Name _____

Date _____ Hour _____

provide a useful model system for studying fertilization and the genes that are expressed during the early stages of development, they are not very useful for studying other aspects of heredity and development.

MATERIALS

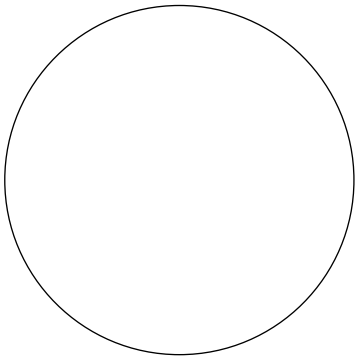
For each group of four students:
- 1 or 2 glass depression slides
- 2 or 3 dropping pipettes
- a compound microscope
- an egg suspension
- a sperm suspension
- a sample of previously fertilized eggs

PROCEDURE

Collecting Sea Urchin Gametes

1. Your teacher will demonstrate the technique used to get the sea urchins to spawn. It involves injecting a bit of a KCl solution into the body cavity. This creates a mild stress that (like many other mild stresses) causes the urchins to release their gametes. The eggs will be collected in a beaker of sea water. The sperm will be collected in a dry tube, and diluted with sea water later.

2. When your teacher informs you that the eggs are ready, use a pipette to pick up a drop of an egg suspension and place it on a clean glass depression slide. Examine the slide in your microscope with a 4X or 10X objective. The eggs are small and round. Draw a picture of their appearance in the microscope.



Sea urchin eggs

3. You will have the best chance of being able to view the fertilization process if you have 10-20 eggs in your depression slide. If you have more than that, remove part of the sample and replace it with sea water.

Name _____

Date _____ Hour _____

Fertilization

4. Your teacher will inform you when a sperm suspension is ready. Using a clean pipette, add a drop of this sperm suspension to the egg suspension on your slide. It is very important not to add too many sperm. If you do, the water will become too cloudy to see the eggs clearly, and excess sperm will cause abnormal development of the embryos. The correct amount is when 10-100 sperm can be seen around each egg.

5. Observe the sperm-egg mixture with a 4X or 10X objective. Draw what you observe. Fertilization will be evident when a fertilization membrane forms around the egg. Draw what this looks like.

Sperm and egg mixture

Fertilized sea urchin egg

6. The eggs that you fertilized in the depression slide probably will not continue to develop normally while being viewed with the microscope; the light source will heat them up too much. Your teacher will prepare a mixture of sperm and eggs in a beaker and leave it on the bench top. You should examine a drop of this suspension every 15 minutes or so to monitor development. The first division should occur about an hour after fertilization. Draw pictures of the divisions. Your teacher may also have samples of eggs that were fertilized some time before your class began that you can examine to see more advanced stages of development.

1 hour

1 1/2 hours

2 hours

2 1/2 hours

Name _____

Date _____ Hour _____

POSTLAB QUESTIONS

1. If the body cells found in one particular species of an adult sea urchin have 14 chromosomes, how many chromosomes would an egg or sperm of that species have?

_____

2. What do you think would happen if one of the gametes (either the egg or the sperm) had the wrong number of chromosomes? Why?

_____

3. What are some differences between a fertilized and unfertilized egg?

_____

4. What is the function of the fertilization membrane? Why would that be important?

_____

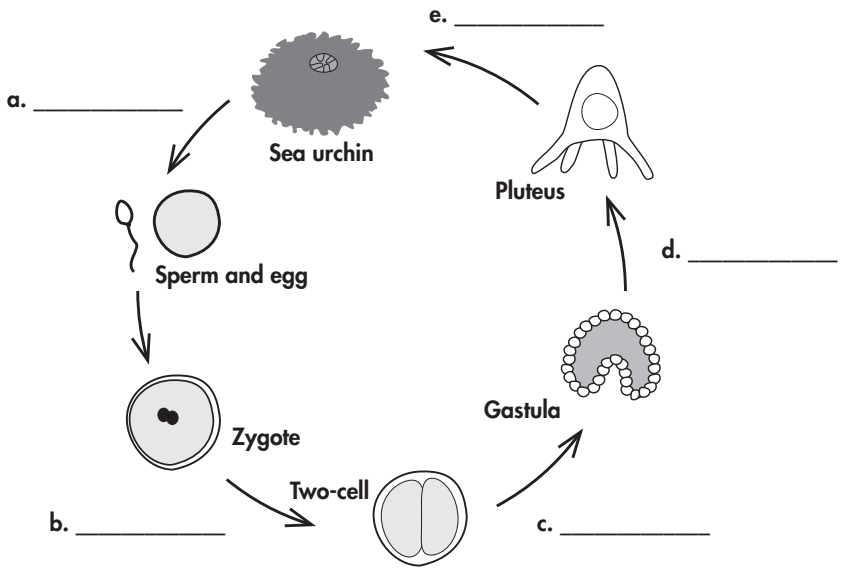
5. What happens to the fertilized egg about an hour after fertilization?

_____

6. When a cell of an embryo divides, how are each of the newly formed cells similar to one another and to the original fertilized egg but different from the unfertilized egg?

_____

7. Mitosis and meiosis are essential aspects of the cycle of life and development. Complete the diagram below by writing mitosis or meiosis on the correct lines.



Name _____

Date _____ Hour _____

The Miracle of Life

WITH ANY LUCK, IN the preceding exercise you saw male and female sea urchins release sperm and eggs and then you watched those cells fuse and initiate the development of a new generation. Now, through the wonders of modern technology, you will be able to follow this up with extraordinary views of the equivalent processes in human beings. The exceptional photography in the video *The Miracle of Life* will take you on a journey through the reproductive tracts of both the human female and the human male and will allow you to observe the numerous stages of the human reproductive process- from the early stages of gamete development, through the moment of conception, and to the moment of birth.

Read the questions on the work sheet below and on the next page before the video begins. As you watch the video, take notes to help you answer the questions later. Then write your answers on the work sheet in complete sentences.

THE MIRACLE OF LIFE QUESTIONS

1. Describe the journey of the egg as it becomes mature and travels toward the sperm.

_____

_____

2. Describe the journey of the sperm as they leave their site of origin and travel toward the exterior.

_____

_____

3. About how many sperm does a man produce in his lifetime?

_____

4. About how many sperm are released in a single ejaculation?

_____

5. After sperm are released into the vagina, how long are they viable?

_____

Name _____

Date _____ Hour _____

6. Describe the barriers that the sperm face as they travel up the female reproductive tract toward the egg.

_____

_____

7. Where is the egg when the sperm reach it?

_____

8. About how many sperm reach the egg?

_____

9. What happens to the sperm after it enters the egg?

_____

10. When does the fertilized egg begin dividing?

_____

11. What is the fertilized egg called after it divides?

_____

12. How long after fertilization does the embryo implant itself in the uterine wall?

_____

13. Describe the human embryo at the following stages:
Example: 4 weeks: It has arm buds and the beginnings of eyes.

5 weeks: _____

6 weeks: _____

7 weeks: _____

8 weeks: _____

10 weeks: _____

14 weeks: _____

18 weeks: _____

C.1

Name _____

Date _____ Hour _____

PROCEDURE

If you find any words in the instructions below that you do not understand, check out the Genetic Glossary (page S 93).

1. You and your lab partner will receive an envelope that contains 14 red chromosomes that belong to Mom Reebop and 14 green chromosomes that belong to Dad Reebop. Decide which of you will act as Mom and which will act as Dad. Place your chromosomes on the table in front of you, letter side down. Your lab partner should do the same with the other set of chromosomes.

2. Arrange your 14 chromosomes into pairs by length and width. Select one chromosome from each of your seven pairs and place all seven in a special "gamete" (egg or sperm) pile. Your lab partner should do the same. The leftover chromosomes should now be returned to the envelope.

   What type of cell division has just occurred? _____

3. Combine the seven red and seven green chromosomes from the two gamete piles to form a "baby" pile. Now each Reebop baby will have 14 chromosomes just like Mom and Dad did. But half will be red and half green, indicating that half came from Mom and half from Dad.

4. Line up the chromosomes contributed to the baby by Mom and Dad in pairs of similar size, letter side up. You will see that each chromosome in a pair carries a gene of similar type (same letter of the alphabet).

   Some chromosome pairs might carry the same allele (either both capital letters or both lower case), indicating that the baby is homozygous (has two alleles of the same type) for the kind of gene carried on that chromosome.

   Other chromosome pairs might carry one dominant (capital letter) allele and one recessive (lower-case) allele, indicating that the baby is heterozygous (has two alleles of different type) for the kind of gene carried on that chromosome.

   The combination of genes carried on these seven chromosome pairs defines your Reebop baby's genotype (genetic constitution). Record this genotype on the lines below.

   ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

Name _____

Date _____ Hour _____

5. Refer to the Reebop Genotype-Phenotype Conversion Table on page S94 to determine your baby's phenotype. Record the phenotype on the lines below, keeping the phenotypic traits in the same order as the genes you listed in step 4.

_____ _____ _____

_____ _____ _____ _____

6. You are now ready to construct your Baby Reebop. Collect the body parts that you will need and return to your desk to build your baby.

Name _____

Date _____ Hour _____

REEBOP REVIEW

1. Define the following terms and give an example of each from this activity. (You may refer to the Genetic Glossary.)

   allele: _____

   genotype: _____

   phenotype: _____

   homozygous: _____

   heterozygous: _____

2. If a Reebop female with a red nose and a Reebop male with a yellow nose marry and have children, what genotype and phenotype for nose color will their children have? (You may refer back to the Reebop Genotype-Phenotype Conversion Table.)

   genotype _____ phenotype _____

3. If a Reebop female with one antenna and a Reebop male with no antennae marry and have children, what genotypes and phenotypes might their children have with respect to number of antennae?

   genotypes _____ _____ phenotypes _____ _____

4. If a Reebop female with one antenna and a Reebop male with one antenna marry and have children, what is the probability that they will have a baby with no antennae? (If you have a problem with this question, check out section C.2!)

   _____

5. If a Reebop female with two green humps and a Reebop male with two green humps marry and have children, what is the probability that their first baby will have two green humps?

   _____

6. If a Reebop female with three green humps and a Reebop male with three green humps marry and have children, what is the probability that they will have a baby with two green humps?

   _____

7. If a Reebop baby has a straight tail, but both of his parents have curly tails, what are genotypes of the two parents?

   _____

C.1

Name _____

Date _____ Hour _____

CLASS REEBOP DATA

FILL IN THE NUMBER of Reebops found in your class with the following heritable traits:

Antennae		**Nose color**		**Humps**	
One	_____	Red	_____	One	_____
Two	_____	Orange	_____	Two	_____
None	_____	Yellow	_____	Three	_____

Eyes		**Segments**		**Tail**		**Leg color**	
One	_____	Two	_____	Curly	_____	Blue	_____
Two	_____	Three	_____	Straight	_____	Red	_____

ANALYSIS OF REEBOP FINDINGS

1. Describe the phenotypes of Mom and Dad Reebop.

   _____

2. Using the information in the Reebop Genotype-Phenotype Conversion Table, list all the possible genotypes that would produce the phenotypes exhibited by Mom and Dad.

   _____

3. How many of the Reebop babies in your class have the same phenotypes as Mom or Dad?

   _____

4. Do any two babies in your class have exactly the same phenotypes?

   _____

5. Why do some Reebop babies have traits that are not seen in either Mom or Dad?

   _____

Name _____

Date _____ Hour _____

6. Which Reebop traits are dominant?

_____

7. Which Reebop traits exhibit codominance?

_____

8. Use the information you have about the phenotypes of all of the Reebop babies in your class to figure out what the genotypes of Mom and Dad Reebop are. Write the answer below.

_____

9. If you know the genotype of the parents, is it possible to predict all of the possible genotypes of babies that they might produce?

_____

10. If you know the genotype of the parents, is it possible to predict the genotype of any particular baby, such as their first one?

_____

11. The Reebops appear to have only one gene on each chromosome. Do you think this is true of real, living organisms?

_____

Name _____

Date _____ Hour _____

3. Above the two boxes at the top place letters corresponding to the genotypes of the haploid eggs a female of the specified genotype (in this case, *Aa*) would produce following meiosis (fig. 2).

4. Beside the two boxes on the left place letters corresponding to the genotypes of sperm a male of the specified genotype (*Aa*) would produce following meiosis (fig. 2).

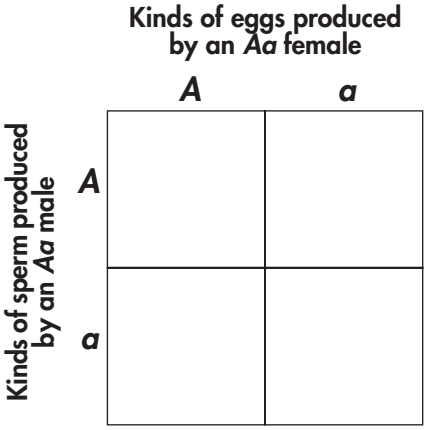


Figure 2

5. Next, place letters in each of the smaller boxes indicating the genotype that would be produced if an egg of the type indicated above were combined with a sperm of the type indicated to the left (fig. 3). These are the four genotypes that would be formed with equal likelihood when an egg is selected at random and combined with a sperm that is also selected at random.

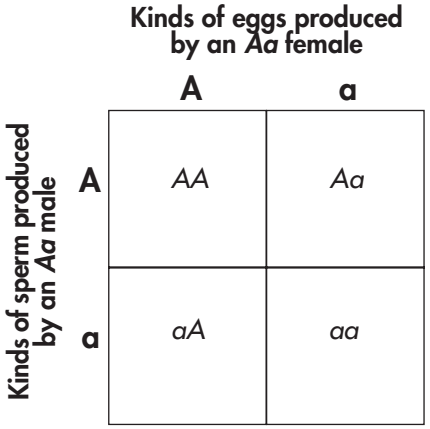


Figure 3

6. Now in each box place words indicating the phenotype that is associated with the genotype specified in that box (fig. 4).

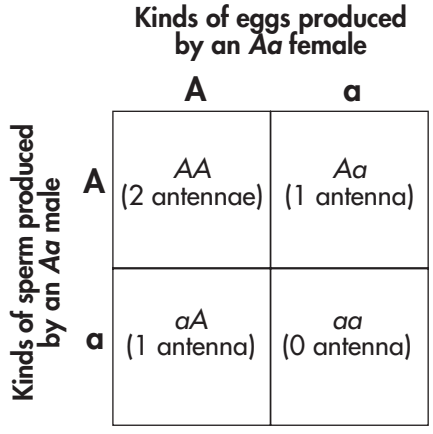


Figure 4

7. Now determine how many of the four equally likely genotypes will result in the phenotype that the question asked about. In this case we get the answer that the probability of having a baby with two antennae is 1 in 4.

C.3

Name _____

Date _____ Hour _____

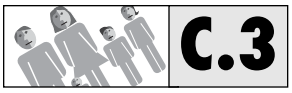
CREATE-A-BABY TABLE

Parent 1's name (the Mom)_____ _____

Parent 2's name (the Dad)_____ _____

Baby's name _____ _____

Trait	Parent 1's Genotype	Parent 2's Genotype	Baby's Genotype	Baby's Phenotype
Gender				
Mole				
Eyebrows (size)				
Eyebrows (texture)				
Eyebrows (shape)				
Eyes (shape)				
Earlobes (shape)				
Cheeks (freckles)				
Cheeks (dimples)				
Chin (dimple)				
Chin (shape)				
Mouth (shape)				
Hairline				
Face (shape)				
Nose (size)				
Lips (size)				
Hair (curliness)				
Eye (separation)				
Eyelashes (length)				
Hair (color)				
Eyes (color)				
Skin (color)				



C.3

Name _____

Date _____ Hour _____

CREATE-A-BABY REVIEW

1. Define each of the following terms.

   chromosome: _____

   codominant: _____

   diploid: _____

   haploid: _____

   meiosis: _____

   multigenic: _____

   recombination: _____

2. What was the probability that you and your partner would produce a boy? A girl? Explain.

   _____

3. Explain how it is possible for your baby to have a visible trait that neither you nor your partner have.

   _____

4. If you and your partner repeated this exercise and produced another imaginary baby, do you think it would look just the same as the one you produced already? Explain.

   _____

5. A woman who is heterozygous for the chin-dimple trait marries a man without a chin dimple. What are the possible genotypes and phenotypes of their children?

   _____

6. What is the probability that the man and woman discussed in the preceding question will have a baby with a chin dimple?

   _____

Name _____

Date _____ Hour _____

7. A man and a woman who are both heterozygous for two traits, the cheek-dimple and the chin-dimple traits, get married. What is the probability that they will have a baby that has cheek dimples but not a chin dimple? (If you have trouble answering this question, check out section C.4.)

_____

_____

_____

_____

8. What is the probability that a man with dark blonde hair and a woman with red hair will have a baby with brown hair?

_____

_____

_____

_____

Name _____

Date _____ Hour _____

DAY 2 WORK SHEET

1. Describe the appearances of the four colonies of haploid yeast cells at the beginning of class on Day 2.

   _____

   _____

2. Formulate a hypothesis about the genetic difference that causes the difference in appearance of the red and white yeast strains.

   _____

   _____

3. Which color trait do you think will be dominant, or do you think that they will be codominant? Why?

   _____

   _____

4. Based on the above hypotheses, what do you predict the color phenotypes of the diploids will be in the following four crosses that you have set up?

   Red Mating type ***A*** x Red Mating type α _____

   Red Mating type ***A*** x White Mating type α _____

   White Mating type ***A*** x Red Mating type α _____

   White Mating type ***A*** x White Mating type α _____

Name _____

Date _____ Hour _____

Day 3: Observing Your F1 (A/α Diploids)

1. Get your petri dish and observe your results.

   Even though there are no sperm and eggs involved, a Punnett square diagram can be used to record and analyze the results of yeast crosses such as the ones you performed. Use your observed results to fill in the blanks on the Punnett square on the Day 3 Work sheet on the next page.

2. Are any of your results unclear? If so, indicate which ones, describe what you see, and provide a good explanation for these results.

   _____

   _____

3. If any of your test circles contain a mixture of red and white cells, incubate the dish for another day and see if things change. If they do, be sure to record this on your Day 3 Work Sheet.

4. When you are through working with your cultures, spray disinfectant in your dish, tape it shut, and dispose of it as instructed by your teacher. Wipe your work area with disinfectant. Wash your hands.

5. Finish filling out the Day 3 Work Sheet.

Name _____

Date _____ Hour _____

DAY 3 WORK SHEET

1. Use the results from your yeast crosses to fill in the blanks on the diagram below:

Mating type α \ Mating type **A**	**R**	**W**
R	Genotype _____ Phenotype _____	Genotype _____ Phenotype _____
W	Genotype _____ Phenotype _____	Genotype _____ Phenotype _____

2. What ratio of phenotypes did you observe as a result of the four crosses you performed?

_____

3. What does this indicate about which allele is dominant and which is recessive?

_____

4. Is this what you predicted on your Day 2 Work Sheet?

_____

5. In the table below, list what you predicted and what you observed for each of the four crosses.

Cross	**Predicted Phenotype of Diploid**	**Observed Phenotype of Diploid**
Red Mating type ***A*** by Red Mating type α		
Red Mating type ***A*** by White Mating type α		
White Mating type ***A*** by Red Mating type α		
White Mating type ***A*** by White Mating type α		

Name _____

Date _____ Hour _____

6. If your predicted and observed phenotypes do not agree, how can you account for that, and can you propose a good hypothesis to account for the results you actually observed?

_____

_____

7. If you have come up with a new hypothesis, can you think of a way to test it?

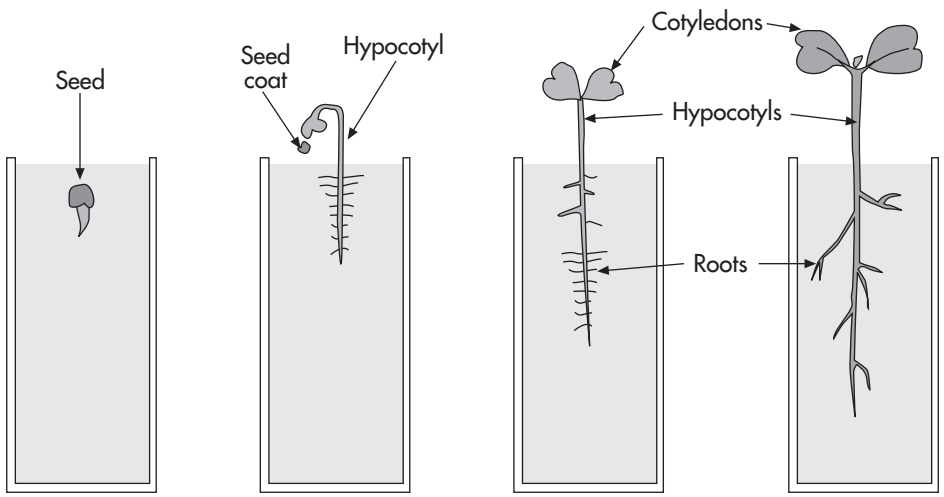
_____

_____

D.2

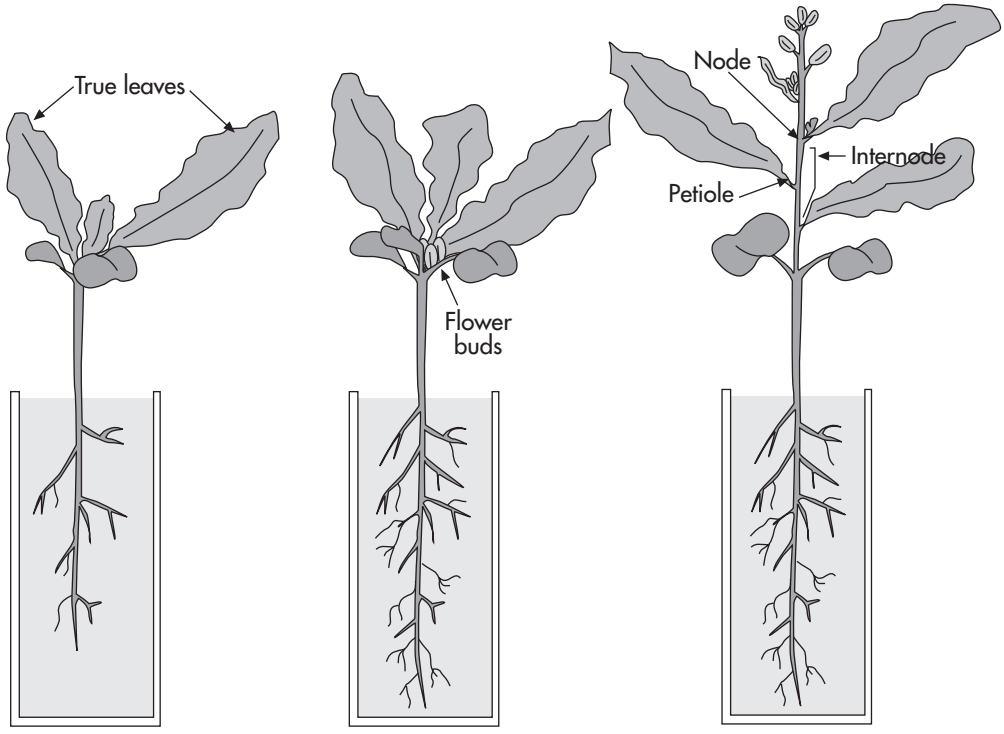
Name _____

Date _____ Hour _____



Calendar date _____ _____ _____ _____

Days since planting _____ _____ _____ _____

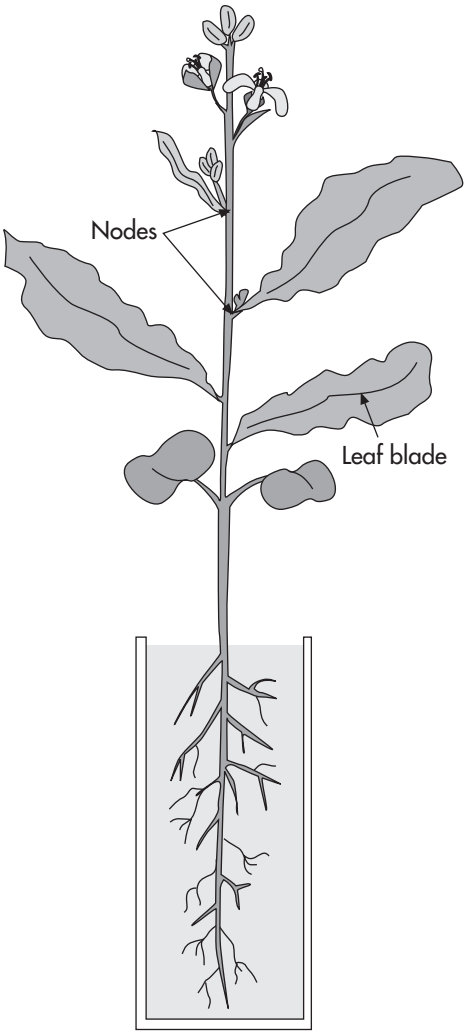


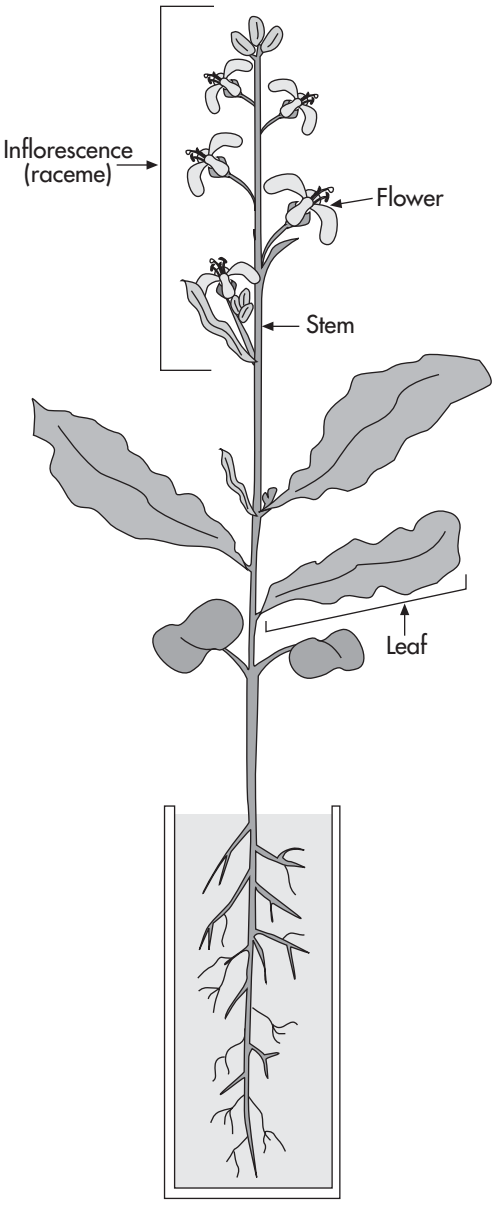
Calendar date _____ _____ _____

Days since planting _____ _____ _____

Name _____

Date _____ Hour _____

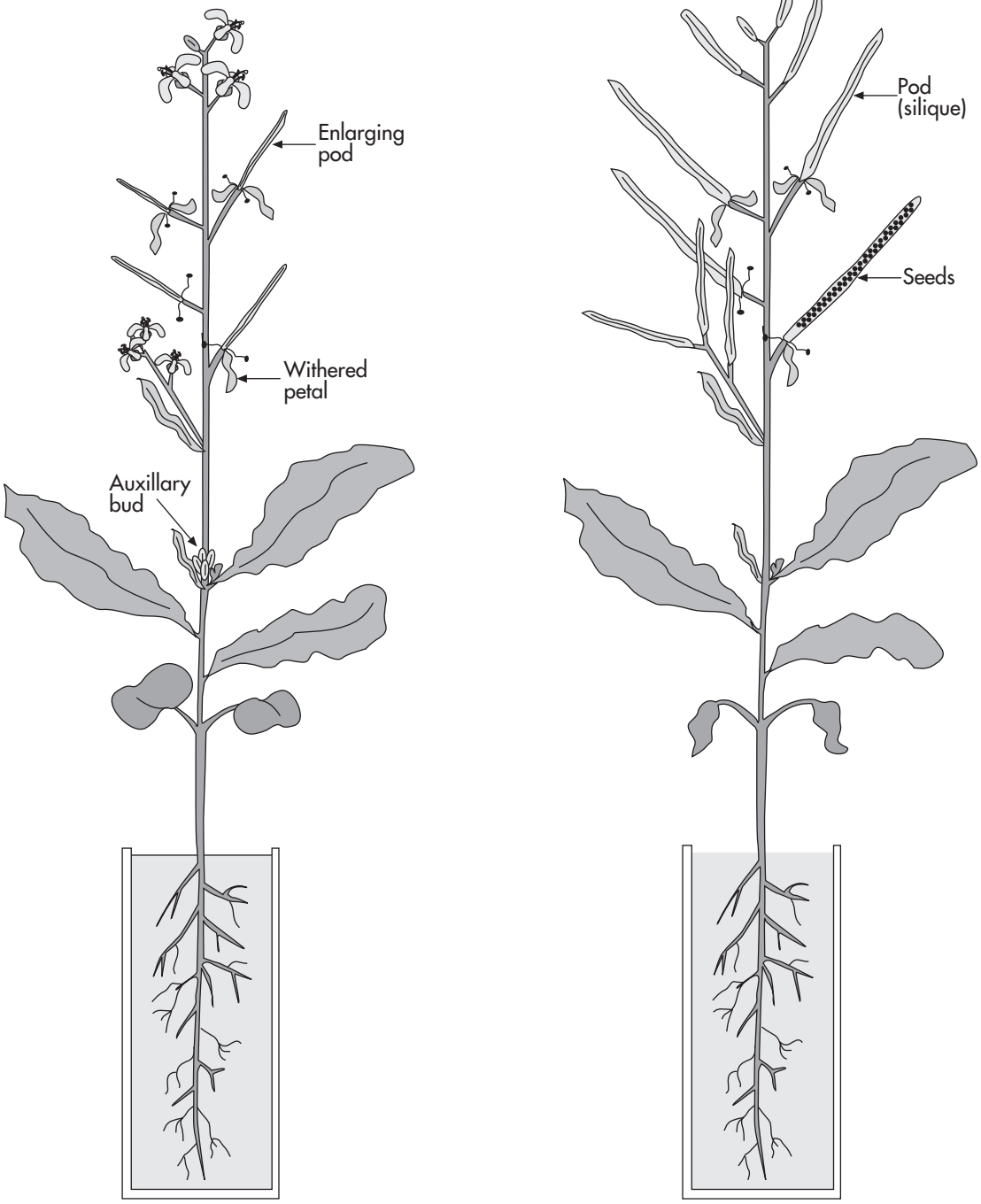




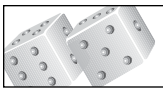
Calendar date	_____	_____
Days since planting	_____	_____

Name _____

Date _____ Hour _____



Calendar date	_____	_____
Days since planting	_____	_____



D.2

Name _____

Date _____ Hour _____

WISCONSIN FAST PLANTS OBSERVATIONS

Be sure to date all comments.

Name _____

Date _____ Hour _____

WISCONSIN FAST PLANTS OBSERVATIONS (CONTINUED)

Name _____

Date _____ Hour _____

WISCONSIN FAST PLANTS WORK SHEET

1. What are the two mutant traits that distinguished your PA and PB plants from one another and from wild-type Wisconsin Fast Plants?

   The PA plants are _____ mutants.
   The PB plants are _____ mutants.

2. If the mutant traits exhibited by the P_1 and P_2 generation are heritable, why didn't those two traits appear in their progeny in the F_1 generation?

   _____

   _____

3. Based on your explanation above, what would you predict that the ratio of wild-type to mutant individuals should have been for each of these two traits in the F_2 generation? Explain.

   _____

   _____

4. Above each of the tables below, record how many F_2 plants germinated and grew large enough that their phenotypes could be determined with confidence. Then in the right hand column of each table record how many of these F_2 plants had each of the indicated phenotypes.

Table 1.A. Data collected by our own group.
The number of plants analyzed was _____.

Phenotype	**Number of F_2 plants**
Wild-type with respect to the PA trait:(_____)	
Mutant with respect to the PA trait: (_____)	
Ratio of wild-type to mutant: _____ to _____	
Wild-type with respect to the PB trait:(_____)	
Mutant with respect to the PB trait:(_____)	
Ratio of wild-type to mutant: _____ to _____	

Name _____

Date _____ Hour _____

Table 1.B. Combined data for the whole class.

The number of plants analyzed was _____.

Phenotype	Number of F_2 plants
Wild-type with respect to the PA trait:(_____)	
Mutant with respect to the PA trait:(_____)	
Ratio of wild-type to mutant: _____ to _____	
Wild-type with respect to the PB trait:(_____)	
Mutant with respect to the PB trait:(_____)	
Ratio of wild-type to mutant: _____ to _____	

5. With respect to the PA trait, how does the ratio of wild-type to mutant individuals that you predicted in Question 3 compare to the ratios of wild-type to mutant individuals that you reported in tables 1A and B?

   The predicted wild-type-to-mutant ratio was ____:1
   The wild-type-to-mutant ratio we observed with our group's F_2 plants was ____:1
   The wild-type-to-mutant ratio observed by the entire class was ____:1
   In your opinion, are these differences between the predicted and the observed wild-type-to-mutant ratios significant?
   Yes ____ No ____ Can't decide ____
   Explain

   _____

   _____

6. How do the predicted and observed wild-type-to-mutant ratios for the PB trait compare?

   The predicted wild-type-to-mutant ratio was ____:1
   The wild-type-to-mutant ratio we observed with our group's F_2 plants was ____:1
   The wild-type-to-mutant ratio observed by the entire class was ____:1
   In your opinion, are these differences between the predicted and the observed wild-type-to-mutant ratios significant?
   Yes ____ No ____ Can't decide ____
   Explain

   _____

   _____

Name _____

Date _____ Hour _____

7. How confident are you of the validity of your answer to Question 6?
   Very confident ____ Fairly confident ____ Not at all confident ____
   Explain your answer:

   _____

   _____

8. Record the observed phenotypes of the F_2 plants with respect to combinations of P_1 and P_2 traits.

   In tables 1A and B (Question 4) you recorded the number of F_2 plants that were wild-type or mutant with respect to the P_A and P_B traits individually. In the next two tables record the numbers of F_2 plants that had each of the four possible combinations of these two traits.

Table 2.A. Data collected by our own group.

The number of plants analyzed was _____.

Phenotype with respect to the P_A trait: (_____)	**Phenotype with respect to the P_B trait: (_____)**	**Number of F_2 plants**
Wild-type	Wild-type	
Mutant	Wild-type	
Wild-type	Mutant	
Mutant	Mutant	

Table 2.B. Combined data for the whole class.

The number of plants analyzed was _____.

Phenotype with respect to the P_A trait: (_____)	**Phenotype with respect to the P_B trait: (_____)**	**Number of F_2 plants**
Wild-type	Wild-type	
Mutant	Wild-type	
Wild-type	Mutant	
Mutant	Mutant	

Name _____

Date _____ Hour _____

9. In the table below, compare the ratios of the four possible combinations of P_A and P_B traits that you and your class observed with the ratios that are predicted for this kind of dihybrid cross. In each case, set the number of double mutants to one.

Phenotypic combinations	Predicted ratio for a dihybrid cross*	Ratio observed in our own plants‡	Ratio observed for entire class‡
Wild-type for the P_A trait and wild-type for the P_B trait			
Mutant for the P_A trait and wild-type for the P_B trait			
Wild-type for the P_A trait and mutant for the P_B trait			
Mutant for the P_A trait and mutant for the P_B trait	1	1	1

* You can obtain this ratio either by (a) using the product-of-probabilities method, (b) using a Punnett Square, or (c) reviewing similar calculations that you made for Exercise 2.C.3 (Create-a-Baby).

‡ To obtain the numbers for each of these blanks, divide the number of plants observed in that category by the number of double-mutant plants observed in the same data set.

10. Do you think that the differences between the predicted and the observed ratios in the above table are significant?

    Yes ____ No ____ Can't decide ____
    Explain

    _____

    _____

11. How confident are you of the validity of you answer to Question 10?
    Very confident ____ Fairly confident ____ Not at all confident ____
    Explain

    _____

    _____

Note: The next unit (2.E) illustrates a mathematical method that many biologists use to determine whether differences between predicted results and observed results in an experiment such as this one are significant. You may find it interesting to review this unit, even if your teacher does not make it a class assignment.

Name _____

Date _____ Hour _____

WISCONSIN FAST PLANTS CHI SQUARE WORK SHEET B

The data necessary for performing the following Chi square tests should be recorded on your Fast Plants Phase 2 Work Sheet.

Part One: A Simple Trial Run

To become familiar with running the Chi square test, let's apply it to just one of the mutant traits that showed up in your F_2 plants.

One half of the class should calculate χ^2 and p values for the trait that was exhibited by the P_A plants, and the other half of the class should do this for the P_B trait. In both cases the pooled data from the entire class should be used for the analysis. And in both cases we will assume that the hypothesis to be tested is that the trait in question is controlled by a single gene with two alleles, with the mutant allele being recessive to the wild-type allele. Thus, in both cases the expected wild-type-to-mutant frequency will be 3:1.

The mutant trait I am analyzing by χ^2 is _____

Total number of F_2 plants obtained by the class: _____.

Phenotype	Expected #	Observed #	Difference	(Difference)^2
Wild-type				
Mutant				

Multiply the total number of F_2 plants by the expected frequencies (3/4 and 1/4) to get the expected numbers of plants in each category. You probably will get non-integral numbers.

$$\chi^2 = \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}} \text{ summed for all classes}$$

(Remember: in this formula "classes" refers to phenotypic classes of plants, not classes of students.)

χ^2: _____ p_____ Use the table on page S150 to determine the value of p.

Conclusion: _____

_____

Name _____

Date _____ Hour _____

Part Two: Chi Square Analysis of the Two Phenotypes at Once

Now that you have performed a Chi square analysis for one phenotype (the PA or PB trait), it should be easy for you to modify the analysis to consider both phenotypes at once.

What you will be able to test this way is whether plants with the four possible combinations of mutant and wild-type traits are present in the F_2 generation in proportions that are not significantly different from the proportions that are predicted by either a Punnett Square diagram, or a product-of-probabilities calculation. If the observed ratios are not significantly different from the predicted ratios, this will indicate that alleles at the two different loci that are being considered exhibit what biologists call "independent assortment." (That is to say, the allele an offspring receives from one of its parents at one locus is independent of the allele that it receives from that parent at the other locus.)

Independent assortment of alleles at two loci always occurs if those loci are on separate chromosomes. However, if the two loci are located close together on the same chromosome, they will exhibit "linkage," which is the opposite of independent assortment. In such cases, an allele at one locus will travel from parent to offspring together with the allele at the second locus with which it is physically linked on a particular parental chromosome. This will result in the F_2 generation exhibiting an overabundance of individuals with the two allelic combinations that their grandparents had, and a deficiency of the other two possible combinations. In extreme cases of linkage, only two of the four possible combinations will be observed.

So, in short, what we will be asking with this next Chi square analysis is whether or not the relative abundance of F_2 plants with the four different phenotypic combinations is significantly different from the proportions predicted on the assumption of independent assortment of alleles at the two different loci we are studying.

COMBINED DATA FOR THE ENTIRE CLASS **TOTAL NUMBER OF F2 PLANTS: _____**

PA phenotype	PB phenotype	Frequency expected*	Number expected	Number observed	Difference	Difference^2
Wild-type	Wild-type					
Mutant	Wild-type					
Wild-type	Mutant					
Mutant	Mutant					

*You can obtain these frequencies by either (a) using the product-of-probabilities method, (b) using a Punnett Square, or (c) reviewing similar calculations you made for previous exercises.

χ^2: _____ p_____

Name _____

Date _____ Hour _____

Conclusion: _____

_____