2020 Winter Biology 2171: Genetics Course Outline [Jan 2, 2020 Final 4 Xili]

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Lecture Location: ATAC 1001
Time: Tuesdays, Thursdays: 1:00-1:30 pm
Duration: 2020/01/06 - 2020/04/03
Credits: 0.50

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

Textbook: "Genetics: From Genes to Genomes" (2017 Second Canadian Edition) by Leland H. Hartwell, Michael L. Goldberg, Janice A. Fischer, Leroy Hood, Charles Aquadro, Jim Karagiannis (University of Western Ontario), Maria Papaconstantinou (University of Toronto). Publisher: McGraw-Hill Ryerson.

(Students are strongly encouraged to buy the textbook of 2017 Second Canadian Edition, but not required. Use of other versions of the book or any other textbook is TOTALLY YOUR OWN CHOICE).

Lab components [20%, which will be assigned and evaluated by the lab instructor Mr. Michael Moore mnmoore@lakeheadu.ca].

Schedule (January 6, 2020: Monday, semester starts, April 3, 2020: Friday, semester ends)

Winter 2020 Term Courses	
First Day of Classes	Monday, January 6, 2020
Final Day of Classes	Friday, April 3, 2020
Final Date to Register (Add)	Friday, January 17, 2020
2020 Winter Reading Week	February 17-21, 2020

Final Date to Withdraw (Drop)	Friday, March 6, 2020
Examination Period	Monday, April 6, 2020 - Sunday, April 19, 2020 (10 days - No exams April 10-13)
Midterm Exam	March 3, 2020
Exam Contingency Date	Monday, April 20, 2020
Marks Due	Thursday, April 23, 2020
Lecturing Time	Tuesday & Thursday 1:00-2:30 PM Jan 6/2020 to April 3/2020

Week 1: Introduction of the Course, Chapter 1: Genetics: The Study of Biological Information, and Chapter 2: Mendelian Genetics
Week 1: Chapter 2: Mendelian Genetics
Week 2: Chapter 2: Mendelian Genetics
Week 2: Chapter 2: Mendelian Genetics
Week 3: Chapter 3: The Chromosome Theory of Inheritance
Week 3: Chapter 3: The Chromosome Theory of Inheritance
Week 4: Chapter 3: The Chromosome Theory of Inheritance
Week 4: Chapter 3: The Chromosome Theory of Inheritance
Week 5: Chapter 4: Linkage, Recombination, and the Mapping of Genes on Chromosomes
Week 5: Chapter 4: Linkage, Recombination, and the Mapping of Genes on Chromosomes
Week 6: Chapter 4: Linkage, Recombination, and the Mapping of Genes on Chromosomes
Week 6: Chapter 5: The Multifaceted Nature of the DNA Molecule
February 17, 2020: Family Day, no class
February 18-21, 2020: Winter Reading Week (February 18-21), no class
Week 8: Chapter 5: The Multifaceted Nature of the DNA Molecule
Week 8: The Multifaceted Nature of the DNA Molecule
Week 9: Chapter 5: Mid-term Exam on March 3, 2020 (Chapters 1-4) [30%] 75 minutes
Week 9: Chapter 6: Chromatin to Chromosomes
Week 10: Chapter 6: Chromatin to Chromosomes
Week 10: Chapter 7: Gene Expression: The Flow of Information from DNA to RNA to Protein
Week 11: Chapter 7: Gene Expression: The Flow of Information from DNA to RNA to Protein
Week 11: Chapter 7: Gene Expression: The Flow of Information from DNA to RNA to Protein
Week 12: Chapter 8: Mutation at the Molecular Level
Week 12: Chapter 8: Mutation at the Molecular Level
Week 13: Chapter 9: Mutation at the Chromosomal Level
Week 13: Chapter 9: Mutation at the Chromosomal Level (Last class)

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 1-9 for exams. (The PPT slides do not contain all the information needed for the exam.) (4) Students must understand well enough to solve all the problem questions in chapters 2-9.

Grading Scheme (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 3, 2020 [30%]: We will have mid-term exam on February 27, 2019, covering chapters 1-4. The midterm exam may include (1) Fill in the blank questions, (2) Multiple choice questions, (3) True/False questions, (4) Essay questions, etc. TA will help administer and mark the exam. Duration is 75 minutes.
2. Final exam (Chapter 5-9) [50%]. 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 notes below).

Notes: If you miss any examination (mid-term 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 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) Request of doing extra assignments for raising your marks is not allowed unless you have both the department chair and registrar's approvals.
(3) In the middle of 1.5 hours of class, we will have 5 minutes of short break.
(4) The important contents and information for examination will be often emphasized in class.
(5) Slides in D2L and slides for lecturing may be slightly different. The lectured version of slides will not be posted in D2L and will not be sent to the students by email as well. This is to encourage students to attend the classes and take your own notes.
(6) Bonus points: Students may be randomly offered to sign class attendance sheet for some classes. Each signature will be counted as 1 bonus point. Each bonus point can value more or less than 1% adding to the final grade. It depends on the class average marks from the exams and class participation. This is a big class. The students are strongly encouraged to sit in the front seats, especially the front 5 rows of seats (You may have a chance to receive extra bonus).
(7) The homework assignments: The questions listed below are from the chapters 1-9.
(8) Buying "Online Connect Access" is not required. It's totally your own choice. If you have any questions about "Online Connect Access", please contact meghan.clark@mheducation.com.

Biology 2171 (Genetics) 2020 Winter Term Assignments (Essay questions from chapters 1-9)

[1] Short hair in rabbits is produced by a dominant gene (l^+) and long hair by its recessive allele (l). Black hair results from the action of a dominant gene (b^+) and brown hair from its allele (b). Determine the genotypic and the corresponding phenotypic ratios of the F_2 offspring, beginning with a parental cross of a female rabbit with brown hair and a male rabbit with long hair. Assume that the P female is homozygous for short hair and the P male is homozygous for black hair.

[2] In rats, the gene for the pigment (P) is dominant to no pigment (p). The gene for black (B) is dominant to the gene for cream (b). If a pigment gene (P) is absent, genes B and b are inoperative. Predict the genotypes and phenotypes of the F_2 of a parental cross between a homozygous black rat and an albino homozygous for cream.

[3] You have obtained an interesting flower for your garden from your neighbor. The neighbor has given you two pure lines of the plant, one with red flowers and one with yellow flowers. You decide to cross them and find that you obtain all orange flowers. The curious molecular geneticist in you decides to test two independent hypotheses: Hypothesis 1: Incomplete Dominance; Hypothesis 2: Recessive Epistasis. The first step in your test is to self the F_1 orange plants, which you complete only to find that the results do not statistically distinguish the two hypotheses. a) What ratio of yellow, orange, and red would you expect in the F_2 population for each hypothesis and b) what crosses would you complete next to definitively test your two hypotheses?

[4] In Drosophila, white eyes (w) and yellow body (y) are both recessive X-linked mutations. The wild type alleles, w+ and y+, control red eyes and dark body color, respectively. If a homozygous yellow body, red-eyed female is crossed with a dark body, white-eyed male, and F1 progeny are interbred, what will the phenotypes and ratios of the F1 and F2 be?

[5] In crosses of white-eyed *Drosophila* females with red-eyed males, Bridges recovered white-eyed daughters and red-eyed sons at a rate of around one per 2,000 offspring. (Most of the offspring were white-eyed males and red-eyed females.) He hypothesized that these exceptional progeny resulted from nondisjunction of the X chromosomes in meiosis in the female. Why did he suspect that nondisjunction was occurring in the female parent? What types of progeny would result from nondisjunction in the male parent?

[6] The Holliday model of recombination has been modified. The current model, termed the consensus model, is now consistent with current research. What are the five properties of recombination, as they are now understood?

[7] When Meselson and Stahl performed the experiment that showed that replication is a semiconservative process, they utilized E. coli, and various isotopes of nitrogen (15N and 14N). Explain briefly what their results would have been if DNA replicated conservatively.

[8] How is DNA altered by hydrolysis, radiation, UV light, and oxidation respectively?

[9] Chemical X has just been screened using the Ames test. A total of 5,000 bacteria were tested against 0.001 M, 1 M, 0.1M, and 1M concentrations for which 4, 1, 0, and 200 colonies grew respectively. Control plate of minimal media supplemented with histidine had 5,000 colonies while minimal media alone had only two. Interpret these data.

[10] The local pet store received several shipments of albino ferrets. You choose two males and two females as pets one breeding pair from the same litter, one from two different litters. When your ferrets' litters are born, one litter has normally pigmented offspring. State which offspring are albino and which are pigmented and explain why?

Answers for the assignments:

[1] Short hair in rabbits is produced by a dominant gene (l+) and long hair by its recessive allele (l). Black hair results from the action of a dominant gene (b+) and brown hair from its allele (b). Determine the genotypic and the corresponding phenotypic ratios of the F2 offspring, beginning with a parental cross of a female rabbit with brown hair and a male rabbit with long hair. Assume that the P female is homozygous for short hair and the P male is homozygous for black hair.

Answer:#	Genotype	Phenotype
1	l+l+ b+b+	Short Black
2	l+l b+b+	Short Black
2	l+l+ b+b	Short Black
4	l+l b+b	Short Black
1	l+l+ bb	Short Brown
2	l+l bb	Short Brown
1	ll b+b+	Long Black
2	ll b+b	Long Black
1	llbb	Long Brown

[2] In rats, the gene for the pigment (P) is dominant to no pigment (p). The gene for black (B) is dominant to the gene for cream (b). If a pigment gene (P) is absent, genes B and b are inoperative. Predict the genotypes and phenotypes of the F2 of a parental cross between a homozygous black rat and an albino homozygous for cream.
Answer: 9 Black; 3 cream; 4 colorless

	Genotype	Phenotype
1	PPBB	Black
2	PPBb	Black
2	PpBB	Black
4	PpBb	Black
1	ppBB	colorless
2	ppBb	colorless
1	PPbb	cream

2	Ppbb	cream
1	ppbb	colorless

[3] You have obtained an interesting flower for your garden from your neighbor. The neighbor has given you two pure lines of the plant, one with red flowers and one with yellow flowers. You decide to cross them and find that you obtain all orange flowers. The curious molecular geneticist in you decides to test two independent hypotheses: Hypothesis 1: Incomplete Dominance; Hypothesis 2: Recessive Epistasis. The first step in your test is to self the F1 orange plants, which you complete only to find that the results do not statistically distinguish the two hypotheses. a) What ratio of yellow, orange, and red would you expect in the F2 population for each hypothesis and b) what crosses would you complete next to definitively test your two hypotheses?

Answer:

a) The expected phenotypic ratio for recessive epistasis is 9:3:4, and for incomplete dominance, 1:2:1. b) Cross the yellow F2 flowers with true breeding red flowers. If the hypothesis for incomplete dominance is correct, the yellow color will be determined by a single gene and all F2 yellow flowers will be homozygous recessive and give rise to only orange flowers in the F3 population [aa x AA = Aa]. However, if the hypothesis for recessive epistasis is correct, a cross of F2 yellow and true breeding red flowers will give rise to some red and some orange flowers [Yyrr x yyRR = either yyRr or YyRr].

[4] In Drosophila, white eyes (w) and yellow body (y) are both recessive X-linked mutations. The wild type alleles, w+ and y+, control red eyes and dark body color, respectively. If a homozygous yellow body, red-eyed female is crossed with a dark body, white-eyed male, and F1 progeny are interbred, what will the phenotypes and ratios of the F1 and F2 be?

Answer:

F1—females: all dark body, red eyes
males: all yellow body, red eyes
F2—females: yellow body, red eyes—1/2
dark body, red eyes—1/2
males: yellow body, red eyes—1/2
dark body, white eyes—1/2

[5] In crosses of white-eyed Drosophila females with red-eyed males, Bridges recovered white-eyed daughters and red-eyed sons at a rate of around one per 2,000 offspring. (Most of the offspring were white-eyed males and red-eyed females.) He hypothesized that these exceptional progeny resulted from nondisjunction of the X chromosomes in meiosis in the female. Why did he suspect that nondisjunction was occurring in the female parent? What types of progeny would result from nondisjunction in the male parent?

Answer:

XXY are white-eyed females and XO are red-eyed males, so male nondisjunction does not account for the observed exceptions. The two XX's of XXY offspring must have come from the white-eyed female parent, and the lack of the second X in the XO, but with the presence of red eyes, also indicates that the X from the white-eyed female parent is missing.

[6] The Holliday model of recombination has been modified. The current model, termed the consensus model, is now consistent with current research. What are the five properties of recombination, as they are now understood?

Answer:

1. Homologs physically break, exchange parts, and rejoin
2. Breakage and repair create reciprocal products of recombination
3. Recombination events can occur anywhere along the DNA molecule
4. The exchange is precise, there is no gain or loss of nucleotides
5. Gene conversion can give rise to an unequal yield of two different alleles

[7] When Meselson and Stahl performed the experiment that showed that replication is a semiconservative process, they utilized E. coli, and various isotopes of nitrogen (15N and 14N). Explain briefly what their results would have been if DNA replicated conservatively.

Answer:

Following centrifugation, the first generation of replication would yield two bands—15N and 14N (no hybrid). The second generation would again result in the same pattern with no hybrid pattern ever revealed.

[8] How is DNA altered by hydrolysis, radiation, UV light, and oxidation respectively?

Answer:

DNA hydrolysis of A or G bases results in depurination and the DNA strand has a continuous sugar backbone but an unspecified base where the depurination occurred. X-irradiation breaks the sugar backbone while UV light induces thymidine dimerization. Oxygen free radicals oxidize bases into analogs that do not hydrogen bond properly in the DNA double strand. During replication, mismatch pairing ends up creating a base change resulting in mutation.

[9] Chemical X has just been screened using the Ames test. A total of 5,000 bacteria were tested against 0.001 M, 1 M, 0.1M, and 1M concentrations for which 4, 1, 0, and 200 colonies grew respectively. Control plate of minimal media supplemented with histidine had 5,000 colonies while minimal media alone had only two. Interpret these data.

Answer:

The control plate supplemented with histidine has 5,000 colonies which indicates the total number of bacteria present in the sample. The control plate with no histidine has 2 colonies indicating that the natural rate of his- reversion is 2/5,000. Only the high concentration of 1M

chemical X caused a his- reversion at a rate significantly higher than control indicating the chemical X is a mutagen only at high levels.

[10] The local pet store received several shipments of albino ferrets. You choose two males and two females as pets one breeding pair from the same litter, one from two different litters. When your ferrets' litters are born, one litter has normally pigmented offspring. State which offspring are albino and which are pigmented and explain why?

Answer:

The breeding pair from the same litter would have albino offspring (they would carry a mutation in the same gene) while the breeding pair with the unrelated male and female could have pigmented offspring if each had a mutation in different genes involved in pigmentation. The two unrelated albino ferret's mutations complemented each other's genetic deficiency leading to pigmented offspring.