TIGP Bio 2024 Spring Syllabus

Basic Molecular Biology II (B2)

For the latest syllabus, please visit the BP website: https://idv.sinica.edu.tw/tigpbio/

Place: Room 308, Institute of Statistical Science, Academia Sinica

Time: Tuesday 09:00-12:00

Chair: Dr. Ho-Ming Chen (homing@gate.sinica.edu.tw)

Aim: Introduce key concepts and methods to manage, integrate and analyze bio big data in the era of post-genomics life sciences

Outline: Big Data in Bioinformatics - From Data-Driven Analysis to Knowledge

Textbook: (Reference books, not required)
1. Scalable Big Data Analytics for Protein Bioinformatics [Publisher: Springer; 1st ed. 2018 edition (September 26, 2018)]
2. Computational Intelligence and Big Data Analytics: Applications in Bioinformatics [Publisher: Springer; 1st ed. 2019 edition (September 9, 2018)]
3. Big Data in Omics and Imaging [Publisher: Chapman and Hall/CRC; 1 edition (June 19, 2018)]
4. Big Data Analytics in Genomics [Publisher: Springer; Softcover reprint of the original 1st ed. 2016 edition (April

TA: N/A (Please refer to the lectures respectively shall you have any questions for each class)

Grades: Midterm exam 50%. Final exam 50%.

【For Non-BP student】

For Non-BP student to register/sit-in any BP course, it is required to gain course chair's permission:

(1) Basic Enrollment Information form: https://forms.gle/oK7vJzzrx9EvybbT9
(2) TIGP-BP Course Registration Consent Form
https://idv.sinica.edu.tw/tigpbio/index/TIGP%20Bioinformatics_Class%20Registration%20Consent%20Form.docx

※ Deadline: **the 4th week** of each semester.
※ Signature of the course chair should be collected before submission. Incomplete form will not be accepted.
※ Course grade will NOT be given (even class enrollment is completed at school) if fail to follow the procedures.

Week	Date	Topics/Brief Description	Lecturers	Evaluation Method	Email
1	2024/2/20 @Webex Only	Genomics and Genome Analysis	Dr. Ueng-Cheng Yang	HW with a specified deadline: ▶ March 5th (**MUST** CC mmtu0103@gmail.com)	uyang@nycu.edu.tw
2	2024/2/27	NGS Analytics - Comparative and Evolutionary Genomics	Dr. I-Sheng Tsai	In-class exam on midterm exam date	ijtsai@gate.sinica.edu.tw
3	2024/3/5	Genome Assemblies and Annotations	Dr. I-Sheng Tsai		
4	2024/3/12	Epigenomics	Dr. Pao-Yang Chen	In-class exam on midterm exam date (open-book)	paoyang@gate.sinica.edu.tw
5	2024/3/19 @Webex Only	Microbiome	Dr. Sen-Lin Tang	HW with a specified deadline: ▶ April 30th (**MUST** CC BP office)	sltang@gate.sinica.edu.tw
6	2024/3/26	Metagenomics	Dr. Sen-Lin Tang		
7	2024/4/2	Review Week (no class)	--	--	--
8	2024/4/9	Midterm Exam	--	--	--
9	2024/4/17 (Wed) 14:00-17:00 @Webex Only	Medical Genomics	Dr. Tai-Ming Ko	HW with a specified deadline: ▶ May 2nd	taiming23@gmail.com
10	2024/4/23	Structural Bioinformatics in Pharmacogenomics	Dr. Jung-Hsin Lin	HW with a specified deadline: ▶ June 4th	jhlin@gate.sinica.edu.tw
11	2024/4/30	Population Genomics	Dr. Jen-Pan Huang	HW with a specified deadline: ▶ by 5 PM on May 24th	jphuang@gate.sinica.edu.tw
12	2024/5/7	Transcriptomics	Dr. Ho-Ming Chen	HW with a specified deadline: ▶ by 11 PM on May 30th	homing@gate.sinica.edu.tw
13	2024/5/14 @Webex Only	Metabolomics	Dr. Yufeng Jane Tseng	HW with a specified deadline: ▶ by 5 PM on May 30th	yjtseng@csie.ntu.edu.tw
14	2024/5/21	Proteomics Informatics	Dr. Wailap Victor Ng	HW with a specified deadline: ▶ June 4th	wailap.ng@gmail.com
15	2024/5/28	Review Week (no class)	--	--	--
16	2024/6/4	Final Exam (take-home exams, no class)	--	--	--

TIGP Bioinformatics Program 2024 Spring Syllabus

Advanced Algorithms (C2)

For the latest syllabus, please visit the BP website: https://idv.sinica.edu.tw/tigpbio/

Place: Room 308, Institute of Statistical Science, Academia Sinica

Time: Friday 14:00-17:00

Chair: Dr. Chien-Yu Chen (chienyuchen@ntu.edu.tw)

Outline: This course is basically about data mining, machine learning and statistical modeling from data, and some other algorithms and applications.

Resources:

There are 7 topics given in the way of **Videos Preview** (about 2~3 hours) + **In-class discussions** (about 1~1.5 hours).

Please find the link (**https://bit.ly/41vGP3G**) that WILL provide the links of the following:

(1) the videos to be watched BEFORE the class

(2) the questions to be discussed IN the class

(3) the homework to be completed AFTER the class

References:

1. Learning from Data- A Short Course (Abu-Mostafa, Magdon-Ismail, Lin, 2012)
2. Learning Pattern Classification (Duda, Harg, and Stork, 2001)
3. An Introduction to Support Vector Machines and Other Kernel-based Learning Methods
   (Cristianini and Shawe-Taylor, 2000)
4. [DL in Life Science] https://mit6874.github.io/
5. [ML for Genomics] https://www.classcentral.com/course/youtube-6-047-6-878-machine-learning-for-genomics-fall-2020-48203

TA: Daniel Garcia-Ruiz   **Email:** gard_ruiz@hotmail.com

Office hours: Thursdays 12:00 ~14:00 pm

Office location: https://meet.google.com/did-zxfu-iyf?pli=1

Grades: Midterm exam 50%. Final exam 50%.

【**For Non-BP student**】

For Non-BP student to register/sit-in any BP course, it is required to gain course chair's permission:

(1) Basic Enrollment Information form https://forms.gle/oK7vJzzrx9EvybbT9

(2) TIGP-BP Course Registration Consent Form

https://idv.sinica.edu.tw/tigpbio/index/TIGP%20Bioinformatics_Class%20Registration%20Consent%20Form.docx

※ Deadline: **the 4th week** of each semester.

※ Signature of the course chair should be collected before submission. Incomplete form will not be accepted.

※ Course grade will NOT be given (even class enrollment is completed at school) if fail to follow the above procedures.

Week	Date	Topics/Brief Description	Lecturers	Lecture Style	Evaluation Method	Email
1	2024/2/23	Data Classification	Dr. Li Su	Lectures	HW with a specified deadline ▶ April 12th	lisu@iis.sinica.edu.tw
2	2024/3/1 @Webex Only	Boolean and Bayesian networks	Dr. Horng-Shing Lu	Online Lectures	HW with a specified deadline: ▶ April 12th	henryhslu@nycu.edu.tw
3	2024/3/8	Hidden Markov Models	Dr. Yu Tsao	Lectures	In-class exam on midterm exam date	yu.tsao@citi.sinica.edu.tw
4	2024/3/15@16:20 Webex Only	Convolutional Neural Networks, Recurrent Neural Networks (optional: Graph Neural Networks)	Dr. Che Lin	Preview videos + online discussions	HW with a specified deadline: ▶ April 12th	chelin@ntu.edu.tw
5	2024/3/22 Webex Only	[DL in Life Science] GWAS and Variants	Dr. Tzu-Pin Lu	Preview videos + online discussions	HW with a specified deadline: ▶ April 5th	tplu@ntu.edu.tw
6	2024/3/29	Single cell RNA-seq	Dr. Yao-Ming Chang	Preview videos + in-class discussions	HW with a specified deadline: ▶ April 19th (was April 12th)	petitming@ibms.sinica.edu.tw
7	2024/4/5	National Holiday & Review Week (no class)	--	--	--	--
8	2024/4/12	Midterm Exam	--	--	--	--
9	2024/4/19	Network Analysis	Dr. Hsuan-Cheng Huang	Lectures	HW with a specified deadline: ▶ May 10th	hsuancheng@nycu.edu.tw
10	2024/4/26	[DL in Life Science] Graph Analysis [DL in Life Science] Drug Discovery	Dr. Yueh-Hua Tu	Preview videos + in-class discussions	HW with a specified deadline: ▶ May 17th	a504082002@gmail.com
11	2024/5/3	[DL in Life Science] Protein Structure Prediction	Dr. Chien-Yu Chen	Preview videos + in-class discussions	HW with a specified deadline: ▶ May 17th	chienyuchen@ntu.edu.tw
12	2024/5/8 (Wed) 14:00-17:00	Advanced Algorithms for Proteomics	Dr. Ching-Tai Chen	Preview videos + in-class discussions	HW with a specified deadline: ▶ June 7th	ctchen@asia.edu.tw
13	2024/5/17 Webex Only	Systems Biology and Biological Modeling of Gene Regulation	Dr. Yu-Chao Wang	Preview videos + online discussions	HW with a specified deadline: ▶ May 31st	yuchao@nycu.edu.tw
14	2024/5/24	Exploring modeling in enzyme kinetics and pharmacokinetics	Dr. An-Chi Wei	Lectures	HW with a specified deadline: ▶ June 7th	acwei86@ntu.edu.tw
15	2024/5/31	Review Week (no class)	--	--	--	--
16	2024/6/7	Final Exam (take-home exams, no class)	--	--	--	--

TIGP Bio 2024 Spring Syllabus
Advanced Statistical Methods in Bioinformatics (S2)

For the latest syllabus, please visit the BP website: https://idv.sinica.edu.tw/tigpbio/

Place: Room 308, Institute of Statistical Science, Academia Sinica

Time: Thursday 9:00-12:00

Chair: Dr. Grace S. Shieh (gshieh@stat.sinica.edu.tw)

Outline: Introduction to useful and advanced statistical methods in computational biology. The topics include: Analysis of next generation sequencing (NGS) Data (e.g., RNA-Seq and ChIP-Seq), maximum likelihood estimation, the EM algorithm, Bayesian inference, Monte Carlo methods, Resampling (Bootstrap & permutation test), Human Genetics, clustering and classification, dimension-reduction and missing data.

Textbook: N/A

TA: Rodrigo Espinoza Silva   **Email:** rodespinosas93@gmail.com

Office hours: Tuesdays 14:00~16:00 pm

Office location: Room 5021-3, Research Center for Environmental Changes Building (5th floor, ISS), Academia Sinica

Grades: Midterm exam 50%. Final exam 50%.

【For Non-BP student】

For Non-BP student to register/sit-in any BP course, it is required to gain course chair's permission:

(1) Basic Enrollment Information form: https://forms.gle/oK7vJzzrx9EvybbT9

(2) TIGP-BP Course Registration Consent Form:
https://idv.sinica.edu.tw/tigpbio/index/TIGP%20Bioinformatics_Class%20Registration%20Consent%20Form.docx

※ Deadline: **the 4th week** of each semester.

※ Signature of the course chair should be collected before submission. Incomplete form will not be accepted.

※Course grade will NOT be given (even class enrollment is completed at school) if fail to follow the above procedures.

Week	Date	Topics/Brief Description	Sub-topics/Detail Descriptions	Lecturers	Evaluation Method	Email
1	2024/2/21 (Wed) 9:00~12:00	Analysis of NGS data I	Analysis of DNA sequencing data	Dr. Shih-Kai Chu	HW with a specified deadline: ▶ April 11th	uhcnivag@gm.ntpu.edu.tw
2	2024/3/1 (Fri) 9:00~12:00	Analysis of NGS data II	Analysis of RNA sequencing data	Dr. Shih-Kai Chu		
3	2024/3/7	Maximum likelihood estimates and the EM algorithm I	Maximum likelihood estimates	Dr. Yen-Tsung Huang	HW with a specified deadline: ▶ April 11th	ythuang@stat.sinica.edu.tw
4	2024/3/13 (Wed) 9:00~12:00	Maximum likelihood estimates and the EM algorithm II	The EM algorithm	Dr. Yen-Tsung Huang		
5	2024/3/21	Bayesian Statistics	prior dist., conjugate families & applications to genetics	Dr. Grace S. Shieh	In-class exam on midterm exam date	gshieh@stat.sinica.edu.tw
6	2024/3/28	Resampling methods	Bootstrap for hypothesis testing , confidence interval, and Permutation method	Dr. Grace S. Shieh	HW with a specified deadline: ▶ 6:00 PM, April 26th	
7	2024/4/3 (Wed) 9:00~12:00	Monte Carlo Markov Chains	Monte Carlo Markov Chains	Dr. Shin-Sheng Yuan	HW with a specified deadline: ▶ April 22nd	syuan@stat.sinica.edu.tw
8	2024/4/11	Midterm Exam	--	--	--	
9	2024/4/18	Prediction of Drug Response	Feature selction, logistic ridge, KNN, ML and transfer learning	Dr. Grace S. Shieh	No exam. (was HW with a specified deadline)	gshieh@stat.sinica.edu.tw
10	2024/4/25	Cluster Analysis	K-Means, Hierarchical Clustering, Heatmap, Cluster Validation	Dr. Han-Ming Wu	HW with a specified deadline: ▶ June 6th	wuhm@g.nccu.edu.tw
11	2024/5/2	Classification and Its Assessment	ROC Curve, Decision Tree, Ensemble Methods	Dr. Han-Ming Wu		
12	2024/5/9	Statistics in Human Genetics/Genomics I	Concept of Statistical Genetics, International Genomic Projects, Linkage Analysis, Genetic Association Analysis	Dr. Hsin-Chou Yang	HW with a specified deadline: ▶ June 10th	hsinchou@stat.sinica.edu.tw
13	2024/5/16	Statistics in Human Genetics/Genomics II	Genome-Wide Association Study, Gene-Gene Interaction, Rare Variant Analysis, Polygenic Risk Score	Dr. Hsin-Chou Yang		
14	2024/5/23	Advanced regression and dimension reduction I	Sliced Inverse Regression and PHD	Dr. Shin-Sheng Yuan	HW with a specified deadline: To Be announced	syuan@stat.sinica.edu.tw
15	2024/5/30	Advanced regression and dimension reduction II	Liquid Association and related developments	Dr. Kang-Chung Yang		kcyang@stat.sinica.edu.tw
16	2024/6/6	Final Exam	--	--	--	

TIGP Bio 2024 Spring Syllabus
Seminar

Announcement: https://www.stat.sinica.edu.tw/cht/index.php?

Place: Auditorium, B1F, Institute of Statistical Science, Academia Sinica.

Time: Thursday 14:00-15:20

Chair: Academia Sinica: Dr. Chung-Yen Lin (Informatics), Dr. Chien-Ling Lin (Biology), Dr. Wei-Chung Liu (Statistics)

Remarks (due on June 13th):

 Step 1 Attend any 2 non-BP Seminars—either on campus or off campus is acceptable—and send 2 seminar reports in the specified format (1-page A4, 12pts font, single-spaced) titled "**TIGP-BP Seminar Student Report** (click to download)" to your advisor/lab professor. The 2 chosen non-BP seminars should be conducted in English and attended within the current semester (i.e. February 19th to June 13th).

 Step 2 Once your reports have been graded and signed by the advisor/lab professor, kindly submit them to the TIGP-BIO office (tigpbio@gate.sinica.edu.tw) before the deadline of June 13th, 2024.

Grades: Attendance 100% (2 non-BP seminar reports included)

Week	Date	Topics/Brief Description	Speaker's Affiliation	Speaker	Abstract	Student Host
1	2024/2/22 @Webex Only	Plasma-Based Cancer Detection: A Machine Learning Enabled Multiomics Approach	Electrical Engineering Department, National Taiwan University	Prof. Tzu-Yu (Joyce) Liu	⧉	Ping-Yun Ou (1)
2	2024/2/26 (Mon) 10:00-11:20 @R308	Adapting to Adaptive: Evolutionary Insights into Biological Networks and Stress Readiness in Land Plants	Institute of Plant and Microbial Biology, Academia Sinica	Dr. Ting-Ying Wu	⧉	Daniel Garcia-Ruiz (1)
3	2024/3/7 Rescheduled to 3/11	Rescheduled to 3/11	--	--	--	--
4	2024/3/11(Mon) 14:00-15:20 @Webex Only	AI in Drug Discovery	Graduate Institute of Biomedical Engineering and Bioinformatics, National Taiwan University	Prof. Yufeng Jane Tseng	⧉	Cai-Sian Liao (1)
4	2024/3/14	Viral epitranscriptomics: reverse transcribing viruses utilizing RNA methylations for efficient replication	Institute of Biomedical Sciences, Academia Sinica	Dr. Kevin Tsai	⧉	Yu-Ching Hsu (1)

5	2024/3/21 **Cancelled**	Please refer to the remark (no class)	Department of Biomechatronics Engineering, National Taiwan University	Prof. Chien-Yu Chen	--	Ping-Yun Ou (2)
6	2024/3/28	Link prediction via exploring common neighborhoods	Institute of Statistical Science, Academia Sinica	Dr. Tso-Jung Yen	⬀	Tzu-Hsiang Lin (1)
7	2024/4/4	National Holiday (no class)	--	--	--	--
8	2024/4/11	Midterm Exam Week (no class)	--	--	--	--
9	2024/4/18	A flexible NoSQL database for agriculture field trial using a cloud server	Department of Agronomy, National Taiwan University	Prof. Steven Hung-Hsi Wu	⬀	Daniel Garcia-Ruiz (2)
10	2024/4/25 **Cancelled**	Please refer to the remark (no class)	Institute of Statistical Science, Academia Sinica	Dr. Grace S. Shieh	--	Cai-Sian Liao (2)
11	2024/5/2	Understanding the genome-wide transcription cis-regulation in Drosophila using deep learning	Department of Biomedical Engineering, National Cheng Kung University	Prof. Tzu-Hsien Yang	⬀	Tzu-Hsiang Lin (2)
12	2024/5/9 @Webex Only	Unraveling the Dynamics of Genome Alteration in Embryonic Neural Progenitor Cells	German Cancer Research Center (DKFZ), Germany	Dr. Pei-Chi Wei	⬀	Shang-Kok Ng
13	2024/5/16	Big Data & AI in Biomedical Research : A Perspective View from ITRI	・Graduate Institute of Biomedical Electronics and Bioinformatics, National Taiwan University ・Biomedical Technology and Device Research Laboratories, Industrial Technology Research Institute	Prof. Eric Y. Chuang	⬀	Rodrigo Espinoza Silva
14	2024/5/23	Harnessing polygenic architectures for disease risk and health outcome prediction	Institute of Health Data Analytics and Statistics, National Taiwan University	Prof. Yen-Chen Anne Feng	⬀	Yu-Ching Hsu (2)
15	2024/5/27 (Mon) 14:00-15:20	Single-cell transcriptomics reveals growth factor signaling in pancreatic neuroendocrine tumors	Rutgers Cancer Institute of New Jersey, New Brunswick, New Jersey	Dr. Chang S. Chan	⬀	Dr. Chen-Hsiang Yeang
16	2024/6/6	Final Exam Week (no class)	--	--	--	--

TIGP-Bio 2024 Spring Syllabus & Guidelines
Student Presentation

Latest syllabus: https://idv.sinica.edu.tw/tigpbio/

Place: Online (Skype): https://join.skype.com/ycvKdxnlMeku

Time: Thursday, 15:30-17:00

Chair: Dr. Chen-Ching Lin (chenching.lin@nycu.edu.tw)

*Effective from the 2014 Fall semester, all TIGP-BP students are required to present once a semester in student presentation.

*First Year Students: the paper should be assigned by your lab professor.

*The following schedule is confirmed and will not be changed. Please contact Dr. Chen-Ching Lin if you do have difficulty with the assigned date.

*The presenter shall introduce the host and attended professors at the beginning of each seminar.

Week	Date	Topic	Student
1	2024/2/22	No Class	--
2	2024/2/29	No Class	--
3	2024/3/7	Inferring single-cell gene regulatory network by non-redundant mutual information	Ping-Yun Ou 歐秉昀
4	2024/3/14	Assembly theory explains and quantifies selection and evolution	Daniel Garcia-Ruiz 加西亞丹尼爾
5	2024/3/21	Biology-aware mutation-based deep learning for outcome prediction of cancer immunotherapy with immune checkpoint inhibitors	Chien-Jung Huang 黃千容
6	2024/3/28	VEGA is an interpretable generative model for inferring biological network activity in single-cell transcriptomics	Shang-Kok Ng 黃襄國
7	2024/4/4	National Holiday & Review Week (no class)	--
8	2024/4/11	Midterm Exam (no class)	--
9	2024/4/18	A statistical method for image-mediated association studies discovers genes and pathways associated with four brain disorders	Cai-Sian Liao 廖才嫻
10	2024/4/25	--	--
11	2024/5/2	--	--
12	2024/5/9	--	--
13	2024/5/16	--	--
14	2024/5/23	--	--
15	2024/5/30	Review Week (no class)	--
16	2024/6/6	Final Exam (no class)	--

< Seminar presentation guidelines on the following pages >

Seminar presentation guidelines for Ph.D. program students:

2023-01-18

This <u>research</u> seminar course is intended to provide students planning a research career in Bioinformatics with the opportunity to develop the skill of <u>critically reading and</u> <u>evaluating research papers</u>. The course consists of a weekly timetabled session in which students will read, present and discuss research papers published on high impact journals. A fixed threshold of impact factors is not imposed. Use your common sense instead.

Guidelines:

1. **Research article**: Each week, students will choose RESEARCH papers to be presented. The paper (+ supplements) pdf file should be emailed to <u>chenching.lin@nycu.edu.tw</u> (Dr. Chen- Ching Lin), <u>tigpbio@gate.sinica.edu.tw</u> (TIGP-Bioinformatics Program), all students in student presentation class, and also other participating professors at least one week before your in-class seminar presentation takes place. Any delay will result in 10 points deducted from your final grade. Please also send the slides to everyone 2 days before the report. Because some modifications may be made right before the report, it is okay if the slides are not the final version.

1. **Article selection:** You are required to select a recent RESEARCH article that was published after September 2020. (Review articles are NOT acceptable.)

2. **Presentations**: Everyone in the class will present one paper. You should plan to talk for around 40 minutes. Starting from this you should initiate a discussion of the paper (so it is a good idea to conclude your slide presentation with a selection of points to consider and discuss). We should plan to <u>have time for a lively discussion of each paper; your job in giving a presentation is to initiate this discussion</u>. Make sure to
   a. Draw **valid** conclusions from results of your presented paper.
   b. Summarize evidence for each conclusion. (How does the paper support its conclusions?)
   c. Compare the results with other similar experiments published previously, if appropriate.

   ■ Please refrain from presenting an article written by your supervisor or your friends/classmates. You need to increase the exposure to the breadth and depth of bioinformatics research.
   ■ Students are encouraged to prepare a few questions for group discussion at the end of the

presentation. Students are not expected to simply sit in the class.

■ Please make a rehearsed presentation if you don't know how long your presentation is going to last. An over-length presentation doesn't translate to a good one.

3. **Language of presentation**: You are required to present your research article in English.

Evaluation Criteria:

You will be evaluated by the following criteria:
1. Your seminar presentation (70%).
2. Your participation of discussion (30%).
   Note: you must participate the discussion, e.g., at least asking one question in each presentation, to obtain this 30% of your final grade. If you don't ask question in any class, this grade will be zero.

TIGP Bio 2024 Spring Syllabus

Lab Rotation

Dear 1st year student:

1. Your lab advisor must be one of the BP core faculty.

2. Inform the BP office for the laboratory you are rotating by March 1st, 2024.

3. Submit the Lab Rotation Form with lab advisor's signatures and score to the BP office by June 13th, 2024.

Student (2023 enrolled)	Lab advisor
Cai-Sian Liao 廖才嫺	Huai-Kuang Tsai 蔡懷寬