Build-a-Bird: The Pigeon Gene Shuffle
LT: I can model recombination to determine traits of offspring.

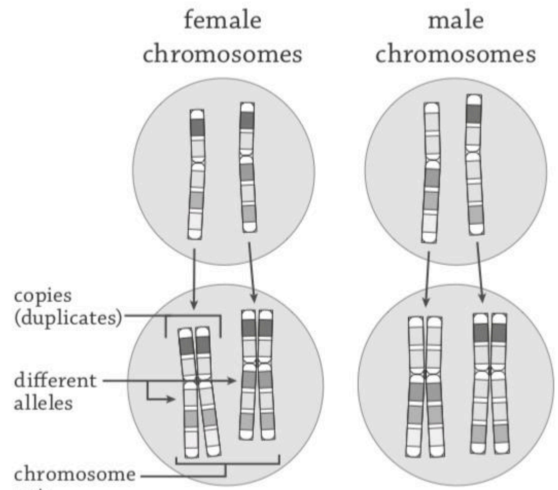
Standard 4.2.1

Background

Animals that reproduce sexually make gametes, also known as eggs and sperm in most animals. Making gametes requires a special type of cell division, during which alleles are shuffled and recombined to make a nearly infinite number of allele combinations.

After the cell copies its DNA, the DNA coils up tightly, forming structures called chromosomes.

- Each chromosome is made up of one very long DNA molecule.
- A single chromosome can have hundreds or even thousands of genes.
- Most sexually reproducing organisms have two copies of each chromosome.



For this activity, the chromosomes have already been duplicated.

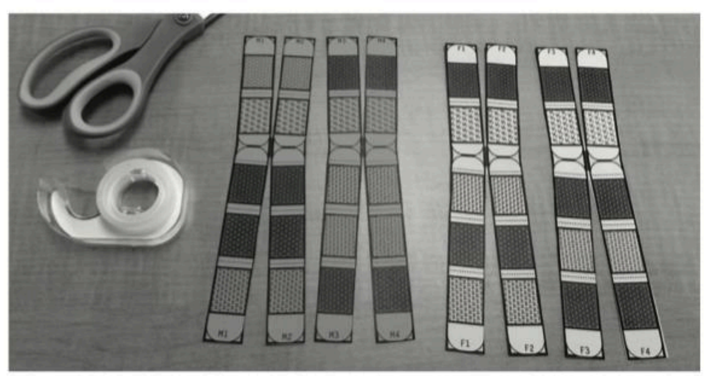
In this activity you will (1) recombine a pigeon chromosome, (2) make gametes, (3) combine gametes to make a pigeon offspring, and (4) determine what traits the offspring has—as you draw it.

The genes you'll be working with are real-life pigeon genes but, for the sake of simplicity, they have all been placed on one chromosome. In reality, pigeons have 80 chromosomes (40 pairs).

Prepare your materials

- Cut out the Male Pigeon Chromosomes and Female Pigeon Chromosomes. Be careful to NOT cut along the center dashed line for each duplicated chromosome or the dashed lines in between genes. Those lines will be important later.

- We will start the activity with the cells having already gone through the process of DNA replication — so each chromosome is already attached to its copy.

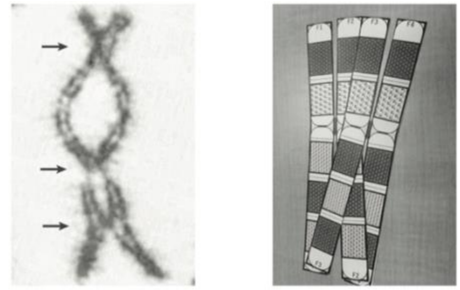


Recombination

1. Show crossing over on the male chromosomes.

   Starting with the female chromosomes, choose two places on the F2 and F3 chromosomes to cross over. Carefully cut along the horizontal dashed lines in the same location on both chromosomes and swap them. Tape the exchanged material in place.

   Then do a crossover between F1 and F4 at a different horizontal dashed line.

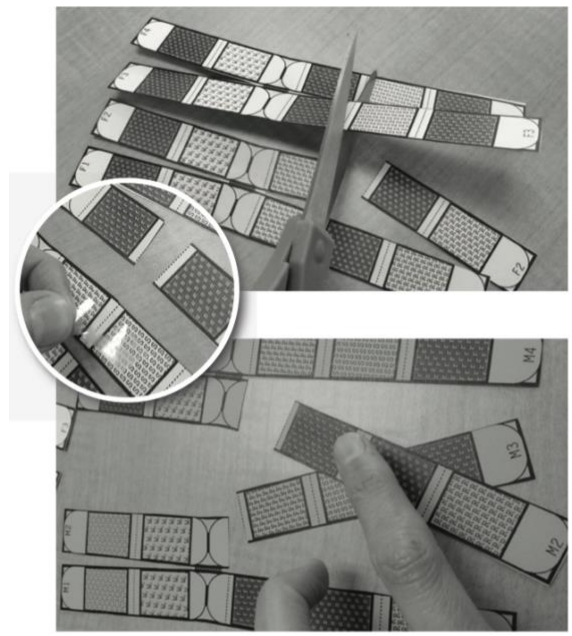


Chromosomes that are crosssing over are visible under the microscope (arrows, left).

2. Now do your crossing over on the male chromosomes.

   Choose two places on the M2 and M3 chromosomes to cross over. Carefully cut along the horizontal dashed lines in the same location on both chromosomes and swap them.
   Tape the exchanged material in place.

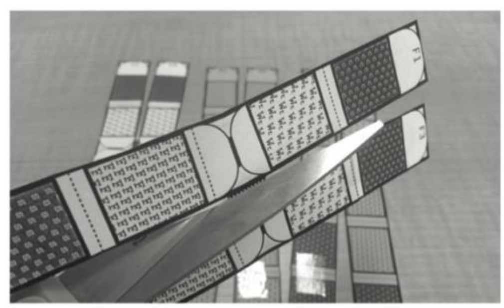
   Then do a crossover between M1 and M4 at a different horizontal dashed line.

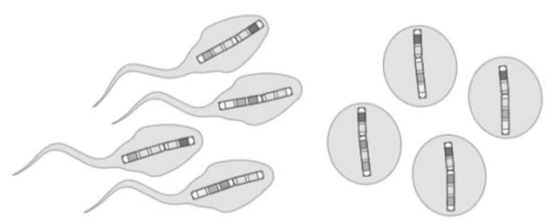


3. Now each of the 4 chromosomes has a different combination of alleles. Next, the cell divides to make four gametes, each with only one copy of every chromosome.

   Carefully cut along the vertical dashed lines holding the chromosome copies together. Do this for both the female and male chromosomes.

   Each chromosome now represents an individual sperm (male) or egg (female) cell.





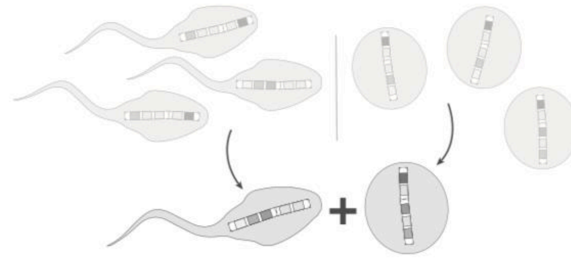
Each chromosome is segregated into sperm (male) or egg (female) cells.

Fertilization

4. Make a pigeon zygote.

   Turn over your male and female chromosomes so you can't see the genes and shuffle them around.

   Randomly select one female chromosome and one male chromosome. This is your zygote.



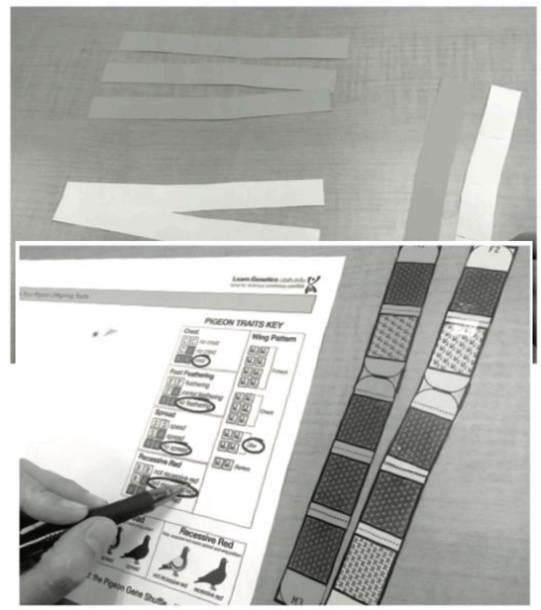
5. What traits does your pigeon offspring have?

   Turn your selected chromosomes right-side up again and line them up together.

   Use the Pigeon Traits Key to see what trait results from the allele combination for each of the five genes. Circle the results.

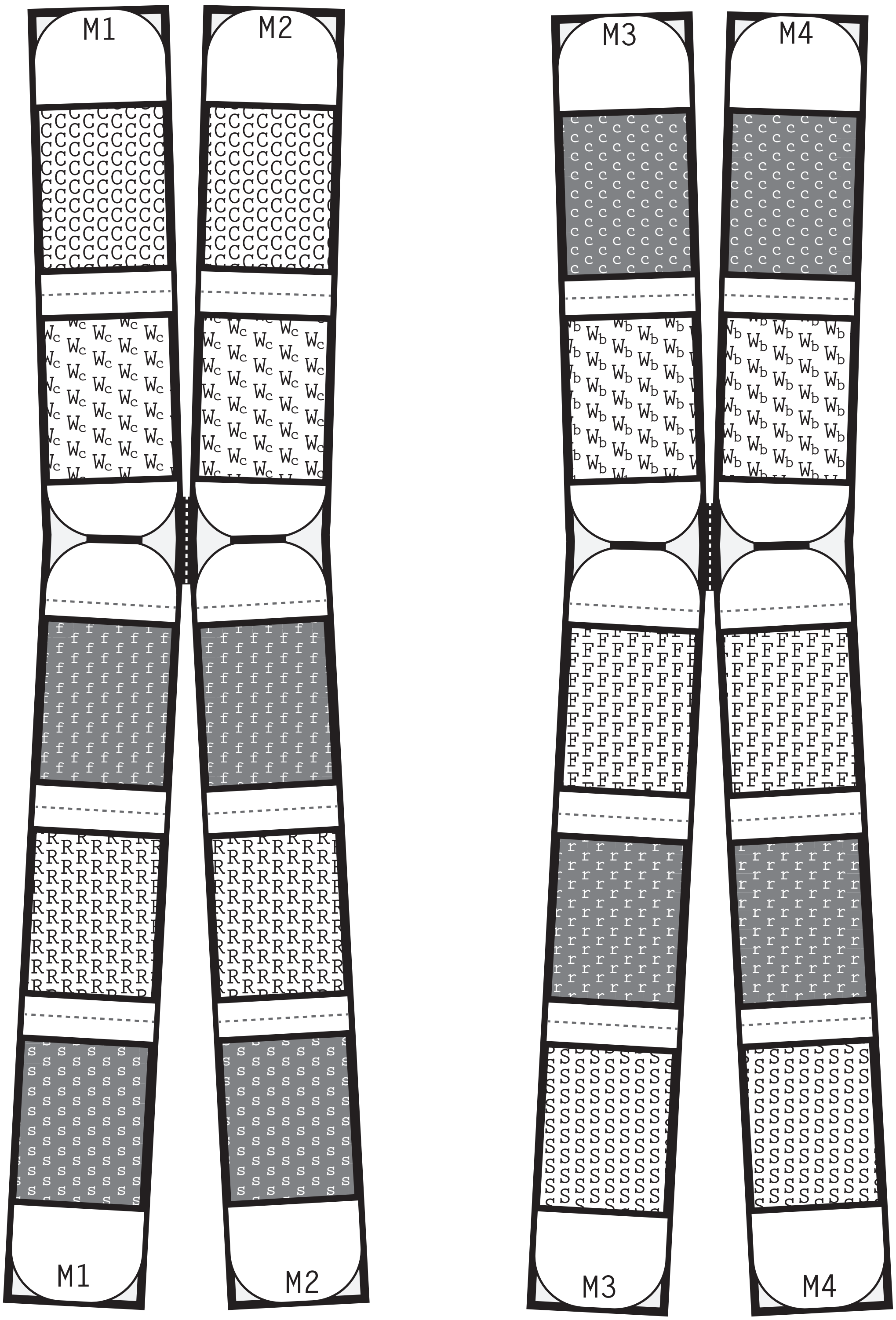
   Draw the traits on your pigeon offspring. Hint: Start with Spread and Recessive Red.

   How does your offspring compare to others in your class?



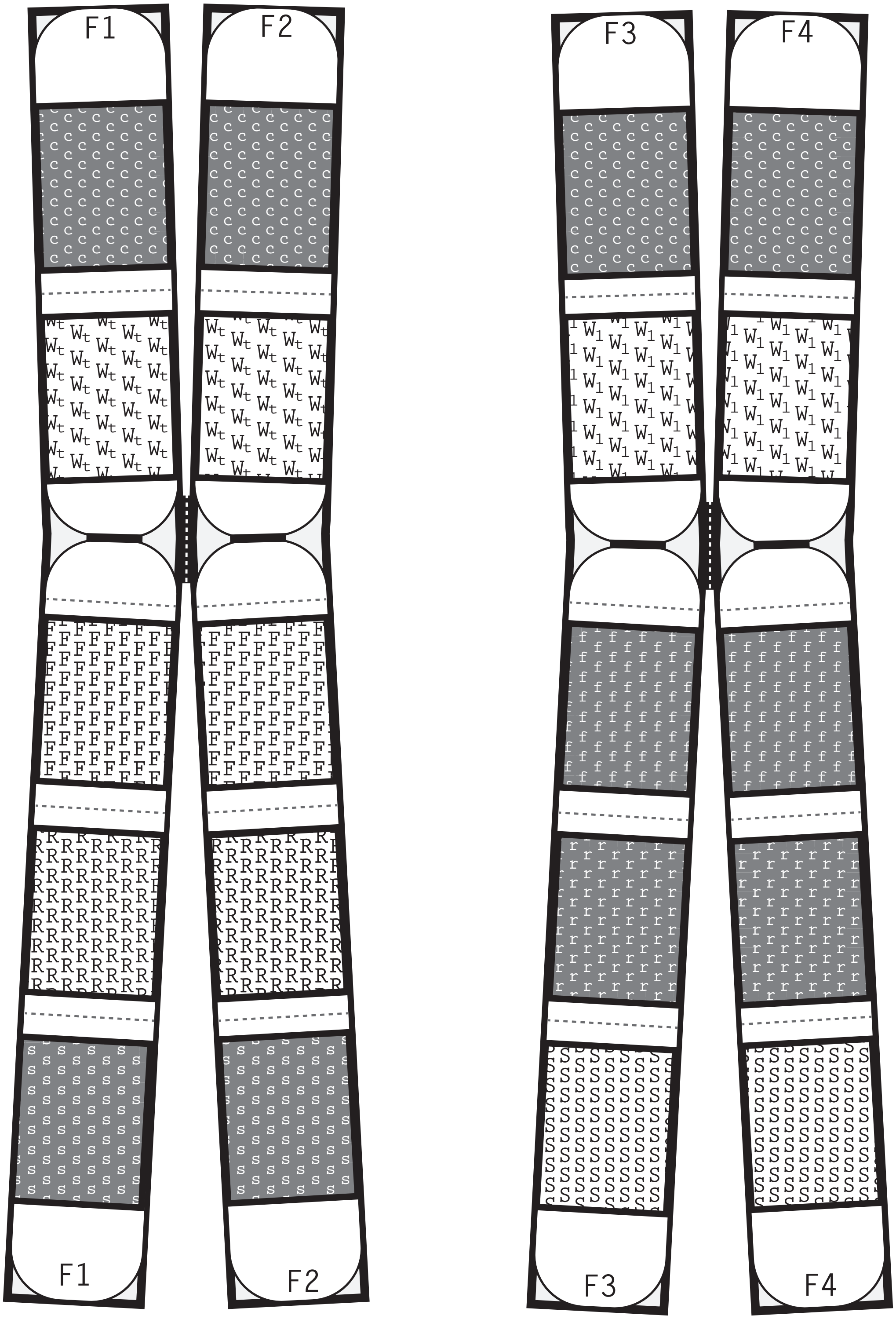
Male Pigeon Chromosomes

(print on plain paper)



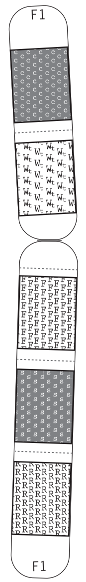
Female Pigeon Chromosomes

(print on colored paper)

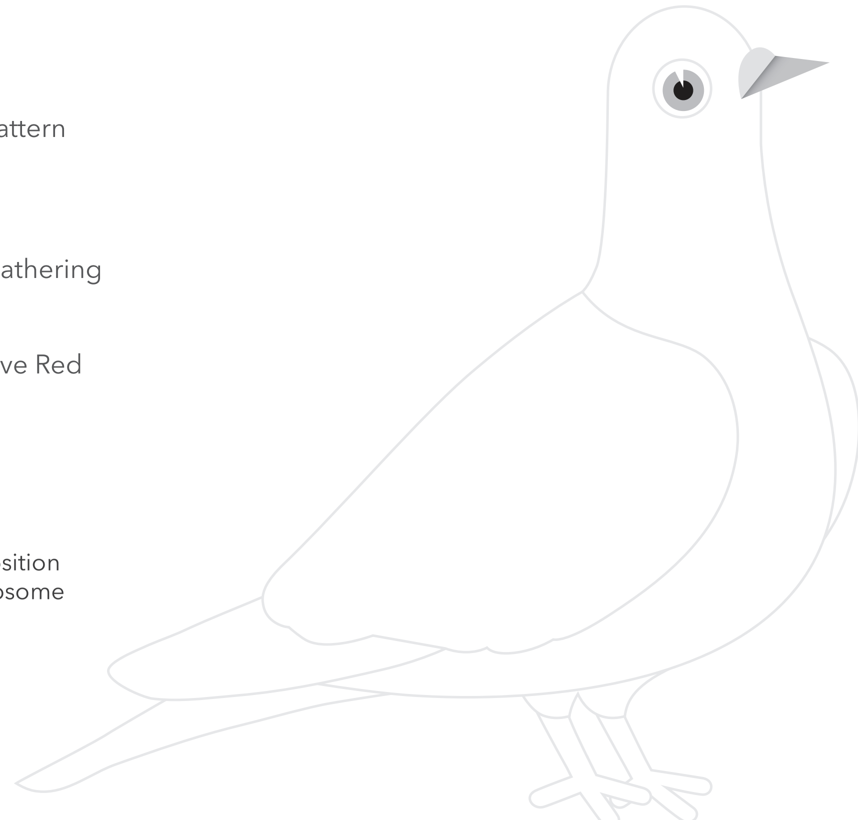


NAME ______________________ DATE ____________

Draw Your Pigeon Offspring Traits



Genes at each position along the chromosome



Pigeon Traits Key

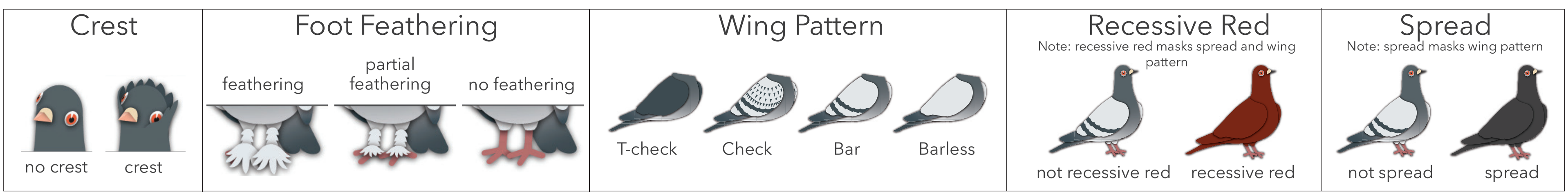
Crest	
C C	no crest
C c	no crest
c c	crest

Foot Feathering	
F F	feathering
F f	partial feathering
f f	no feathering

Spread	
S S	spread
S s	spread
s s	no spread

Recessive Red	
R R	not recessive red
R r	not recessive red
r r	recessive red

Wing Pattern	
W_t W_t	T-check
W_t W_c	T-check
W_t W_b	T-check
W_t W_1	T-check
W_c W_c	Check
W_c W_b	Check
W_c W_1	Check
W_b W_b	Bar
W_b W_1	Bar
W_1 W_1	Barless



	3	2	1
Model Recombination	The model and explanation for recombination is neat, accurate and clear.	The model and explanation for recombination is lacking clarity and/or neatness.	The model and explanation for recombination is inaccurate.
Model Fertilization	The model and explanation for fertilization is neat, accurate and clear.	The model and explanation for recombination is lacking clarity and/or neatness.	The model and explanation for fertilization is inaccurate.
Model Offspring	The model and explanation for offspring is neat, accurate and clear.	The model and explanation for offspring is lacking clarity and/or neatness.	The model and explanation for offspring is inaccurate.