Biology 321 ***Assignment Set #1*** ***Spring 2013***

Goals of this problems set:

1. To review basic Mendelian principles
2. To review meiosis and its connection to Mendel's principles
3. To begin a consideration of probability and how it can be used to assess genetic data

Required Reading Assignment

Zebrafish researchers hook gene for human skin color
Science 310: 1754 Dec. 16, 2005
http://fire.biol.wwu.edu/trent/trent/zebrafishskincolor.pdf

Required Reading and Problem Assignments in Introduction to Genetic Analysis 10th edition. *These are practice problems to prepare you for the quizzes and exams. I will not collect answers to these problems.*

Chapter 1 – Browse through this chapter. Look carefully at sections 1.1, 1.2, 1.3 (review of basics) & 1.5 (Model Organisms). Also browse through *the Brief Guide to Model Organisms* (starts on pg 759) and the *Index to Model Organisms* on the end papers at the back of the book

Chapter 2 pgs. 27-42 & 49-50 (on testcrosses)***.*** ***Work problems 1, 2, 6, 15, 18, 23, 27, 30, 31, 36, 40, 50, 59***

- NOTE on pg. 39: You are not responsible for yeast mating types.
- Be sure to look carefully at Figure 2-11 illustrating the relationship between chromatids and DNA molecules

Chapter 3 pgs. 81-89 (stop at Chi Square) & pgs. 94-100
Optional: read Section 3.5 on Organellar Genes
Read through Solved problem 2. Work problems 12, 13, 18, 21, 25, 48 & 57

Using the 9th edition? It will work fine for most the course.
Required Reading and Problem Assignments in 9th edition of text
http://fire.biol.wwu.edu/trent/trent/assignmentset1.9.pdf

Assignment Set 1 Problems sorted by analytical and/or content type

Using and understanding genetic terminology
Text Chapter 2: 2,
This problem set: most of the questions

Understanding Meiosis/mitosis & chromosome numbers
Text Chapter 2: 18, 23, 27, 30, 31
Text Chapter 3: 13, 18, 21, 57
This problem set: 1a, 1b, 2, 3, 4, 13, 15, 17

Explaining/relating Mendel principles of inheritance with chromosome movement in meiosis
Text Chapter 3: 21
This problem set: 17

Figuring out which trait is dominant:
Text Chapter 2: 36, 40, 50
This problem set: 6, 8, 12

Assigning appropriate allele symbols
Text Chapter 2: 40
This problem set: 8, 12, 14

Deducing parental and/or progeny genotypes from progeny phenotypic ratios
➔data set large so ratios more or less match predicted probabilities for each phenotypic/genotypic class
Text Chapter 2: 50
Text Chapter 3: Solved problem 2 (also 28 & 29– not officially assigned)
This problem set: 8, 9, 10, 11

Using Mendel to predict progeny genotypes/phenotypes and ratios from parental genotypes/phenotypes
Text Chapter 3: 12, 25, 48
This problem set: 7, 17

Sorting through the complexities of real data
Text Chapter 2: 50
This problem set: 6, 7e, 12

Sorting through small data sets where progeny count will not necessarily match predicted probabilities for each phenotypic/genotypic class
This problem set: 7e

Basic Probability Product and Sum rules
Text Chapter 2: 45
Text Chapter 3: 21, 25, 48
This problem set: 7

These are additionl practice problems to prepare you for the quizzes and exams. I will not collect the answers to these problems.

❖ **Problem 1a** *2n= 48* What does this symbolism tell you about the genetic content of a cell? Be explicit.
2: _______________ n: _______________
48:______________

❖ **Problem 1b . The genetic content of a somatic tomato cell is 2n=24.** *How many different double-stranded DNA polymers comprise a single genome copy?*

❖ **Problem 2**
Ferns have both a haploid and diploid stage in their life cycle. Early in the life cycle, all the cells in the prothallus (the young fern plant) are haploid. The prothallus is the gamete-producing stage of the life cycle. What type of nuclear division must be involved in the production of gametes by the prothallus?

❖ **Problem 3** The common red fox has a genome content of 2n=38 chromosomes and the Arctic fox 2n=50. Viable, but sterile hybrid offspring can be produced from a mating between these two species. Studies of meiosis in these sterile hybrids have shown that both bivalents and univalents are present at metaphase I.
a. How many chromosomes would the hybrid progeny have in each somatic cell?
b. The production of viable but sterile offspring indicates that mitosis can proceed normally in these hybrid cells, but meiosis cannot. **Briefly** explain these observations in light of the differences between mitosis and meiosis.

❖ **Problem 4** Many plants are polyploid, which means that they have more than two sets of chromosomes. Seedless strains of bananas and watermelon are triploid (3n) having 3 copies of each chromosome. Such triploids rarely produce viable seeds because the gametes produced during meiosis have “unbalanced” chromosome numbers (2 copies of some chromosomes and one copy of others). Briefly speculate on what problems a triploid cell might encounter when undergoing meiosis to produce these unbalanced gametes.

❖ **Problem 5** Is it possible by breeding procedures alone to detect the presence of a gene if it exists in only one allelic form? Explain.

❖ **Problem 6** You have recently purchased a red mare. You mate her to a black stallion and she produces twin foals: one red and one black.
From this information, can you determine which trait is dominant? Explain your answer very briefly.
What matings should you do to sort this out? Explain your answer and indicate the predicted results if red is dominant and if black is dominant. Be sure that your crosses will differentiate between the two possibilities. NOTE: there are a couple of possible strategies depending on what animals are available for mating.

❖ **Problem 7** In Klingons, one gene determines hair texture while another determines whether the individual will have a saggital crest.

K = curly klingon hair (dominant) **k** = silky earthling hair (recessive)
S = large saggital crest (dominant)
s = smooth, flat earthling forehead (recessive)

Kayless is half human, half Klingon with a genotype of **KkSs**. He is mated to Lieutenant Worf's sister, who is also **heterozygous** for both alleles. Dr. Beverly Crusher wants to better examine the genotypes of their offspring. Help her out by answering the following questions:

a. What are the 4 possible **phenotypes** that may result from this mating? (Include a description of both hair and forehead for each phenotype.)
b. What is the expected phenotypic ratio of a dihybrid cross?
c. What fraction of their offspring will be heterozygous for both genes?
d. What fraction will be homozygous for both genes?
e. Are Kayless and his mate more likely to see an actual ratio close to that predicted if they have 16 children or 160? Why? In other words, what effect does larger sample size have on observed phenotypic ratios?

❖ **Problem 8** A plant with orange spotted flowers was grown in the greenhouse from a seed collected in the wild. The plant was self-pollinated and gave rise to the following progeny: 91 orange spotted 31 yellow spotted 32 orange plain, and 10 yellow plain. What can you conclude about the dominance relationships of plain vs. spotted? Of orange vs. yellow? What can you conclude about the genotype of the original "orange-spotted" plant?

NOTE: Problems 9, 10 & 11 on the following pages are different variations of the same type of problem. If you want more practice on this type of problem, work text problems 28 & 29 at the end of Chapter 3

❖ **Problem 9** The wild-type fruitfly *Drosophila melanogaster* has straight wings and long bristles. Mutant strains have been identified that have curled wings or short bristles. The genes for these two traits are autosomal.

CAREFULLY EXAMINE THE DATA IN THE TABLE BELOW.

a. Which traits are dominant?

b. Are the genes for these traits on different chromosomes?

c. For each cross, give the genotypes of the parents. Fill in the table below using the following allele designations:

w^+ = straight wings, w = curled wings b^+ = long bristles, b = short bristles

Genotype of parents:

Cross #1..

Cross #2..

Cross #3..

Cross #4..

Cross #5..

Cross	Parental phenotype male	X female	Number of progeny in each class (160 total for each cross): straight wings long bristles	straight wings short bristles	curled wings long bristles	curled wings short bristles
#1	straight, short	straight, short	30	90	10	30
#2	straight, long	straight, long	120	0	40	0
#3	curled, long	straight, short	40	40	40	40
#4	straight, short	straight, short	40	120	0	0
#5	curled, short	straight, short	20	60	20	60

❖ **Problem 10** In the sesame plant, phenotypic variants exist with respect to the number of seed pods per leaf axil (one-pod vs. three-pod) and the morphology of the leaf (smooth vs. wrinkled). The gene controlling these two traits are located on different chromosomes.

a. Examine the crosses below. Which traits are dominant?

b. Use the following allele symbols and indicate the genotypes of the parents for each cross. p^1= one-pod p^3 = three-pod l^s = smooth leaf l^w = wrinkled leaf

GENOTYPES OF PARENTS:

Cross 1...

Cross 2...

Cross 3...

Cross 4...

Progeny Phenotypes

Parents	1-pod smooth	1-pod wrinkled	3-pod smooth	3-pod wrinkled
#1 1-pod smooth X 3-pod smooth	300	100	300	100
#2 1-pod smooth x 1-pod wrinkled	100	100	33	33
#3 1-pod smooth X 3-pod wrinkled	200		200	
#4 1-pod wrinkled X 3-pod smooth	100	100	100	100

❖ **Problem 11** In tomatoes, stem color (***purple vs green***) is controlled by a single-gene that is located on chromosome 5. Likewise, plant height ***(tall versus dwarf)*** is controlled by a gene located on chromosome 1.
a. Examine the crosses below. Which traits are dominant? By each dominant trait, indicate which cross(es) you used to determine dominance
b. Define allele symbols. If you are using upper and lower case letters that look the same, be sure to make ***the size difference very clear*** (**for example: *C* vs *c*)**

FILL IN THE GENOTYPES OF PARENTS FOR EACH CROSS:
INDICATE IF THERE IS MORE THAN ONE POSSIBILITY

Cross 1

Cross 2

Cross 3

Cross 4

Progeny Phenotypes/Counts

Parents	purple tall	purple dwarf	green tall	green dwarf
#1 green, tall X green, tall	0	0	300	100
#2 purple, tall X green, dwarf	100	100	100	100
#3 green, tall X green, tall	60	20	180	60
#4 purple, tall X green, tall	300	100	300	100

❖ **Problem 12** Wild-type foxgloves have single flowers. In a population of flowers growing in British Columbia you discover a phenotypic variant that has double flowers. Pollen from the double plant is used to fertilize several different wild-type plants obtained from the same location in BC. In each case, a 1:1 ratio of single to double is observed in the progeny of each cross. Carefully interpret these data. [Keep in mind that the wild-type parents are taken directly from a wild population.]

Some T/F and Multiple Choice Problems from previous exams: Each question may have more than one answer. To get full credit you must circle all correct answers and no incorrect answers. Partial credit is possible for these questions.

❖ **Problem 13** Which of the following statements are true for an organism, such as the tobacco plant, where 4n = 48. Circle all correct answers.
a. Before S phase, a single copy of the tobacco genome is contained in 4 double-stranded polymers of DNA.
b. Before S phase, a single copy of the tobacco genome is contained in 12 double-stranded polymers of DNA.
c. Each somatic (non-sex) cell of this plant contains 24 chromosomes and the final products of meiosis contain 12 chromosomes.
d. Each somatic (non-sex) cell of this plant contains 48 chromosomes and the final products of meiosis contain 24 chromosomes.
e. There are four copies of each chromosome in each somatic (non-sex) cell. A single complete set is comprised of 12 chromosomes
f. There are four copies of each chromosome in each somatic (non-sex) cell. A single complete set is comprised of 24 chromosomes

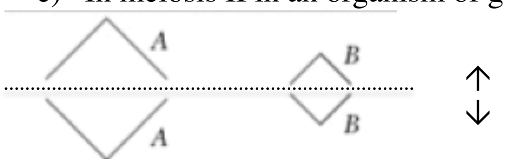
❖ **Problem 14:** Which of the following statements are true for an organism where **3n = 12.** Circle T or F for each statements. Answer false if any part of the statement is false.
T F There are four copies of each chromosome in each somatic (non-sex) cell
T F Before S phase, a single copy of the genome is contained in four double-stranded polymers of DNA.
T F After S phase and before mitosis, there are 24 double-stranded polymers of DNA in the somatic cell.
T F Each somatic (non-sex) cell of this plant contains 12 chromosomes and the final products of meiosis contain 6 chromosomes.

Problem 16: Consider the self progeny of an F1 organism of genotype AaBb.
1. What is the probability that a given F2 is phenotypically dominant for both traits?
2. What fraction of F2 plants will show both dominant traits?
➔ *When are the answers to 1 & 2 likely to be the same?*
➔ *When might 2 be different from 1?*

❖ **Problem 17:** Examine the diagrams shown below which were taken from one your assigned problems in Chapter 3. Each line represents a single molecule of double-stranded DNA, which will segregate as indicated.

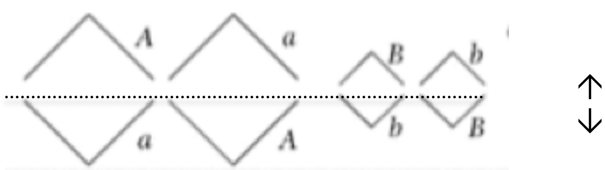
A. ***Diagram #1 (below). Choose all correct interpretations.***

a) This drawing shows a 1n=2 cell undergoing mitosis
b) This drawing shows a 2n=2 cell undergoing mitosis
c) In meiosis II in an organism of genotype AABB, all MII divisions will look like this
d) In meiosis II in an organism of genotype AaBB, ½ of MII divisions will look like this
e) In meiosis II in an organism of genotype AaBb, ½ of MII divisions will look like this



B. ***Examine Diagram #2 (below).*** This drawing is consistent with which of the scenarios listed below? ***Choose all correct interpretations.***

a) Mitosis in a 2n=4 cell of genotype AaBb
b) Mitosis in a 4n=8 organism of genotype AaBb
c) Meiosis I in a 2n=4 organism of genotype AaBb
d) Meiosis I in a 4n=8 organism of genotype AaBb
e) None of these interpretations are correct



Problem 18: How does meiosis explain Mendel's principle of independent assortment?

a. What does Mendel's principle of independent assortment predict about the gamete composition of an individual of genotype AaBb, where the (A & a are alleles of one gene and B & b are alleles of another gene on a different chromosome)?

b. Draw a diagram that shows the physical basis for independent assortment. **Show only metaphase of Meiosis I and Meiosis II** and the final products. **LABEL** sister chromatids, homologous chromosomes, and place the different alleles of the two genes on your drawings of the chromosomes.

- *Be sure to account for all gamete classes and the gamete ratios.*
- *Your answer must not involve any crossing over events*
- *Do NOT draw out all of the stages of meiosis.*
- *alleles should be indicated on each portion of your drawing*
- *please make your drawing big enough so that the labels don't obscure the chromosomes*