2021 Winter Biology 2171: Genetics Course Outline   [Submitted to the Department of Biology]

Instructor: Dr. Wensheng Qin   Office: CB 4016 (Tel: 343 8467)

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Homepage: http://flash.lakeheadu.ca/~wqin/

Lecture Location: UC 0050 or by Zoom
Time: Tuesdays, Thursdays: 1:00-1:30 pm
Duration: 2021/01/04 – 2021/04/06
Credits: 0.50

TA: Sarita Shrestha, PhD student
TA's Tel: 766 7141, Office: CB 3037
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Qin's Office Hours: CB4016, Tuesdays, 11:00 am to 12:00 pm (noon), or by appointment or by Zoom

Textbook (Required): Genetics Textbook <<Essentials of Genetics (10th Edition)>> by William S. Klug (Author), Michael R. Cummings (Author), Charlotte A. Spencer (Author), Michael A. Palladino (Author), Darrell Killian (Author). Publisher: Pearson. (Students are required to buy the textbook. Use of the other versions of the textbook or any other textbook or whether to buy a textbook is your own choice).

Lab Components Marks: 20%, it will be assigned and evaluated by the lab instructor Mr. Michael Moore]. For lab schedules or related concerns, please contact Michael Moore. His office is CB 3011A, his phone number is 807-343-8909 and his email is mnmoore@lakeheadu.ca.

Additional Requirements: (1) Preview the textbook and think about the questions in the related chapter(s) before the applicable class. (2) Review the textbook and try to answer the questions in the chapter(s) after the class. (3) Read the entire lectured chapters 1-14 for exams (The PPT slides do not contain all the information needed for the exam, you have to study the textbook as well). (4) Students must understand well enough to solve all the problem questions in the chapters 1-14.

Grading Scheme (Once again, the PowerPoint slides do not cover all the information for exams, so intensive reading and understanding of the whole lectured chapters are necessary).

1. Mid-term exam March 4, 2021 [35%]: Covering the chapters 1-7. The midterm exam may include (1) Fill in the blank questions, (2) Multiple choice questions, (3) True/False questions, (4) Essay questions, etc. Duration is one and half hours.
2. Final exam (Chapter 8-14) [45%]. Exam may include (1) Fill in the blank questions, (2) Multiple choice questions, (3) True/False questions, (4) Essay questions, etc. Duration is 3 hours.
3. Lab components [20%, which will be assigned and evaluated by the lab instructor Michael Moore.
4. Bonus marks: Some bonus marks may be offered when necessary (see the extra notes below).

Notes: If you miss any examination (midterm exam or final exam), we strictly follow the university regulations of "Missed Examinations Due to Illness or Other Extenuating Circumstances". If you are permitted to write your missed exam, an alternative test paper (Test B) may be made. Test B will be very different in questions and/or format from the test questions for the class (Test A).

Extra notes:
(1) We strictly follow the course outline as rules for the course.
(2) The important contents and information for examination will often be emphasized in class.
(3) Slides in D2L and slides for lecturing may be slightly different. The lectured version of slides will not be posted in D2L. This is to encourage the students to attend the classes and take your own notes.
(4) Bonus points: Student attendance is monitored by D2L/Zoom system, up to 6 bonus points will be awarded to you based on your class attendance. If you actively ask questions or participate in class discussion, you may obtain up to 4 bonus points. In total, you have chances to receive up to 10 bonus points. Each bonus point can value more or less than 1% adding to the student final grade. The bonus point value depends on class average marks.
(5) Homework assignments: The questions listed below are from the chapters 1-14.
(8) Buying "Online Access" to the textbook is your own choice. If you have any questions about "Online Access", please contact Nikita Yhap <Nikita.Yhap@pearsoned.com>.

Winter 2021 Term Courses	
First Day of Classes	Monday, January 11, 2021
Final Day of Classes	Tuesday, April 13, 2021
Final Date to Register (Add)	Friday, January 22, 2021
Final Date to Withdraw (Drop)	Friday, March12, 2021
Examination Period	Friday, April 16, 2021 - Sunday, April 25, 2021 (10 Days)
Exam Contingency Date	Monday, April 26, 2021
Marks Due	Thursday, April 29, 2021

Lecture Schedule:

January 2021	Chapter 1: Introduction to Genetics
12	Chapter 2: Mitosis and Meiosis
14	Chapter 2: Mitosis and Meiosis
19	Chapter 3: Mendelian Genetics
21	Chapter 3: Mendelian Genetics
26	Chapter 4: Modification of Mendelian Ratios
28	Chapter 4: Modification of Mendelian Ratios
February 2021	
2	Chapter 4: Modification of Mendelian Ratios
4	Chapter 5: Sex Determination and Sex Chromosomes
9	Chapter 6: Chromosome Mutations: Variation in Number and Arrangement
11	Chapter 6: Chromosome Mutations: Variation in Number and Arrangement
16	February reading week
18	February reading week
23	Chapter 7: Linkage and Chromosome Mapping in Eukaryotes
25	Chapter 8: Genetic Analysis and Mapping in Bacteria and Bacteriophages
March 2021	
2	Chapter 9: DNA Structure and Analysis
4	Midterm exam covering chapters 1-7
9	Chapter 9: DNA Structure and Analysis
11	Chapter 10: DNA Replication
16	Chapter 10: DNA Replication
18	Chapter 11: Chromosome Structure and DNA Sequence Organization
23	Chapter 12: The Genetic Code and Transcription
25	Chapter 12: The Genetic Code and Transcription
30	Chapter 13: Translation and Proteins
April 2021	
1	Chapter 13: Translation and Proteins
6	Chapter 14: Gene Mutation, DNA Repair, and Transposition
8	Chapter 14: Gene Mutation, DNA Repair, and Transposition
13	Chapter 14: Gene Mutation, DNA Repair, and Transposition
Final exam	Cover chapters 8-14 only

Assay questions from Chapter 1-7.

[1] The trait of medium-sized leaves in iris is determined by the genetic condition PP'. Plants with large leaves are PP, whereas plants with small leaves are $P'P'$. A cross is made between two plants each with medium-sized leaves. If they produce 80 seedlings, what would be the expected phenotypes, and in what numbers would they be expected? What is the term for this allelic relationship?

[2] The trait for medium-sized leaves in iris is determined by the genetic condition PP'. Plants with large leaves are PP, whereas plants with small leaves are $P'P'$. The trait for red flowers is controlled by the genes RR, pink by RR', and white by $R'R'$. A cross is made between two plants each with medium-sized leaves and pink flowers. If they produce 320 seedlings, what would be

the expected phenotypes, and in what numbers would they be expected? Assume no linkage.

[3] A color-blind woman with Turner syndrome (XO) has a father who is color-blind. Given that the gene for the color-blind condition is recessive and X-linked, provide a likely explanation for the origin of the color-blind and cytogenetic conditions in the woman.

[4] Dosage compensation leads to a variety of interesting coat color patterns in certain mammals. For instance, a female cat that is heterozygous for two coat color alleles, say black and orange, will usually have the "calico" or mosaic phenotype. Describe the chromosomal basis for the mosaicism (calico) in the female. Explain why chromosomally normal male cats do not show the mosaic phenotype, but XXY male cats can be calico.

[5] Give the sex-chromosome constitution (X and Y chromosomes) and possible genotypes of offspring resulting from a cross between a white-eyed female (Xw XwY) and a wild-type male (normal chromosome complement) in *Drosophila melanogaster*. Include all zygotic combinations whether viable or unviable.

[6] Assume that investigators crossed a strain of flies carrying the dominant eye mutation Lobe on the second chromosome with a strain homozygous for the second chromosome recessive mutations smooth abdomen and straw body. The F_1 Lobe females were then backcrossed with homozygous smooth abdomen, straw-body males, and the following phenotypes were observed:

smooth abdomen, straw body	820
Lobe	780
smooth abdomen, Lobe	42
straw body	58
smooth abdomen	148
Lobe, straw body	152

(a) Give the arrangement of alleles of the F1 Lobe females
(b) Which gene is in the middle?
(c) Determine the distances in map units for these three loci.
(d) What is the coefficient of coincidence and interference values?
(e) Is there positive, negative, total or no interference?

[7] In the fruit fly, *Drosophila melanogaster*, a spineless (no wing bristles) female fly is mated to a male that is claret (dark eyes) and hairless (no thoracic bristles). Phenotypically wild-type F_1 female progeny were mated to fully homozygous (mutant) males, and the following progeny (1000 total) were observed:

Phenotypes	Number Observed
spineless	321
wild-type	38
claret, spineless	130
claret	18
claret, hairless	309
hairless, claret, spineless	32
hairless	140
hairless, spineless	12

(a) With respect to the three genes mentioned in the problem, what are the genotypes of the homozygous parents used in making the phenotypically wild-type F_1 heterozygote?
(b) Which gene is in the middle?
(c) What are the map distances for the three genes? A correct formula with the values "plugged in" for each distance will be sufficient.
(d) What is the coefficient of coincidence? A correct formula with the values "plugged in" will be sufficient.
(e) What is the value for interference? Is there positive, negative, total, or no interference?

Assay questions from Chapter 8-14.
[8] Explain the composition and use of minimal medium in the study of bacterial genetics.

[9] Assume that one counted 67 plaques on a bacterial plate where 0.1 ml of a 10^{-5} dilution of phage was added to bacterial culture. What is the initial concentration of the undiluted phage?

[10] If the linker DNA between nucleosomes is 103 base pairs in length, how many H4 proteins are expected in a stretch of DNA 30,000 base pairs long?

[11] Describe the role of chemical modification in the generation of CpG islands. Predict where CpG islands are likely to be found within the genome.

[12] Describe a difference between the RNA polymerases of eukaryotes and prokaryotes.

[13] In eukaryotes, which three factors appear to encourage the specific association of RNA polymerase(s) to a specific region of DNA?

[14] Describe the basic structure of normal adult hemoglobin and the abnormality observed in sickle-cell hemoglobin.

[15] In what ways do the amino acid side chains interact to influence protein function?

[16] Under which condition(s) might have an amino acid substitution in a protein that does not result in an altered phenotype?

[17] Three major types of RNAs are mRNA, rRNA, and tRNA. For each of the conditions below, predict the consequences in terms of the population of proteins being synthesized in a particular cell. What qualitative and quantitative changes, if any, are expected in the individual protein involved (if one is involved) and in the population of proteins produced in that cell?
(a) A frameshift mutation in mRNA. The condition is heterozygous in the involved cell.
(b) A deletion (homozygous) that removes approximately half of each type of rRNA genes.

[18] Imagine that an Ames test was performed on a new red dye to determine if it will be safe for consumers. For this *his-* mutants are grown in growth media and the disk is soaked in the red dye. The results show that the reversion rate is not significantly above the spontaneous rate. Would you conclude that this dye is safe? Explain why or why not.