

Gen 409 MOLECULAR GENETICS

Gen 409 Fall 2014
10:00 -10:50 am MWF – W262 Lagomarcino

Instructor: Dr. Maura McGrail
Office: 638 Science Hall II
email: mmcgrail@iastate.edu
Office Hours: email to set up an appointment

Teaching Assistant: **Melanie Torrie**
Interdepartmental Genetics Graduate Program
email: metorrie@iastate.edu
Office Hours will be held in:

| | |
|------------------|----------------------------|
| | 541 Science Hall II |
| Monday | 1:10-2 PM |
| Wednesday | 11-11:50 AM |
| Thursday | 4:10-5 pm |

Text: **Molecular Biology, Fifth Edition**
Robert F. Weaver
McGraw-Hill Publishers.

Course Description:

The principles of molecular genetics. Topics covered include: molecular organization of genes and genomes; molecular mechanisms of DNA replication, recombination, and repair; molecular mechanisms of transcription, translation and the regulation of gene expression. Emphasis is placed on experimental evidence from the scientific literature. Current technologies used in genetic engineering and genomics will be highlighted.

Student Learning Outcomes:

1. Students will gain a deeper understanding of the molecular mechanisms underlying the central dogma in molecular biology and the structure and function of genomes.
2. Students will learn methods in molecular genetics for studying genes and measuring gene activity.
3. Students will gain knowledge of the in vitro and in vivo experimental systems used in molecular genetics to study the mechanisms controlling genome activity and gene expression.
4. Students should be able to interpret experimental data from the primary literature and critically assess whether it does or does not support a hypothesis.
5. Students should be able to apply their knowledge of molecular genetics to formulate a hypothesis and design experiments to test the hypothesis.
6. Students will again an appreciation for:
 - a. How genetics research is carried out.
 - b. How our scientific understanding is built on previous studies and changes based on current research.
 - c. The importance of molecular genetic engineering and technology to improvements in agriculture and health.

SYLLABUS
Tentative Schedule

| <u>Lecture</u> | <u>Date</u> | <u>Topic</u> | <u>Chapter</u> |
|----------------|---------------|---|----------------|
| 1 | Aug 25 | Course Introduction | |
| | | Review | |
| 2 | Aug 27 | The Structure of DNA and Genes | 1-3 |
| 3 | Aug 29 | Chromosomes and Chromatin | 13.1 |
| - | Sep 1 | Labor Day (No Class) | |
| 4 | Sep 3 | Genome Content, Gene Number, Mapping Genes | 24 |
| - | Sep 5 | Quiz on review topics – in class | |
| | | <u>Unit 1: DNA Replication, Recombination and Repair</u> | |
| 5 | Sep 8 | DNA Replication I | 20.1-.2 |
| 6 | Sep 10 | DNA Replication II | 21 |
| 7 | Sep 12 | Journal Discussion groups 1, 2 – DNA replication | Blackboard |
| 8 | Sep 15 | DNA Repair I | 20.3 |
| 9 | Sep 17 | DNA Repair II | 20.3 |
| 10 | Sep 19 | Journal Discussion groups 3, 4 – DNA repair | Blackboard |
| 11 | Sep 22 | Homologous Recombination I | 22 |
| 12 | Sep 24 | Homologous Recombination II | 22 |
| 13 | Sep 26 | Journal Discussion groups 5, 6 – recombinase systems | Blackboard |
| - | Sep 29 | no class EXAM 1 – Due Wed Oct 1 | Blackboard |
| | | <u>Unit 2: Transcription</u> | |
| 14 | Oct 1 | Transcription in Bacteria | 6 |
| 15 | Oct 3 | Bacterial Operons | 7 |
| 16 | Oct 6 | Journal Discussion groups 7, 8 – riboswitches | Blackboard |
| 17 | Oct 8 | Transcription in Eukaryotes I | 10 |
| 18 | Oct 10 | Transcription in Eukaryotes II | 11, 12.1-.2 |
| 19 | Oct 13 | Journal Discussion groups 9, 10 – transcription factors | Blackboard |
| 20 | Oct 15 | RNA Processing: Splicing, Capping and Polyadenylation | 14, 15 |
| - | Oct 17 | no class EXAM 2 - Due Mon Oct 20 | |
| | | <u>Unit 3: Translation</u> | |
| 21 | Oct 20 | Translation Initiation I | 17 |
| 22 | Oct 22 | Translation Initiation II | 17 |
| 23 | Oct 24 | Journal Discussion group 1, 2 – translation initiation | Blackboard |
| 24 | Oct 27 | Translation Elongation and Termination | 18 |
| 25 | Oct 29 | Ribosomes and tRNA | 18 |
| 26 | Oct 31 | Journal Discussion group 3, 4 – translational regulation | Blackboard |
| - | Nov 3 | no class EXAM 3 - Due Wed Nov 5 | |

| <u>Lecture</u> | <u>Date</u> | <u>Topic</u> | <u>Chapter</u> |
|---|--------------------|---|----------------|
| <u>Unit 4: Regulation of Gene Expression</u> | | | |
| 27 | Nov 5 | Transcriptional Activators I | 12 |
| 28 | Nov 7 | Transcriptional Activators II | 12 |
| 29 | Nov 10 | Journal Discussion groups 5, 6 – enhancers | Blackboard |
| 30 | Nov 12 | Chromatin I | 13 |
| 31 | Nov 14 | Chromatin II | 13 |
| 32 | Nov 17 | Journal Discussion groups 7, 8 – chromatin modifiers | Blackboard |
| 33 | Nov 19 | Post-transcriptional Control – mRNA stability, RNA interference | 16 |
| 34 | Nov 21 | Post-transcriptional Control – microRNAs | 16 |
| - | Nov 24 – 28 | THANKSGIVING BREAK | |
| 35 | Dec 1 | Post-transcriptional Control | 16 |
| 36 | Dec 3 | Journal Discussion group 9, 10 – regulatory RNAs | Blackboard |
| 37 | Dec 5 | noncoding RNA transcriptome | Blackboard |
| 38 | Dec 8 | Genome Engineering – Transposons | 23 |
| 39 | Dec 10 | Genome Editing with Engineered Site Specific Nucleases: Zinc finger Nucleases, TAL-effector Nucleases, CRISPR-Cas9 | Blackboard |
| - | Dec 12 | no class EXAM 4 – Due Wed Dec 17 | |

Assessments and Assignments:

| <u>1 Quiz</u> | <u>In class Sep 5</u> | |
|------------------------------|----------------------------|--------------------------------|
| <u>4 Exams</u> | <u>Release Date</u> | <u>Date Due @ 10am</u> |
| 1 | Sep 26 | Oct 1 |
| 2 | Oct 15 | Oct 20 |
| 3 | Oct 31 | Nov 5 |
| 4 | Dec 10 | Dec 17 |
| <u>10 Assignments</u> | <u>Release Date</u> | <u>Date Due @ 10 am</u> |
| 1 | Aug 29 | Sep 3 |
| 2 | Sep 12 | Sep 17 |
| 3 | Sep 19 | Sep 24 |
| 4 | Sep 26 – in class | Wed Oct 1 |
| 5 | Oct 3 | Oct 8 |
| 6 | Oct 10 | Oct 15 |
| 7 | Oct 24 | Oct 29 |
| 8 | Nov 7 | Nov 12 |
| 9 | Nov 14 | Nov 19 |
| 10 | Dec 5 | Dec 10 |

Graded Exams and Assignments will be returned in ~1 week.

Journal Articles for in class discussions

Unit 1: DNA Replication, Recombination and Repair

- Sep 12** Groups 1 & 2 Waga et al., 2001. "DNA polymerase ϵ is required for coordinated and efficient chromosomal DNA replication in *Xenopus* egg extracts." PNAS.
- Sep 19** Groups 3 & 4 Attikum et al., 2004. "Recruitment of the INO80 complex by H2A phosphorylation links ATP-dependent chromatin remodeling with DNA double-strand break repair." Cell.
- Sep 26** Groups 5 & 6 Livet et al., 2007. "Transgenic strategies for combinatorial expression of fluorescent proteins in the nervous system." Nature.

Unit 2: Transcription

- Oct 6** Groups 7 & 8 Winkler et al., 2004. "Control of gene expression by a natural metabolite-responsive ribozyme." Nature.
- Oct 13** Groups 9 & 10 De Val et al., 2008. "Combinatorial Regulation of endothelial gene expression by Ets and Forkhead transcription factors." Cell.

Unit 3: Translation

- Oct 24** Groups 1 & 2 Kahvejian et al., 2005. "Mammalian poly(A)-binding protein is a eukaryotic translation initiation factor, which acts via multiple mechanisms." Genes and Development.
- Oct 31** Groups 3 & 4 Kondrashov et al., 2011. "Ribosome-mediated specificity in Hox mRNA translation and vertebrate tissue patterning." Cell.

Unit 4: Regulation of Gene Expression

- Nov 10** Groups 5 & 6 Visel et al., 2009. ChIP-Seq accurately predicts tissue-specific activity of enhancers." Nature.
- Nov 17** Groups 7 & 8 Lee et al., 2006. "Control of developmental regulators by polycomb in human embryonic stem cells." Cell.
- Dec 3** Groups 9 & 10 Small regulatory RNAs TBD

GRADING

Review quiz: In-class quiz covering review material. 50 points.

Exams: Four exams, 100 points each.
The exams will be take home exams.

Assignments: 10 weekly homework/problem sets worth 5 points each.

Journal Discussion/ Class Participation:

During the semester 10 lectures will be replaced with a journal article review. The journal articles chosen illustrate the experimental evidence for the concepts covered in previous lectures. Each student will be randomly assigned to a group. Two groups will be responsible for answering specific questions and discussion points for figures from each journal article. Each group will be assigned two journal articles. 25 points each.

| | | | |
|-----------------|---------------------------------------|-----------------|------------|
| Grading: | 1 Quiz | 50 points | 50 points |
| | 4 Exams | 100 points each | 400 points |
| | 10 Assignments | 5 points each | 50 points |
| | 2 in class Journal Article Discussion | 25 points each | 50 points |
| | | Total | 550 points |

Grading Scale:

| Grade | Percentage | Points |
|-------|------------|---------|
| A | 93-100% | ≥ 511 |
| A- | 90-92% | 495-510 |
| B+ | 87-89% | 479-494 |
| B | 83-86% | 456-478 |
| B- | 80-82% | 440-455 |
| C+ | 77-79% | 424-439 |
| C | 73-76% | 401-423 |
| C- | 70-72% | 385-400 |
| D+ | 67-69% | 369-384 |
| D | 63-66% | 346-368 |
| D- | 60-62% | 330-345 |
| F | ≤ 60% | ≤ 329 |

Academic Dishonesty

The class will follow Iowa State University's policy on academic dishonesty. Anyone suspected of academic dishonesty will be reported to the Dean of Students Office.

<http://www.dso.iastate.edu/ja/academic/misconduct.html>

Disability Accommodation

Iowa State University complies with the Americans with Disabilities Act and Sect 504 of the Rehabilitation Act. If you have a disability and anticipate needing accommodations in this course, please contact Dr. McGrail to set up a meeting within the first two weeks of the semester or as soon as you become aware of your need. Before meeting with Dr. McGrail you will need to obtain an SAAR form with recommendations for accommodations from the [Disability Resources Office](#), located in Room 1076 on the main floor of the Student Services Building. Their telephone number is 515-294-7220 or email disabilityresources@iastate.edu. Retroactive requests for accommodations will not be honored.

Harassment and Discrimination

Iowa State University strives to maintain our campus as a place of work and study for faculty, staff, and students that is free of all forms of prohibited discrimination and harassment based upon race, ethnicity, sex (including sexual assault), pregnancy, color, religion, national origin, physical or mental disability, age, marital status, sexual orientation, gender identity, genetic information, or status as a U.S. veteran. Any student who has concerns about such behavior should contact his/her instructor, [Student Assistance](#) at 515-294-1020 or email dso-sas@iastate.edu, or the [Office of Equal Opportunity and Compliance](#) at 515-294-7612.

Religious Accommodation

If an academic or work requirement conflicts with your religious practices and/or observances, you may request reasonable accommodations. Your request must be in writing, and your instructor or supervisor will review the request. You or your instructor may also seek assistance from the [Dean of Students Office](#) or the [Office of Equal Opportunity and Compliance](#).

Contact Information

If you are experiencing, or have experienced, a problem with any of the above issues, email academicissues@iastate.edu.