

Course Organization

MCB 406 Gene Expression & Regulation (CRN: 62528)

Course description:

MCB 406 is a lecture-discussion course that provides in-depth and up-to-date coverage of gene expression and regulation. Lectures are centered on the principles of regulating gene expression in eukaryotic cells. The course covers molecular mechanisms of the key gene expression events including transcription, RNA processing, mRNA localization, translation and degradation, as well as macromolecule structures and functions in gene expression and regulation. Applications of these principles in medicine and therapeutics such as aging, cancer biology and drug design are also discussed.

Prerequisite: MCB 354

Course Objectives:

- Understand molecular mechanisms of the key gene expression events in eukaryotic cells
- Use chemistry and biochemistry knowledge to explore interdisciplinary research on gene expression
- Understand the many roles of RNA in gene expression
- Gain awareness of gene expression in therapeutics including drug design
- Develop skills for understanding and analyzing the primary scientific literature
- Develop skills for communicating scientific information at an advanced level

Duration: Jan 17th, 2017 – May 03, 2017
Tuesday and Thursday: 9:30am -10:50am
Location: 370 Armory

Instructor Contact Information

Prof. Hong Jin
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Lab Website: <http://publish.illinois.edu/hongjinlab/>

Office Hour (Professor): Tuesday 2:00-3:00pm
Location: RAL 493

TA: Ziqiao “Tim” Ding
Phone: (217)333-4939
Email: zding4@illinois.edu
Office Hour (TA) Wed. 4-6pm and Fri. 2:30-4:30pm
Location: CLSL A320

Textbooks

No specific textbook is required for this course.

Highly recommended books:

Biochemistry (4th Edition)

By Voet, Voet and Pratt, John Wiley & Sons, Inc, 2013 ISBN 978-0470-54784-7

Nucleic Acids: Structures, Properties, and Functions

By Bloomfield, Crothers, and Tinoco, University Science Books, Sausalito, 2000. ISBN 0-935702-49-0

RNA Worlds: From Life's Origins to Diversity in Gene Regulation

By John F. Atkins; Raymond F. Gesteland and Thomas R. Cech, 2011. ISBN 978-0-879699-46-8

RNA: A Laboratory Manual

By Donald C. Rio; Manuel Ares, Jr; Gregory J. Hannon and Timothy W. Nilsen, 2011
ISBN 978-0-879698-91-1

The above textbooks will be on reserve in the Funk library.

1101 S. Goodwin

Urbana, Illinois 61821

<http://www.library.illinois.edu/funkaces/>

Class handouts, recent review articles and original research articles will be posted on the course website (<https://moodle.life.illinois.edu>). They can also be accessed through the UIUC online journals.

Students are responsible for the material presented or assigned during lectures and the material on the handouts.

Disability Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TTY), or e-mail a message to disability@uiuc.edu.

Exams:

- There are three lecture examinations. The examinations are in closed book format
- The final examination will be a review and prospect paper on one of the two chosen research topics. The paper needs to be turned in **on or before May 10th, 2016.**

Grading procedures

Student grades in MCB 406 will be based on total of 1000 points

- Lecture Participation (and Quizzes): 100 points
- Homework: 250 points
- Discussion and Oral Presentation Participation: 150 points
- Three Lecture Exams: 300 points
- Final Exam (Research Paper): 200 points

A more specific point breakdown for MCB 406 follows:

- Lecture Participation (and Quizzes): 100 points
 - Lecture participation: 4 points each (25 lectures @ 4 points each)
- Homework: 250 points
 - Five homework sets: 50 points each
- Discussion and Oral Presentation Participation: 150 points
 - General discussion participation are expected for all
 - Three individual oral presentation and question sessions 50 points each
- Three Lecture Exams (non-accumulative): 300 points
 - Three exams: 100 points each
- Final Exam (Research Paper): 200 points

MCB 406: Gene Expression & Regulation

	Day	Date	Lecture Topics
1	Tu	Jan 17	<p>Introduction to MCB 406: An Overview of Gene Expression</p> <ul style="list-style-type: none"> ▪ Differences of gene expression in prokaryotes and eukaryotes ▪ Gene expression profiles in healthy and cancer cells ▪ The chemical structure and physical property of DNAs and RNAs ▪ Course organization, Grading and Office Hours
2	Thr	Jan 19	<p>Chromatin Structure and Remodeling</p> <ul style="list-style-type: none"> ▪ Nucleic acid structure ▪ Physical and chemical properties of nucleic acids ▪ Chromatin structure ▪ Chromatin remodeling
3	Tu	Jan 24	<p>Mechanisms of transcriptional regulation in gene expression:</p> <ul style="list-style-type: none"> ▪ Eukaryotic transcriptional apparatus ▪ RNA polymerase I, II, III ▪ Atomic structure of RNA polymerase II ▪ Actions of regulatory factors in transcription ▪ Transcriptional regulation and human disease
4	Thr	Jan 26	<p>Macromolecule structure, function and evolution I</p> <ul style="list-style-type: none"> ▪ Protein-DNA interactions in gene expression ▪ The DNA-binding Proteins and Their Recognition Motifs <p>Methods in studying gene expression I: Protein-nucleic acid interactions</p> <ul style="list-style-type: none"> ▪ General methods: in vivo and in vitro methods ▪ Gene cloning and manipulation ▪ Protein expression ▪ Protein and nucleic acid purification
5	Tu	Jan 31	<p>Mechanisms of post-transcriptional regulation in gene expression I: An Overview</p> <p>The World of RNA</p> <ul style="list-style-type: none"> ▪ Why RNA is So Important? ▪ Basic Physical and Chemical Properties of RNA <p>RNA Anatomy:</p> <ul style="list-style-type: none"> ▪ Nucleotide <ul style="list-style-type: none"> ▪ Phosphate backbones ▪ Sugar Puckers ▪ Bases ▪ Primary, Secondary and Tertiary Structures ▪ Helix Parameters ▪ Hydrogen bonds in the Watson-Crick, Hoogsteen and Base-Sugar edges of RNAs ▪ Common RNA structure motifs ▪ RNA Structure Model Building
6	Thr	Feb 02	<p>Methods in gene expression II: Tools for RNA Science</p> <ul style="list-style-type: none"> ▪ Biochemical and Biophysical Methods in Studying RNAs

			<ul style="list-style-type: none"> Probing gene expression in three dimensions: Structural Biology An introduction to X-ray crystallography
7	Tu	Feb 07	Non-coding RNAs in gene expression I: Catalytic RNAs <ul style="list-style-type: none"> A story of serendipity: The Discovery of Catalytic RNAs; the Group I Intron and RNase P Catalytic Mechanisms The RNA World Hypothesis Group II Introns Other Small Ribozymes: Hammerhead and HDV Ribozymes
	Thr	Feb 09	Examination I
8	Tu	Feb 14	RNA Folding <ul style="list-style-type: none"> Roles of RNA folding in gene expression Riboswitches and their Functions Macromolecule structure, function and evolution II <ul style="list-style-type: none"> Protein-RNA interactions in gene expression The RNA-binding Proteins and Their Recognition Motifs
9	Thr	Feb 16	Discussions on RNA, DNA Structures and Motifs
10	Tu	Feb 21	Discussions on Riboswitches and Ribozymes
11	Thr	Feb 23	Mechanisms of post-transcriptional regulation in gene expression II: RNA Processing 1 <ul style="list-style-type: none"> RNA processing in prokaryotes RNA processing in eukaryotes: Pre-mRNA splicing
12	Tu	Feb 28	Mechanisms of post-transcriptional regulation in gene expression III: RNA Processing 2 <ul style="list-style-type: none"> Spliceosome: Pre-mRNA Splicing Machinery Alternative Splicing and Organismal Complexity
13	Thr	Mar 02	Mechanisms of post-transcriptional regulation in gene expression IV: Overview of RNA export and localization, translation and degradation <ul style="list-style-type: none"> RNA export RNA localization
14	Tu	Mar 07	Discussions on Splicing and Human Disease I
15	Thr	Mar 09	Discussions on Splicing and Human Disease II
	Tu	Mar 14	Examination II
16	Thr	Mar 16	Mechanisms of post-transcriptional regulation in gene expression V: Translational regulation 1 <ul style="list-style-type: none"> General features of prokaryotic and eukaryotic translation Ribosome: Protein Synthesis Machine Mechanisms on Peptide Bond Formation and Peptide Release
Mar 20-Mar 24: Spring Break			
17	Tu	Mar 28	Mechanisms of post-transcriptional regulation in gene expression VI: Translational regulation 2 <ul style="list-style-type: none"> Translation initiation and control Eukaryotic ribosome Actions of regulatory factors in translation
18	Thr	Mar 30	Mechanisms of post-transcriptional regulation in gene expression VII: Translational regulation 3

			<ul style="list-style-type: none"> ▪ The translational apparatus: Assembly, Biogenesis and Diseases ▪ Functionally specialized ribosome: The forefront of the translational control <p>Extending Genetic Code with Catalytic RNAs</p>
19	Tu	Apr 04	Discussion on Translation and Expanding Genetic Code I
20	Thr	Apr 06	Discussion on Translation and Expanding Genetic Code II
21	Tu	Apr 11	RNA Degradation and Control
22	Thr	Apr 13	Non-coding RNAs in gene expression II: snoRNAs, snRNAs and microRNAs in development and disease Short non-coding RNAs and gene silencing
23	Tu	Apr 18	Non-coding RNAs in gene expression III: The long non-coding RNAs: Epigenetic regulation of gene expression
	Thr	Apr 20	Examination III
24	Tu	Apr 25	Mechanisms of post-translational regulation in gene expression
25	Thr	Apr 27	Spatial patterning of gene expression
26	Tu	May 02	A summary of gene expression and regulation in eukaryotes Applications in human health and disease RNA and RNPs in Disease and Therapeutics
	Tu	May 09	Final Exam (Final paper is due)