Name___________________________ Section__________________

7.014 Problem Set 5

Please print out this problem set and record your answers on the printed copy. Answers to this problem set are to be turned in to the box outside 68-120 by 5:00pm on Friday April 13, 2007. Problem sets will <u>not</u> be accepted late. Solutions will be posted online.

1. Cell Cycle

(a) You are doing genetic research on a new species of fly, which has two different chromosomes each of which is present in two copies (*i.e.* – the fly is diploid). You are studying three genes: A, B and D. You determine that genes A and B are on chromosome 1, and gene D is on chromosome 2.

(i) Are genes A and B absolutely linked? Briefly support your answer.

(ii) Can a cross-over event occur between genes A and D? Briefly support your answer.

(b) The cell cycle of this new fly species is just like the one we discussed in lecture. Based on that cell cycle, how many copies of gene B would you expect to find present in…(circle your answer)

(i) a cell that has just finished meiosis I: 1 2 4 6 8

(ii) a cell that has just finished mitosis: 1 2 4 6 8

(iii) a cell that has just finished S phase: 1 2 4 6 8

(iv) a cell that has just finished meiosis II: 1 2 4 6 8

(v) a cell that is in G1: 1 2 4 6 8

Question 1 continued

(c) Cancer is a disease that results uncontrolled cell division. Cancer cells have lost the ability to regulate the cell cycle. Which of the following mutations could contribute to a cell losing the ability to control cell division. Circle **all** that apply.

1. A loss-of-function mutation in a gene that is necessary to halt the cell cycle while the cell repairs its DNA.

2. A loss-of-function mutation in the gene for DNA polymerase.

3. A loss-of-function mutation in a gene is necessary to repress the expression of genes that stimulate cell division.

4. A gain-of-function mutation in a gene that stimulates cell division.

5. A loss-of-function mutation in a gene that is important for oxidative phosphorylation.

2. You are working in a lab that studies kernel development in a diploid corn plant. Your current project is studying the genetics of kernel color, which you know is controlled by a single gene.

(a) You are studying three different corn plants, each with a different kernel color: yellow, red and blue. Do each the three different types of plants have identical genotypes? Explain.

(b) You cross a yellow-kernel plant with a blue-kernel plant. One color phenotype is recessive to the other. From the mating, you get the following number of offspring:

237 yellow-kernel plants
252 blue-kernel plants

(i) Why do these results indicate that one of your parental strains is not homozygous for the color gene?

(ii) It turns out that yellow-colored kernels are dominant to blue-colored kernels. What should be the genotype of the parental and F1 plants for the cross described above (where K^Y is the allele for yellow and K^B is the allele for blue)?

yellow parent _______________ blue parent_______________

yellow F1__________________ blue F1__________________

(c) Next you cross a true-breeding red-kernel plant with a true-breeding yellow-kernel plant. You then cross two of the F1 plants (self-cross). You get the following offspring:

150 yellow-kernel plants
289 orange-kernel plants
136 red-kernel plants

Are red-colored kernels dominant to yellow-colored kernels? Explain your reasoning.

(d) Based on the information above, if you crossed a red-kernel plant to a blue-kernel plant, what color kernels would you expect to find in the offspring and in what ratio?

(e) You next cross your true-breeding yellow-kernel plant with a light yellow-kernel plant you found in a random corn field. You get the following offspring in the F1 generation:

F1	87 yellow-kernel plants 80 light yellow-kernel plants

You then cross two of the light-yellow offspring and get the following offspring in the F2 generation:

F2	49 yellow-kernel plants 110 light yellow-kernel plants

(i) Using K^X to describe the mystery allele, write out the genotypes for the F2 generation of offspring

yellow-kernel plants_______________ light yellow-kernel plants_______________

(ii) Provide an explanation the phenotypic ratios of the offspring in the second generation.

Question 2 continued

Your lab wants to create a true-breeding variation of corn that has yellow kernels and striped husks. The husk phenotype is controlled by one gene. You cross a true-breeding yellow-kernel plant with green husks to a true-breeding red-kernel plant with striped husks. The green husk is dominant to the striped husk.

(f) What is the phenotype of the F1 plants?

(g) You then cross two F1 plants to each other to create a true-breeding yellow-kernel, striped-husk plant. What are the genotypes of the possible **gametes** of the F1 plants? Label which gametes represent parental genotypes and which are recombinant genotypes.

Parental 1: Parental 2:

Recombinant 1: Recombinant 2:

(h) The results from the cross above do not give the expected 9:3:3:1 ratio. What does a 9:3:3:1 ratio indicate?

(i) You want to determine the Recombination Frequency, so you cross one of your heterozygous F1 plants from part (f) with a test strain. Test strains are homozygous for the alleles that give the recessive phenotype. Circle the genotype of the test strain that you should use (H represent the allele that encodes for green husks and h represents the allele that encodes for striped husks):

$\frac{K^RH}{K^RH}$ $\frac{K^Rh}{K^RH}$ $\frac{K^YH}{K^YH}$ $\frac{K^Bh}{K^Rh}$ $\frac{K^RH}{K^Yh}$ $\frac{K^Bh}{K^Bh}$ $\frac{K^Yh}{K^Yh}$ $\frac{K^BH}{K^Bh}$ $\frac{K^Yh}{K^Rh}$

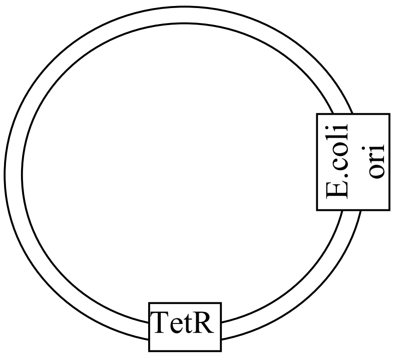
(j) From your cross in part (j), you get 200 plants and determine that the Recombination Frequency is 15%. How many of **each** recombinant class should you have? Show your work.

3. Recombinant DNA

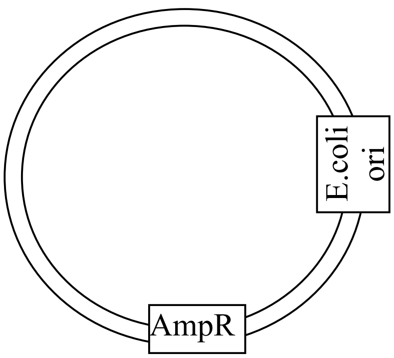
(a) A plasmid is made of (circle one answer):

Proteins RNA DNA Carbohydrates Lipids

(b) You have the following plasmids. Indicate if bacteria transformed with each plasmid would grow on an LB + ampicillin plate. If you do not think the transformed bacteria will grow, explain what should be changed and why.

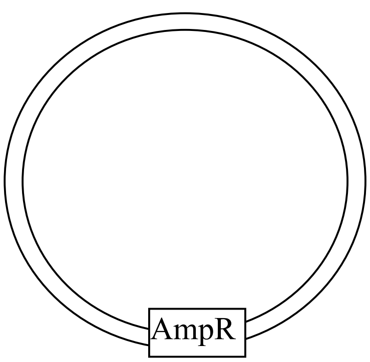


Growth?
Explanation:



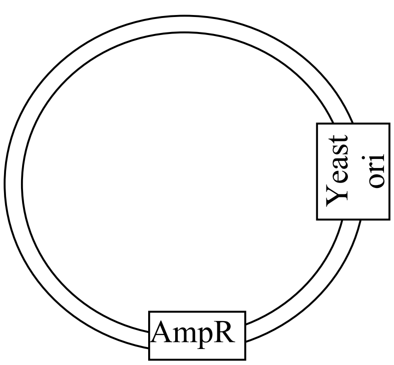
Growth?

Explanation:



Growth?

Explanation:



Growth?

Explanation:

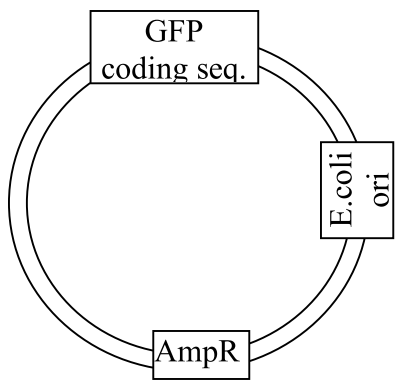
(c) EcoRI is a restriction endonuclease that cuts (hydrolyzes) DNA at the following sequence:

5’-GAATTC-3’
3’-CTTAAG-5’

Explain why EcoRI can not cut the sequence below as well as the sequence above:

5’-GATATC-3’
3’-CTATAG-5’

(d) You want to create a plasmid that will allow the bacteria you transform with the plasmid to glow green when under a UV light source. To do this, you plan to insert a gene that encodes the green fluorescent protein (GFP) into a plasmid. Using restriction endonucleases, you insert the coding sequence of GFP into the plasmid. Below is your resulting plasmid:



You isolate bacterial colonies that are ampicillin-resistant. When you look at these colonies using a fluorescent microscope, nothing glows! What other DNA sequence do you need to include on your plasmid to get expression of GFP?