery; holistic view of life

- Brief discussions on Rasachikitsa, Nadi vijnana, Yoga, Siddha, Homeopathy, Sowa-Rigpa

#### **UNIT 5: Engineering Sciences and Technology**

- Architecture and Vastu Shastra
- Alchemy and metallurgy
- Marine science

#### **Text Books:**

- **Suresh Soni (2008).** India's Glorious Scientific Tradition. Ocean Books
- **Bose et al. (2009).** A Concise History of Science in India. Universities Press

#### **Additional Readings:**

- **BB Datta and AN Singh (1962).** History of Hindu Mathematics. Asia Publishing House
- **NG Dongre and SG Nene (2016).** Physics in Ancient India. National book Trust.
- **MS Valiathan.** The Legacy of Caraka/ Susruta/ Vagabhata. Universities Press.
- **P.C. Ray (1903).** A History of Hindu Chemistry. The Bengal chemical and pharmaceutical works ltd.

# Semester – III



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Academic Campus, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Biological Databases and Management Systems**

**Course Code: BIN 515**

**Total Hours: 20**

L	T	P	Cr
2	0	0	2

**Learning Outcomes:** Upon successfully completing this course, students will be able to apply principles of DBMS to create novel solution in bioinformatics.

- Identify/characterize/define and solve a data collection, sorting and management problem
- Design an approach to create a Relational DBMS
- Create non-redundant databases

### Course Content

#### Unit1

Biological Databases: Nucleotide Sequence Databases, GenBank, DDBJ, EMBL, Sequence Flatfile and submission process, Protein sequence databases, UniProt, Mapping databases, Genomic databases, PDBsum, PDB, SCOP, CATH, Pathway and molecular interaction databases.

#### Unit 2

Database planning and Design concepts General Database Planning and Design – Document or forms – preparation and architecture Entity-Relational ship Model- entities, Attributes, keys, tables design, relationships, roles and dependencies.

#### Unit 3

Relational DB Introduction to relational DB and transactions. SQL-statements-Data Definition-Manipulation-control-Objects, - Views, sequences and Synonyms. Working with code and forms- Front end development-query sublanguage-modifying relations in SQL.

#### Unit 4

Internals of RDBMS Physical data structures, query optimization. Join algorithm statistics and cost base optimization.

#### Unit 5

Transaction processing.concurrency control and recovery management. Transaction model properties, state serizability, lock base protocols, two phase locking.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

#### Suggested Readings

- 1 Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
- 2 Elmasri Ramez and Novathe Shamkant, “ Fundamentals of Database systems” (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
- 3 P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
- 4 Jim Gray and A.Reuter “ Transaction processing : Concepts and Techniques” Morgan Kaufmann Press.(1997) ISBN- 10: 1558601902
- 5 V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279

6 Date C.J. “ Introduction to database management” (2009) Vol1, Vol2, Vol3 addison Wesley.

7 Ullman, JD “ Principles of Database systems” (1992) Galgottia publication

8 James Martin Principles of Database Management systems” (1985) PHI.

6. Introduction to NCBI Taxonomic Browser

7. DDL & DML: Creating and working with databases, creating tables, dropping tables, primary and secondary keys, data validation, simple queries using MySQL, cursors, stored procedures.

8. DTD and XML schema- simple DTD and creation of data in XML.



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Academic Campus, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Systems Biology and Biological Networks

**Course Code:** BIN 516

**Total Lecture:** 40

L	T	P	Cr
4	0	0	4

**Learning Outcomes:** This course will be centered on (i) the theoretical and practical aspects of modelling in systems biology – both deterministic and stochastic and (ii) the study of biological networks. After completion of this course students will become acquainted with the key concepts and approaches of both these fields including mathematical and computational concepts of Synthetic Biology.

## Course Contents

### Unit 1: Introductory Interdisciplinary Concepts

Definition and scope of Systems biology and Synthetic biology.

Introduction to biological complexity -- Self organization, Emergence, Chaos, Robustness.

First-order systems: fixed points and stability, population growth. bifurcations.

Second-order systems: phase portraits, fixed points and linearization. attractors and limit cycles. Hopf bifurcations. Software: XPPAut

### Unit 2: Deterministic Modelling in Systems Biology

Chemical Kinetics, Michaelis-Menten Kinetics, Hill equations.

Deterministic Methods of systems modelling (Euler and RK4)

Modelling positive and negative feedback.

Examples from natural systems: Predator-Prey, Circadian Rhythms, p53-mdm2.

Examples from synthetic systems: Brusselator, Repressilator.

### Unit 3: Design principles of Biological Networks

Introduction to Networks. Basic terminology, Random networks: Erdős-Renyi model, Watts-Strogatz model.

Scale-free networks, Modular and hierarchical networks. Dynamics on networks. Topology of genetic, metabolic, social, ecological and language networks.

Flux balance analysis.

### UNIT 4: Analysis of Biological Networks 1

Global Properties: average path length, network diameter, centrality measures, clustering coefficients

etc. Local Properties: regulatory motifs and graphlets in networks.

### Unit 5: Analysis of Biological Networks 2

Motifs in TRNs: discussion on FFL, SIM and other motifs. Network Clustering: clique based clustering, center based clustering

Petri Nets. Softwares: Pajek, Cytoscape, Mfinder, Graphviz etc.

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning.

## Suggested reading:

1. Steven H. Strogatz (1994), Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Perseus Books, Massachusetts.
2. Szallasi et al. (2010), System Modelling in Cellular Biology. MIT Press.



3. Junker and Schreiber (2008), Analysis of Biological Networks. Wiley-Interscience, New Jersey.
4. Uri Alon (2006), An Introduction to the Systems Biology. Chapman and Hall.
5. Mark Newman (2010), Networks: An Introduction. Oxford University Press.
6. Klipp et al. (2009), Systems Biology in Practice. Wiley-VCH.
7. BO Palsson (2006), Systems Biology. Cambridge University Press.
8. Press et al. (2007), Numerical Recipes in C. Cambridge University Press.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Essentials of Immunology

**Course Code:** BIN 517

**Total Lectures:** 20

L	T	P	Cr
2	0	0	2

## Learning Outcomes:

On successful completion of the course the student will be able to:

- Evaluate basic concepts of immune system.
- Gain knowledge about various key processes related to development of immune system.
- Understand the concept of immune-based diseases as either a deficiency of components or excess activity as hypersensitivity.
- Apply the knowledge how immune system is involved in diseases caused by internal or external factors.

## Unit: I

**Immune System:** The cells and organs of immune system, humoral immunity-immunoglobulin, basic structure, classes and subclasses, structural and functional relationships,

## Unit: II

**Antigen and Antibody:** Nature of antigen, antigen-antibody reaction, antibody diversity, class switching, B and T cell development.

## Unit: III

**Immune Effectors:** Complement system, their structure, functions and mechanisms of activation by classical, alternative and lectin pathway. Th1 and Th2 response, various effector cells of immune system: DC, NK, Monocytes etc.

## Unit: IV

**Mechanisms of Immune System Diversity:** Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system, polymorphism, distribution, variation and their functions.

## Unit: V

**Immune System in Health and Diseases:** Inflammation, hypersensitivity and autoimmunity, AIDS and immunodeficiencies, vaccine development.

**Transactional Modes:** Lecture; Demonstration; Tutorial; Lecture cum demonstration; Problem solving; Self-learning.

## Suggested Reading:

- Kindt, T.J., Osborne, B.A. and Goldsby, R.A. (2018). *Kuby Immunology*. W.H. Freeman, USA.
- Abbas. (2018). *Cellular and Molecular Immunology*. CBS Publishers & Distributors, India.
- Charles, A. and Janeway, J.R. (2001). *Immunobiology: The immune system in health and disease*. Blackwell Publishing, USA.
- Delves, P.J., Roitt, I.M. and Seamus, J.M. (2016). *Roitt's Essential Immunology (Series–Essentials)*. Blackwell Publishers, USA.
- Elgert, K.D. (2015). *Immunology: Understanding the immune system*. Wiley-Blackwell, USA.



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Academic Campus, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Research Methodology**

**Course Code: BIN 518**

**Total Hours: 40**

L	T	P	Cr
4	0	0	4

**Course Objectives:** The objective of this subject is to ensure that a student learns the fundamentals of research methodologies

## **Learning Outcomes:**

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

- Prepare a research plan, reading and gain knowledge from scientific papers
- Develop skills for scientific writing, research proposal writing,
- Analyze the data using R

## **Course Content:**

### **UNIT –I: Introduction to research design:**

Definition of the Problem: Identifying and formulating the problem. Developing a research plan: Research objective: information required for solving the problem: defining each major concept in operational terms: an overall description of approach, clearly stating any assumptions.

### **UNIT –II: Scientific literature review - 1**

Reading and critical analysis of scientific literature/ research paper/case reports etc. Drafting and communicating research results in peer-reviewed journals.

### **UNIT –III: Scientific literature review - 2**

Acknowledgement of contributions, authorship issues; Intellectual Property Rights (IPR), scientific ethics, rules of plagiarism.

### **UNIT –IV: Writing and presentation skills**

Communication skills of research work through Poster and oral presentation Writing review paper on a relevant research topic and presentation of the same in a seminar /conferences / workshop / symposium etc.

### **UNIT –V: Data Analysis with R**

Define sensitivity, accuracy, precision and specificity, miss rate, fall-out, false omission rate, prevalence threshold, critical success index, F1 Score, Balanced accuracy, MCC, FM Index, informedness, markedness. Confusion Matrix

**Transactional Modes:** Lecture; Tutorial; Problem solving; Self-learning

## **Suggested Readings**

1. Blum, Deborah and Mary Knudson, eds. A field guide for science writers: the official guide of the National Association of Science Writers, New York: Oxford University Press, 1997.

2. Booth, Wayne, Gregory G Colomb, Joseph M. Williams. The craft of Research Chicago University of Chicago Press, 1995.
3. Davis, Martha. Scientific Papers and Presentations. San Diego: Academic Press, 1997.
4. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.
5. Bajpai, PK. Biological Instrumentation and Methodology. New Delhi: S. Chand & Co. Ltd. 2006.,
6. Kothari, C. R. (2014). 2/e, Research Methodology- Methods and Technique.(New Age International, New Delhi)
7. Montgomery, Douglas C. and Runger, George C. (2007), 3/e. applied statistics and probability for Engineers. (Willey, India)



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Computer Aided Drug Design Lab

**Course Code:** BIN 519

**Total Hours:** 40

L	T	P	Cr
0	0	2	2

Course Content –

Introduction to Structure based Drug Design and process layout of Docking

-Data mining, literature study and acquisition of target structure

-Comparative modelling of protein (Homology modelling) \*target structure not available

-Server based –PHYRE, RaptorX, SWISSMODEL, I-TASSER, etc.

-Protein structure validation(ProSA)

-Ramachandran plot assessment(RAMPAGE,Pdbsum,Procheck)

-Active site/ Pocket identification

–MetaPocket,CastP,Active site identification using PyMol

-Molecular Docking \*using AutoDock vina/AutoDock Tools/PyRx (For docking of multiple ligands)

-Protein and ligand preparation -Setting grid parameters and Docking parameters

-Docking analysis (based on binding energy, Hydrogen bond interactions, electrostatic interactions, hydrophobic interactions, etc.)

-BINANA (BINding ANAlyser)

-Pdbsum for visualising protein-ligand interactions -Building protein-ligand complex and visualization(publication standard)

-Report construction



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Systems Biology Lab

**Course Code:** BIN 520

**Total Hours:** 40

L	T	P	Cr
4	0	0	2

**Course Objectives:** The course is designed to give students an opportunity for learning the computational techniques to understand biological complexity at systems level. They will be introduced to the softwares implementing deterministic and stochastic modeling algorithms. At the same time they will also be acquainted with the network visualization and analysis softwares.

Students having working knowledge of any programming language will be encouraged to write their own codes for simulating and analysing model biological systems. Students will be required to learn the following modeling and analysis suites.

- CellDesigner, MCell
- Cytoscape
- XPPAut

## Contents:

Standards in Systems Biology -- SBML, SBGN, BioPAX

Deterministic simulation of a natural biological system.

Deterministic simulation of a synthetic biological system.

Implementation of Gillespie's stochastic simulation algorithm to model the given chemical reaction system.

Introduction to biological network databases –

KEGG, STRING, STITCH, DIP, BIND, HPRD, EMP, EcoCyc, MetaCyc, AraCyc etc.

To construct and visualize simple biological network.

To analyze a given biological network by calculating the following characteristics

Diameter, density

Average path length

Clustering coefficient

Centrality measures (Degree, Closeness, Eccentricity, Betweenness)

Degree distribution

Community detection Etc.

To identify motifs and graphlets in a given network.

Stability analysis of a given 1-dimensional dynamical system.

Stability analysis of a given 2-dimensional biological system.

Systems Biology Capstone



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title:** Review of Literature and Research Proposal

**Course Code:** BIN 521

**Total Hours:** 160

L	T	P	Cr
0	0	16	8

## Course objectives

In this course a student will learn about the

- Basic techniques of literature review
- Various sources for literature review
- Writing the research proposal

Student must perform following task in the supervision of allotted supervisor

- Hands on browsing various literature retrieval databases such as PUBMED, Google Scholar, Shodhgangotri / Shodhganga.
- Student must submit the detailed research proposal/ synopsis along with a literature review in the Department / Centre.

# Semester IV



## Central University of Himachal Pradesh

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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Statistical genetics**

**Course Code: BIN 565**

**Total Hours: 20**

L	T	P	Cr
2	0	0	2

**Learning Outcomes:** The course is designed to ensure that the students understand the fundamentals, theoretical and practical aspects of statistics which could be applied in wide fields of life sciences.

### Course Contents

#### UNIT I Fundamentals of statistics -I

- Introduction to statistics
- Describing datasets
- Probability
- Random variables

#### UNIT II Fundamentals of statistics -II

- Testing statistical hypothesis
- Analysis of variance
- Linear regression
- Chi-square tests
- Non parametric hypothesis tests & quality control

#### UNIT III Genetic linkage maps

- Mendel's law, Hardy Weinberg equilibrium and overview of linkage and association
- Map function & recombination fraction
- Genetic map construction
- Multipoint analysis of mendalian loci

#### UNIT IV Analysis of Quantitative traits

- Introduction to quantitative genetics
- Major gene detection and segregation analysis
- Interval mapping & CIM
- QTL mapping & GWAS

#### UNIT V Applications in life sciences

- Statistics for population genetics
- Statistics for genetic epidemiology and biomedical sciences
- Statistics for evolutionary genetics and epigenetic research
- Statistical genetics for animal and plant breeding
- Application of R in statistical genetics

### Text Books:

- a) D.J. Balding, M Bishop and C. Cannings. Handbook of Statistical Genetics Vol 1 & 2. Wiley



- b) Murray R Spiegel and Larry J Stephens: Schaum's outline of statistics. *Tata McGraw Hill*
- c) Sheldon M. Ross. Introductory Statistics. *Academic Press*
- Shizhong Xu. Principles of Statistical Genomics. *Springer*



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Molecular Evolution**

**Course Code: BIN 566**

**Total Hours: 40**

L	T	P	Cr
4	0	0	4

**Learning Outcomes:** After completing the course the student should be able to

- describe evolutionary processes that give rise to variation in sequences and genomes and how these influence the architecture of the genome, contents and variation in base composition
- explain and justify different models for sequence and genome evolution
- choose, apply and evaluate bioinformatics methods for studying genetic variation in and between species.

## Course Content

### Unit 1

Comparison of DNA sequences to calculate gene distance; Convergent and divergent evolution; Mutation Vs. Substitution-Rate of Molecular Evolution.

### Unit 2

Jukes Cantor Correction and evolutionary distance. Hardy-Weinberg equilibrium – Heterozygosity, gene frequency and heterozygosity; Loss of heterozygosity-mutant alleles-theta as the measure

### Unit 3

Molecular clock- Concepts and significance-molecular mechanisms of molecular clock- Neutral theory -gene family organization.

### Unit 4

Paralogy and Orthology- coordination expression in evolution-genome: content, structure and evolution.

### Unit 5

Molecular evolution of recently diverged species - Databases of Molecular evolution.

**Transactional Modes:** Lectures; Tutorials; Problem solving; Self-learning

## Suggested Readings

1. Darwin, C.R. (1911). On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life. Hurst Publishers, UK.
2. Dawkins, R. (1996). The Blind Watchmaker, W.W. Norton & Company Jones and Bartlett Publishers.
3. Futuyma, D.J. (2009). Evolution. Sinauer Associates Inc. USA
4. Bromham, L. (2016). An Introduction to Molecular Evolution and phylogenetics. OUP Oxford.



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Academic Campus, Shahpur, Distt. Kangra (HP) – 176206

[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Introduction of Synthetic Biology**

**Course Code: BIN 567**

**Total Lectures: 20**

L	T	P	Cr
2	0	0	2

## Course Objectives:

The course is designed to introduce students the concepts of synthetic biology – a field of study at the interface of (i) complexity of biological systems and (ii) techniques of traditional engineering. This course is designed to acquaint students about the following basic questions:

- Can we study and understand biology as an engineering discipline?
- Why is it necessary to consider stochasticity while modeling biological processes?
- What are the basic parts and devices that have been successfully bioengineered?
- What are the implications of Synthetic Biology on the society?

## Course Contents

### UNIT I: Introductory Interdisciplinary Concepts

- Definition and scope of systems biology and synthetic biology.
- Engineering concepts: parts, devices, circuits -- digital vs. analog, logic gates.
- Biological complexity: Self organization, Emergence, Robustness.

### UNIT II: Modeling methods for Biological Systems

- Review of kinetic chemistry, Aspects of noise in designing biological systems.
- Brief overview of deterministic modeling, master equation and Gillespie's Stochastic
- Simulation Algorithm. Lambda switch and Chemotactic module in E coli.
- Open source programs: CellDesigner, etc

### UNIT III: Standards and parts in Synthetic Biology

- Standards: SBML, SBGN, BioPAX
- MIT Registry of standard biological parts
- Bio-brick and non-biobrick initiatives, iGEM events
- Lac operon, Promoter designing, Quorum sensing
- ZFNs, TALENs, CRISPR/Cas

### UNIT IV: Bio-engineered Synthetic Circuits

- Gates: AND gate, Counters: Pulse generators, Switches: Toggle switch
  - Oscillators: Repressilator, mammalian oscillator
  - Brief overview of cascades, time delayed circuits, spatial patterning, biosensors, and other
- Logical formula driven circuits.
  - Riboswitches and riboregulators
  - Four and Six-letter genetic code

### UNIT V: From Modules to Systems

### Integrating gene circuits

- DNA Origami,
- Genome Synthesis, Minimal synthetic cell, Multicellular synthetic systems
- Protocell construction
- Bio-energetics and Bio-fuels
- Safety and Legal issues: Bio-security, Bio-safety

### **Text Books:**

Chris Myers (2009). Engineering Genetic Circuits. Chapman & Hall.

Edda Klipp et al. (2009). Systems Biology: A Textbook. Wiley-VCH.

Huimin Zhao (2013). Synthetic Biology: Tools and Applications. Academic Press.

### **Additional Readings:**

- Freemont and Kitney (2012). Synthetic Biology: A Primer. World Scientific
- Fu and Panke (2009). Systems Biology and Synthetic Biology. Wiley, New Jersey.
- Presidential Commission for the Study of Bioethical Issues (2010). NEW DIRECTIONS:
- Ethics of Synthetic Biology and Emerging Technologies. (<http://bioethics.gov>)
- Singh V., and Dhar, P. K. (2015). Systems and Synthetic Biology, Springer Science, 385. ISBN: 978-94- 017-9513- 5.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Academic Writing**

**Course Code: BIN 568**

**Total Hours: 40**

L	T	P	Cr
4	0	0	2

## Course objectives

- To understand the importance of academic writing
- To understand and avoid the plagiarism
- To understand the basic skills of literature review
- To understand the basic skills of research paper, review paper and thesis writing.
- To target the research work to suitable journal and communicate for publication
- To understand Time and team management
- To understand digital writing or OER development
- To understand research proposal writing, conference abstract and book writing

## Course content

### Unit 1:

Introduction of academic and research writing, importance of academic writing and basics of academic writing. English in academic writing and styles of research writing.

### Unit 2:

UGC guidelines on Plagiarism, tools of detection of plagiarism and avoiding plagiarism. Journal metrics, author metrics

### Unit 3:

Literature review, process of literature review, online literature databases. Literature management tools. Referencing and citation, submission, and post submission.

### Unit 4:

Introduction and tips for writing the Popular article, research proposal, Research article, review articles, book and thesis. Empirical study.

### Unit 5

Challenges in Indian research and writing, team management, time management, Open education resources, Ethics in academic writing.

## Reading material

- [https://onlinecourses.swayam2.ac.in/ugc19\\_ge03/preview](https://onlinecourses.swayam2.ac.in/ugc19_ge03/preview)
- Stephen B. Heard. The Scientist's Guide to Writing: How to Write More Easily and Effectively throughout Your Scientific Career, Princeton University Press (2016)
- John M. Swales, Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills, University of Michigan Press (2012)



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Paper Public/Seminar/Conference**

**Course Code: BIN 569**

**Total Hours: 40**

L	T	P	Cr
0	0	4	2

## **Paper publication/ seminar/ conferences**

### **Course objective**

The main objective of this course is to give students real world exposure of publishing papers/ seminar/ conferences etc. In this course student must fulfill at least one of the objectives with the due permission of respective supervisor/ Director of the Centre.

1. Publish at least one research article in UGC approved research journal/Journal of Himalayan Life Sciences.
2. Publish at least one review article in UGC approved research journal/ Journal of Himalayan Life Sciences.
3. Participate in an oral presentation/ talk in refereed conference/ Seminar. Additionally, student must submit a writeup at CUHP before the end of this course.
4. Participate in poster presentation in a referred conference / Seminar. Additionally, student must submit a writeup at CUHP before the end of this course.
5. Participate in a seminar/ conference/ training event etc and make a detailed report.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Molecular Dynamics Simulation Lab**

**Course Code: BIN 570**

**Total Hours: 40**

L	T	P	Cr
0	0	4	2

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

- learn the modelling of small to large molecular environments
- understand various force field for biomolecular simulation in details
- learn different methods for simulating large systems
- gain the knowledge about different molecular simulation techniques understand the dynamics of the structural transitions

## Course Content

1. Visualization Software and 3D representations with VMD and PYMOL
2. Coordinate generations and inter-conversions.
3. Energy minimizations and optimization.
4. Molecular Dynamics with Gromacs:
  - Protein in water
  - Membrane protein
  - Umbrella Sampling
  - Free Energy of Solvation
  - Protein ligand interaction
  - Free Energy of Solvation

**Transactional Modes:** Laboratory based practicals; Problem solving; Self-learning.

## Suggested Readings:

1. Andrew R. Leach Molecular Modelling Principles and applications . (2001) II ed . Prentice Hall.
2. Fenniri, H. “Combinatorial Chemistry – A practical approach”,(2000) Oxford University Press, UK.
3. Lednicer, D. “Strategies for Organic Drug Discovery Synthesis and Design”; (1998) Wiley International Publishers.
4. Gordon, E.M. and Kerwin, J.F “Combinatorial chemistry and molecular diversity in drug discovery” (1998) Wiley-Liss Publishers.



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[Website: www.cuhimachal.ac.in](http://www.cuhimachal.ac.in)

**Course Title: Data Analysis Lab**

**Course Code: BIN 571**

**Total Hours: 40**

L	T	P	Cr
0	0	4	2

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

- The techniques used to perform statistical inference on high-throughput and high-dimensional data.
- Several techniques widely used in the analysis of high-dimensional data.

## **Course Content**

Mathematical Distance

Dimension Reduction

Singular Value Decomposition and Principal Component Analysis

Multiple Dimensional Scaling Plots

Factor Analysis

Dealing with Batch Effects

Clustering

Heatmaps

Basic Machine Learning Concepts

## **Suggested readings:**

Statistical Analysis for High-Dimensional Data; Editors: Frigessi, A., Bühlmann, P., Glad, I.K., Langaas, M., Richardson, S., Vannucci, M. (Eds.) Hardcover ISBN 978-3-319-27097-5  
Softcover ISBN 978-3-319-80073-8

Python for Data Analysis Year: 2017 Edition: 2 Publisher: O'Reilly Media Language: english Pages: 544 / 541 ISBN 10: 1491957662 ISBN 13: 9781491957660



## Pre Ph.D. Course in Computational Biology and Bioinformatics

### Scheme of Courses for Pre Ph.D. Course in Computational Biology and Bioinformatics

Course Code	C/E*	Course Name	Credits	Credits for students
CPE-RPE	C	Research and Publication Ethics	2	2
<b>BIN – 601</b>	C	Research Methodology	4	4
<b>BIN – 602</b>	C	<b>Indian Knowledge System</b>	2	2
<b>BIN – 603</b>	C	<b>Pedagogy of teaching learning Process</b>	2	2
<b>BIN – 604</b>	E	Sequence and Structural Bioinformatics	4	<b>12</b>
<b>BIN – 605</b>	E	Statistical Mechanics	4	
<b>BIN – 606</b>	E	Scientific Programming Lab	4	
<b>BIN – 607</b>	E	Molecular Dynamics Lab	4	
<b>BIN -608</b>	E	Plant Bioinformatics	4	
<b>BIN – 609</b>	E	Machine Learning and Applications	4	
<b>BIN – 610</b>	E	Scientific Writing and Presentation Skills	4	
Total				

\*Students can select any **three elective** papers from above scheme.

**C-** Compulsory

**E-**Elective

#### **Mode of Transaction:**

Lecture, Laboratory based Practical, Seminar, Group discussion, Team teaching, Self-learning.

IV Semester Examination Result: MSc (Computational Biology & Bio-Informatics) Academic Year 2016-17

Sr. No.	Registration / Enrolment No.	Course Code	CBB 428			CBB 499A			CBB 522			CBB 523			CBB 525			CBB 527			Grand Total			Remarks	
		Credits	2			8			2			2			2			4							
		Maximum Marks	100			400			100			100			100			200							
		Name of the Student	Total Mark Obtained	GP	LG	Total Mark Obtained	GP	LG	Total Mark Obtained	GP	LG	Total Mark Obtained	GP	LG	Total Mark Obtained	GP	LG	Total Mark Obtained	GP	LG	SPM	SGPA	SLG		Credits Earned
1	CUHP15CBB01	Amita	70.00	8	A+	300.00	8	A+	54.00	5	B	66.00	7	A	59.50	6	B+	141.00	8	A+	69.05	7.40	A	20	Pass
2	CUHP15CBB02	Anju Sharma	62.00	7	A	260.00	7	A	61.00	7	A	68.00	7	A	69.50	7	A	155.00	8	A+	67.55	7.20	A	20	Pass
3	CUHP15CBB03	Deepika Rana	59.00	6	B+	300.00	8	A+	65.00	7	A	63.00	7	A	65.50	7	A	146.00	8	A+	69.85	7.50	A+	20	Pass
4	CUHP15CBB04	Diksha Sharma	65.00	7	A	260.00	7	A	50.00	5	B	64.00	7	A	69.00	7	A	147.00	8	A+	65.50	7.00	A	20	Pass
5	CUHP15CBB05	Gurmeet Kumari	56.00	6	B+	300.00	8	A+	58.00	6	B+	67.00	7	A	63.50	7	A	155.00	8	A+	69.95	7.40	A	20	Pass
6	CUHP15CBB06	Ishu	73.00	8	A+	300.00	8	A+	64.00	7	A	75.00	8	A+	53.50	5	B	151.00	8	A+	71.65	7.60	A+	20	Pass
7	CUHP15CBB07	Komal	57.00	6	B+	280.00	8	A+	62.00	7	A	77.00	8	A+	73.00	8	A+	150.00	8	A+	69.90	7.70	A+	20	Pass
8	CUHP15CBB08	Mamta Masand	64.00	7	A	280.00	8	A+	69.00	7	A	72.00	8	A+	76.50	8	A+	161.00	9	O	72.25	8.00	A+	20	Pass
9	CUHP15CBB09	Meenakshi Kaundal	67.00	7	A	280.00	8	A+	60.00	7	A	72.00	8	A+	61.00	7	A	143.00	8	A+	68.30	7.70	A+	20	Pass
10	CUHP15CBB10	Meenu	67.00	7	A	280.00	8	A+	59.00	6	B+	71.00	8	A+	64.50	7	A	150.00	8	A+	69.15	7.60	A+	20	Pass
11	CUHP15CBB11	Mohita Mahajan	77.00	8	A+	280.00	8	A+	82.00	9	O	87.00	9	O	76.50	8	A+	157.00	8	A+	75.95	8.20	A+	20	Pass
12	CUHP15CBB13	Neha Chouhan	77.00	8	A+	340.00	9	O	80.00	9	O	86.00	9	O	83.00	9	O	146.00	8	A+	81.20	8.70	O	20	Pass
13	CUHP15CBB14	Nisha	72.00	8	A+	300.00	8	A+	76.00	8	A+	80.00	9	O	78.50	8	A+	153.00	8	A+	75.95	8.10	A+	20	Pass
14	CUHP15CBB15	Nitin Thapa	62.00	7	A	320.00	9	O	64.00	7	A	70.00	8	A+	62.00	7	A	151.00	8	A+	72.90	8.10	A+	20	Pass
15	CUHP15CBB16	Poonam Alias Sarita Devi	69.00	7	A	280.00	8	A+	66.00	7	A	67.00	7	A	67.50	7	A	170.00	9	O	71.95	7.80	A+	20	Pass
16	CUHP15CBB17	Preeti Salaria	64.00	7	A	280.00	8	A+	66.00	7	A	75.00	8	A+	68.00	7	A	154.00	8	A+	70.70	7.70	A+	20	Pass
17	CUHP15CBB18	Priyanka Kumari	63.00	7	A	300.00	8	A+	54.00	5	B	64.00	7	A	56.00	6	B+	150.00	8	A+	68.70	7.30	A	20	Pass
18	CUHP15CBB19	Pushpa Kumari	62.00	7	A	260.00	7	A	64.00	7	A	65.00	7	A	69.00	7	A	148.00	8	A+	66.80	7.20	A	20	Pass
19	CUHP15CBB20	Reetu Devi	69.00	7	A	260.00	7	A	74.00	8	A+	71.00	8	A+	67.00	7	A	148.00	8	A+	68.90	7.40	A	20	Pass
20	CUHP15CBB21	Rhythm Sharma	66.00	7	A	280.00	8	A+	70.00	8	A+	66.00	7	A	62.50	7	A	163.00	9	O	70.75	7.90	A+	20	Pass
21	CUHP15CBB22	Ritika	64.00	7	A	300.00	8	A+	67.00	7	A	67.00	7	A	74.00	8	A+	158.00	8	A+	73.00	7.70	A+	20	Pass
22	CUHP15CBB23	Savita	57.00	6	B+	280.00	8	A+	59.00	6	B+	70.00	8	A+	67.00	7	A	157.00	8	A+	69.00	7.50	A+	20	Pass
23	CUHP15CBB24	Shikha Bharti	62.00	7	A	260.00	7	A	71.00	8	A+	66.00	7	A	61.00	7	A	151.00	8	A+	67.10	7.30	A	20	Pass
24	CUHP15CBB25	Shilpa Chauhan	71.00	8	A+	300.00	8	A+	85.00	9	O	84.00	9	O	78.50	8	A+	171.00	9	O	78.95	8.40	A+	20	Pass
25	CUHP15CBB26	Shivani	73.00	8	A+	300.00	8	A+	71.00	8	A+	68.00	7	A	66.50	7	A	155.00	8	A+	73.35	7.80	A+	20	Pass
26	CUHP15CBB27	Shiwani Dhiman	73.00	8	A+	300.00	8	A+	72.00	8	A+	75.00	8	A+	78.00	8	A+	143.00	8	A+	74.10	8.00	A+	20	Pass
27	CUHP15CBB28	Vandna Kumari	74.00	8	A+	340.00	9	O	83.00	9	O	84.00	9	O	69.00	7	A	167.00	9	O	81.70	8.70	O	20	Pass
28	CUHP15CBB29	Varsha Patial	64.00	7	A	280.00	8	A+	67.00	7	A	64.00	7	A	55.50	6	B+	159.00	8	A+	68.95	7.50	A+	20	Pass
29	CUHP15CBB30	Vijay Singh	58.00	6	B+	280.00	8	A+	51.00	5	B	54.00	5	B	50.00	5	B	116.00	6	B+	60.90	6.50	A	20	Pass

Abbreviations:

CIA: Cumulative Internal Assessment  
MTE: Mid-term Examination  
ESE: End Semester Examination  
GP: Grade Point  
LG: Letter Grade  
SPM: Semester Percentage Marks  
SGPA: Semester Grade Point Average  
SLG: Semester Letter Grade  
CGPA: Cumulative Grade Point Average

Percentage of Marks	GP	LG	Description of the Letter Grade
90-100	10	O+	Outstanding
80-89	9	O	Excellent
70-79	8	A+	Very Good
60-69	7	A	Good
55-59	6	B+	Average
50-54	5	B	Pass
00-49	-	F	Fail
Absent	-	Ab	
Incomplete	-	I	

Prepared by

Checked By

Controller of Examinations

CGPA/SGPA Range	LG	Description of the Letter Grade
9.50 - 10.00	O+	Outstanding
8.50 - 9.49	O	Excellent
7.50 - 8.49	A+	Very Good
6.50 - 7.49	A	Good
5.50 - 6.49	B+	Average
5.00 - 5.49	B	Pass
0 - 4.99	F	Fail

Central University of Himachal Pradesh  
(Established Under Central Universities Act 2009)

IV Semester Examination Result: M.Sc. Computational Biology & Bioinformatics Academic Year 2017-18

Sr. No.	Registration / Enrolment No.	Course Code	CBB 422						CBB 499A				CBB 513				CBB 525				CBB 522				CBB 523				Grand Total			Credits Earned	Remarks								
			Credits						8				4				2				2				2																
			Maximum Marks						25	25	50	100			200	400			50	50	100	200			25	25	50	100			25			25	50	100					
			Name of the Student						CIA	MTE	ESE	Total Mark Obtained	GP	LG	ESE	Total Mark Obtained	GP	LG	CIA	MTE	ESE	Total Mark Obtained	GP	LG	CIA	MTE	ESE	Total Mark Obtained	GP	LG	CIA			MTE	ESE	Total Mark Obtained	GP	LG	SPM	SGPA	SLG
1	CUHP16CBB01	ANKITA DHIMAN	18.25	21	37	76.25	8	A+	324	324.00	9	O	37	39	71	147.00	8	A+	23	19	31	73.00	8	A+	20	17	34	71.00	8	A+	19	15	30	64.00	7	A	75.53	8.30	A+	20	Pass
2	CUHP16CBB02	ANUPAMA	17.25	17	31	65.25	7	A	300	300.00	8	A+	36	32	64	132.00	7	A	19	15	28	62.00	7	A	20	15	28	63.00	7	A	18	13	27	58.00	6	B+	68.03	7.30	A	20	Pass
3	CUHP16CBB03	APRAJITA SOOD	18.25	18	32	68.25	7	A	272	272.00	7	A	34	32	75	141.00	8	A+	21	19	31	71.00	8	A+	17	13	31	61.00	7	A	17	10	25	52.00	5	B	66.53	7.10	A	20	Pass
4	CUHP16CBB04	ARAK CHOUDHARY	20.25	21	31	72.25	8	A+	300	300.00	8	A+	39	40	84	163.00	9	O	23	21	35	79.00	8	A+	22	18	33	73.00	8	A+	21	15	32	68.00	7	A	75.53	8.10	A+	20	Pass
5	CUHP16CBB05	BASUDEV PANIGRAHI	18	17	32	67.00	7	A	272	272.00	7	A	34	38	63	135.00	7	A	21	18	36	75.00	8	A+	19	14	35	68.00	7	A	20	13	25	58.00	6	B+	67.50	7.00	A	20	Pass
6	CUHP16CBB06	BINDIYA KAUNDAL	20.25	17	34	71.25	8	A+	260	260.00	7	A	33	40	77	150.00	8	A+	22	18	42	82.00	9	O	19	18	34	71.00	8	A+	19	15	26	60.00	7	A	69.43	7.60	A+	20	Pass
7	CUHP16CBB07	DEEPIKA KUMARI	16.75	19	33	68.75	7	A	320	320.00	9	O	32	36	73	141.00	8	A+	21	17	37	75.00	8	A+	19	17	33	69.00	7	A	20	15	30	65.00	7	A	73.88	8.10	A+	20	Pass
8	CUHP16CBB08	DIKSHA KUMARI	19.5	20	34	73.50	8	A+	324	324.00	9	O	35	40	73	148.00	8	A+	23	17	35	75.00	8	A+	20	18	39	77.00	8	A+	20	15	28	63.00	7	A	76.05	8.30	A+	20	Pass
9	CUHP16CBB09	DIPALI	16.5	17	25	58.50	6	B+	248	248.00	7	A	27	28	57	112.00	6	B+	23	16	30	69.00	7	A	17	14	32	63.00	7	A	19	13	24	56.00	6	B+	60.65	6.60	A	20	Pass
10	CUHP16CBB10	DIVYA BHARTI	15.75	17	37	69.75	7	A	288	288.00	8	A+	36	42	74	152.00	8	A+	21	20	40	81.00	9	O	20	16	40	76.00	8	A+	19	17	31	67.00	7	A	73.38	7.90	A+	20	Pass
11	CUHP16CBB11	INDU BALA	16.5	16	35	67.50	7	A	244	244.00	7	A	32	30	56	118.00	6	B+	23	18	34	75.00	8	A+	19	16	39	74.00	8	A+	18	13	27	58.00	6	B+	63.65	6.90	A	20	Pass
12	CUHP16CBB13	MANISHA SATAUN	17.5	14	29	60.50	7	A	272	272.00	7	A	33	32	67	132.00	7	A	22	17	37	76.00	8	A+	19	14	35	68.00	7	A	18	13	28	59.00	6	B+	66.75	7.00	A	20	Pass
13	CUHP16CBB14	NANDINI RANA	19.75	17	30	66.75	7	A	280	280.00	8	A+	31	33	50	114.00	6	B+	22	17	33	72.00	8	A+	18	12	34	64.00	7	A	18	15	25	58.00	6	B+	65.48	7.20	A	20	Pass
14	CUHP16CBB15	NIRJALA DEVI	15	17	29	61.00	7	A	284	284.00	8	A+	32	29	69	130.00	7	A	21	18	33	72.00	8	A+	19	13	39	71.00	8	A+	18	13	27	58.00	6	B+	67.60	7.50	A+	20	Pass
15	CUHP16CBB16	RASHMI SHARMA	18	18	31	67.00	7	A	324	324.00	9	O	34	33	71	138.00	7	A	20	19	40	79.00	8	A+	20	12	34	66.00	7	A	19	14	28	61.00	7	A	73.50	7.90	A+	20	Pass
16	CUHP16CBB17	RIMIKA SHARMA	16.75	17	28	61.75	7	A	340	340.00	9	O	32	40	71	143.00	8	A+	24	22	40	86.00	9	O	21	15	42	78.00	8	A+	20	16	31	67.00	7	A	77.58	8.30	A+	20	Pass
17	CUHP16CBB18	RUPENDER SINGH	17.5	20	29	66.50	7	A	280	280.00	8	A+	36	29	60	125.00	7	A	20	20	34	74.00	8	A+	16	14	35	65.00	7	A	17	15	29	61.00	7	A	67.15	7.50	A+	20	Pass
18	CUHP16CBB19	SABIR KHAN	18.5	18	32	68.50	7	A	260	260.00	7	A	35	40	71	146.00	8	A+	19	19	34	72.00	8	A+	19	16	35	70.00	8	A+	21	15	28	64.00	7	A	68.05	7.40	A	20	Pass
19	CUHP16CBB20	SAKSHI SINGH	14.75	17	26	57.75	6	B+	300	300.00	8	A+	36	36	62	134.00	7	A	22	16	29	67.00	7	A	18	16	39	73.00	8	A+	17	14	27	58.00	6	B+	68.98	7.30	A	20	Pass
20	CUHP16CBB21	SAVITA CHOUDHARY	14.5	19	32	65.50	7	A	244	244.00	7	A	32	33	65	130.00	7	A	22	17	33	72.00	8	A+	16	15	38	69.00	7	A	17	14	25	56.00	6	B+	63.65	7.00	A	20	Pass
21	CUHP16CBB22	SHEFALI CHAUDHARY	18.5	20	34	72.50	8	A+	312	312.00	8	A+	34	35	62	131.00	7	A	21	19	37	77.00	8	A+	19	15	37	71.00	8	A+	19	14	29	62.00	7	A	72.55	7.70	A+	20	Pass
22	CUHP16CBB23	SHIKHA	16	18	31	65.00	7	A	248	248.00	7	A	32	31	64	127.00	7	A	21	16	32	69.00	7	A	18	16	35	69.00	7	A	18	14	24	56.00	6	B+	63.40	6.90	A	20	Pass
23	CUHP16CBB24	SHILPA DEVI	15.75	18	35	68.75	7	A	340	340.00	9	O	32	33	65	130.00	7	A	20	17	35	72.00	8	A+	20	20	35	75.00	8	A+	21	16	33	70.00	8	A+	75.58	8.10	A+	20	Pass
24	CUHP16CBB25	SHILPA SHARMA	18	17	35	70.00	8	A+	268	268.00	7	A	37	36	59	132.00	7	A	23	20	33	76.00	8	A+	17	16	37	70.00	8	A+	19	13	25	57.00	6	B+	67.30	7.20	A	20	Pass
25	CUHP16CBB26	SHIVANI DHIMAN	16.75	16	33	65.75	7	A	324	324.00	9	O	33	33	71	137.00	7	A	21	18	33	72.00	8	A+	17	16	40	73.00	8	A+	18	12	22	52.00	5	B	72.38	7.80	A+	20	Pass
26	CUHP16CBB27	SHIVANI DHIMAN	16.5	16	28	60.50	7	A	280	280.00	8	A+	30	32	64	126.00	7	A	21	17	34	72.00	8	A+	18	14	37	69.00	7	A	17	13	27	57.00	6	B+	66.45	7.40	A	20	Pass
27	CUHP16CBB28	SHIVANI THAKUR	14.5	18	33	65.50	7	A	272	272.00	7	A	35	31	72	138.00	7	A	22	17	36	75.00	8	A+	16	15	39	70.00	8	A+	17	13	24	54.00	5	B	67.45	7.00	A	20	Pass
28	CUHP16CBB29	SWETA DEVI	14.5	18	36	68.50	7	A	328	328.00	9	O	39	42	82	163.00	9	O	22	20	39	81.00	9	O	22	22	39	83.00	9	O	21	17	36	74.00	8	A+	79.75	8.70	O	20	Pass
29	CUHP16CBB30	VISHAL BHAT	16.5	14	26	56.50	6	B+	220	220.00	6	B+	28	34	54	116.00	6	B+	19	18	16	37.00		F	17	15	28	60.00	7	A	17	12	21	50.00	5	B	55.83	6.00	B+	18	Fail

Abbreviations:	Percentage of Marks	GP	LG	Description of the Letter Grade
CIA: Cumulative Internal Assessment	90-100	10	O+	Outstanding
MTE: Mid-term Examination	80-89	9	O	Excellent
ESE: End Semester Examination	70-79	8	A+	Very Good
GP: Grade Point	60-69	7	A	Good
LG: Letter Grade	55-59	6	B+	Average
SPM: Semester Percentage Mark	50-54	5	B	Pass
SGPA: Semester Grade Point Average	00-49	-	F	Fail
SLG: Semester Letter Grade	Absent	-	Ab	
CGPA: Cumulative Grade Point	Incomplete	-	I	

Checked by \_\_\_\_\_ Prepared by \_\_\_\_\_

Controller of Examinations

CGPA/SGPA Range	LG	Description of the Letter Grade
9.50 - 10.00	O+	Outstanding
8.50 - 9.49	O	Excellent
7.50 - 8.49	A+	Very Good
6.50 - 7.49	A	Good
5.50 - 6.49	B+	Average
5.00 - 5.49	B	Pass
0 - 4.99	F	Fail

Central University of Himachal Pradesh  
(Established Under Central Universities Act 2009)

IV Semester Examination Result: M.Sc. Computational Biology & Bioinformatics (Academic Year 2018-19) held in June 2019

Sr. No.	Registration / Enrolment No.	Course Code	CBB 428						CBB 499A						CBB 513						CBB 522						CBB 523						CBB 525						Grand Total			Remarks
			Credits						8						4						2						2						2									
			25	25	50	100			200	400			50	50	100	200			25	25	50	100			25	25	50	100			25	25	50	100			SPM	SGPA	SLG	Credits Earned		
Maximum Marks						Total Mark Obtained						Total Mark Obtained						Total Mark Obtained						Total Mark Obtained						Total Mark Obtained												
Name of the Student		CIA	MTE	ESE	Total Mark Obtained	GP	LG	ESE	Total Mark Obtained	GP	LG	CIA	MTE	ESE	Total Mark Obtained	GP	LG	CIA	MTE	ESE	Total Mark Obtained	GP	LG	CIA	MTE	ESE	Total Mark Obtained	GP	LG	CIA	MTE	ESE	Total Mark Obtained	GP	LG	SPM	SGPA	SLG	Credits Earned			
1	CUHP17CBB01	AKRUTI SHARMA	22	21	33	76.00	8	A+	320	320.00	9	O	40	23	84	147.00	8	A+	19	20	36	75.00	8	A+	21	15	34	70.00	8	A+	20	21	37	78.00	8	A+	76.60	8.40	A+	20	Pass	
2	CUHP17CBB03	APARNA BHARDWAJ	23	22	41	86.00	9	O	320	320.00	9	O	42	42	77	161.00	9	O	22	18	41	81.00	9	O	21	18	39	78.00	8	A+	21	22	38	81.00	9	O	80.70	8.90	O	20	Pass	
3	CUHP17CBB04	DEEPANSHI AWASTHI	23	23	44	90.00	10	O+	340	340.00	9	O	43	44	80	167.00	9	O	24	22	43	89.00	9	O	22	23	47	92.00	10	O+	24	23	46	93.00	10	O+	87.10	9.30	O	20	Pass	
4	CUHP17CBB05	DEEPIKA	22	21	34	77.00	8	A+	280	280.00	8	A+	41	40	71	152.00	8	A+	15	17	34	66.00	7	A	19	19	36	74.00	8	A+	21	20	34	75.00	8	A+	72.40	7.90	A+	20	Pass	
5	CUHP17CBB06	DEEPIKA BHARMORIA	20	19	31	70.00	8	A+	272	272.00	7	A	38	39	74	151.00	8	A+	18	14	42	74.00	8	A+	19	15	29	63.00	7	A	18	17	25	60.00	7	A	69.00	7.40	A	20	Pass	
6	CUHP17CBB08	IBHA THAKUR	20	19	26	65.00	7	A	260	260.00	7	A	38	19	54	111.00	6	B+	15	13	32	60.00	7	A	16	16	30	62.00	7	A	17	15	12	0		F	62.00	6.78	A	18	Fail	
7	CUHP17CBB09	JYOTI VERMA	21	19	27	67.00	7	A	304	304.00	8	A+	38	30	61	129.00	7	A	15	14	39	68.00	7	A	19	19	36	74.00	8	A+	18	14	32	64.00	7	A	70.60	7.50	A+	20	Pass	
8	CUHP17CBB10	KAJAL SHARMA	21	20	25	66.00	7	A	268	268.00	7	A	38	23	73	134.00	7	A	16	18	34	68.00	7	A	18	15	31	64.00	7	A	16	15	24	55.00	6	B+	65.50	6.90	A	20	Pass	
9	CUHP17CBB11	KANCHAN BALA	20	18	25	63.00	7	A	240	240.00	7	A	38	18	63	119.00	6	B+	15	13	31	59.00	6	B+	16	14	28	58.00	6	B+	15	14	14	0		F	59.89	6.56	A	18	Fail	
10	CUHP17CBB14	MUKUL KUMAR	21	19	38	78.00	8	A+	304	304.00	8	A+	40	28	88	156.00	8	A+	19	19	39	77.00	8	A+	19	19	35	73.00	8	A+	17	20	25	62.00	7	A	75.00	7.90	A+	20	Pass	
11	CUHP17CBB15	NAVEEN CHAUDHARY	20	13	23	56.00	6	B+	264	264.00	7	A	37	25	59	121.00	7	A	16	15	30	61.00	7	A	17	14	30	61.00	7	A	16	15	15	0		F	62.56	6.89	A	18	Fail	
12	CUHP17CBB16	PANKAJ KUMAR	19	14	26	59.00	6	B+	280	280.00	8	A+	37	30	68	135.00	7	A	15	15	33	63.00	7	A	14	16	30	60.00	7	A	17	16	19	0		F	66.33	7.33	A	18	Fail	
13	CUHP17CBB17	PAWANA DEVI	16	20	A	#VALUE!	##	##	292	292.00	8	A+	36	27	A	#VALUE!	##	##	18	14	A	#VALUE!	##	##	17	17	A	#VALUE!	##	##	14	18	A	#VALUE!	##	##	#VALUE!	##	##	#VALUE!	#####	Fail
14	CUHP17CBB18	POONAM	21	21	32	74.00	8	A+	300	300.00	8	A+	38	37	74	149.00	8	A+	18	13	37	68.00	7	A	19	16	33	68.00	7	A	17	17	38	72.00	8	A+	73.10	7.80	A+	20	Pass	
15	CUHP17CBB19	RUPINDER KAUR	21	20	27	68.00	7	A	260	260.00	7	A	38	34	74	146.00	8	A+	16	12	36	64.00	7	A	16	13	34	63.00	7	A	16	18	30	64.00	7	A	66.50	7.20	A	20	Pass	
16	CUHP17CBB20	SACHIN SHARMA	23	14	35	72.00	8	A+	336	336.00	9	O	41	40	66	147.00	8	A+	19	16	36	71.00	8	A+	20	20	38	78.00	8	A+	17	20	37	74.00	8	A+	77.80	8.40	A+	20	Pass	
17	CUHP17CBB21	SAKSHI	22	15	35	72.00	8	A+	288	288.00	8	A+	39	35	68	142.00	8	A+	20	16	35	71.00	8	A+	21	17	39	77.00	8	A+	19	17	36	72.00	8	A+	72.20	8.00	A+	20	Pass	
18	CUHP17CBB22	SHIKHA SHARMA	23	22	36	81.00	9	O	268	268.00	7	A	38	38	69	145.00	8	A+	18	14	38	70.00	8	A+	20	18	38	76.00	8	A+	19	22	33	74.00	8	A+	71.40	7.70	A+	20	Pass	
19	CUHP17CBB23	SHIVALI DOGRA	20	16	24	60.00	7	A	272	272.00	7	A	38	17	70	125.00	7	A	15	11	33	59.00	6	B+	18	16	29	63.00	7	A	16	12	15	0		F	64.33	6.89	A	18	Fail	
20	CUHP17CBB24	SWATI	22	16	29	67.00	7	A	268	268.00	7	A	39	32	67	138.00	7	A	16	14	36	66.00	7	A	19	14	31	64.00	7	A	19	16	32	67.00	7	A	67.00	7.00	A	20	Pass	
21	CUHP17CBB25	TANIYA CHANDEL	20	16	29	65.00	7	A	268	268.00	7	A	37	30	62	129.00	7	A	17	16	37	70.00	8	A+	16	15	33	64.00	7	A	15	16	15	0		F	66.22	7.11	A	18	Fail	
22	CUHP17CBB26	VARSHA KUMARI	21	17	33	71.00	8	A+	340	340.00	9	O	40	31	59	130.00	7	A	22	13	38	73.00	8	A+	22	17	34	73.00	8	A+	14	16	34	64.00	7	A	75.10	8.10	A+	20	Pass	
23	CUHP17CBB27	VISHALI	21	15	30	66.00	7	A	260	260.00	7	A	37	30	67	134.00	7	A	16	18	40	74.00	8	A+	16	18	32	66.00	7	A	17	19	32	68.00	7	A	66.80	7.10	A	20	Pass	

Prepared by

Checked by

Controller of Examinations

Abbreviations:	Percentage of Marks	GP	LG	Description of Letter
CIA: Cumulative Ir	90-100	10	O+	Outstanding
MTE: Mid-term Ex	80-89	9	O	Excellent
ESE: End Semeste	70-79	8	A+	Very Good
GP: Grade Point	60-69	7	A	Good
LG: Letter Grade	55-59	6	B+	Average
SPM: Semester Pe	50-54	5	B	Pass
SGPA: Semester G	00-49	-	F	Fail
SLG: Semester Let	Absent	-	Ab	
CGPA: Cumulative	Incomplete	-	I	

CGPA/SGP A Range	LG	Description of the Letter
9.50 - 10.00	O+	Outstanding
8.50 - 9.49	O	Excellent
7.50 - 8.49	A+	Very Good
6.50 - 7.49	A	Good
5.50 - 6.49	B+	Average
5.00 - 5.49	B	Pass
0 - 4.99	F	Fail