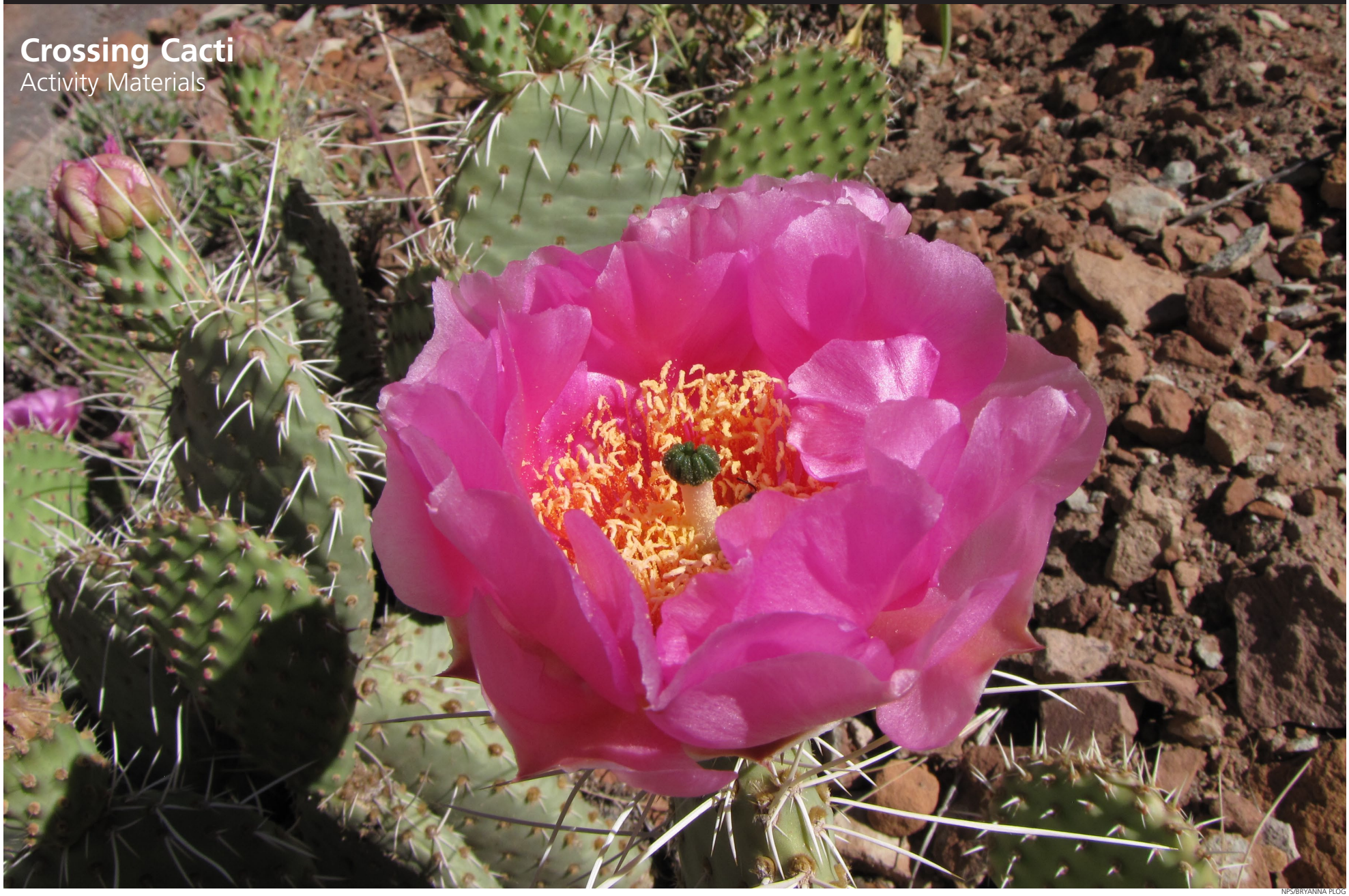
National Park Service
U.S. Department of the Interior

Zion National Park

Crossing Cacti

Activity Materials



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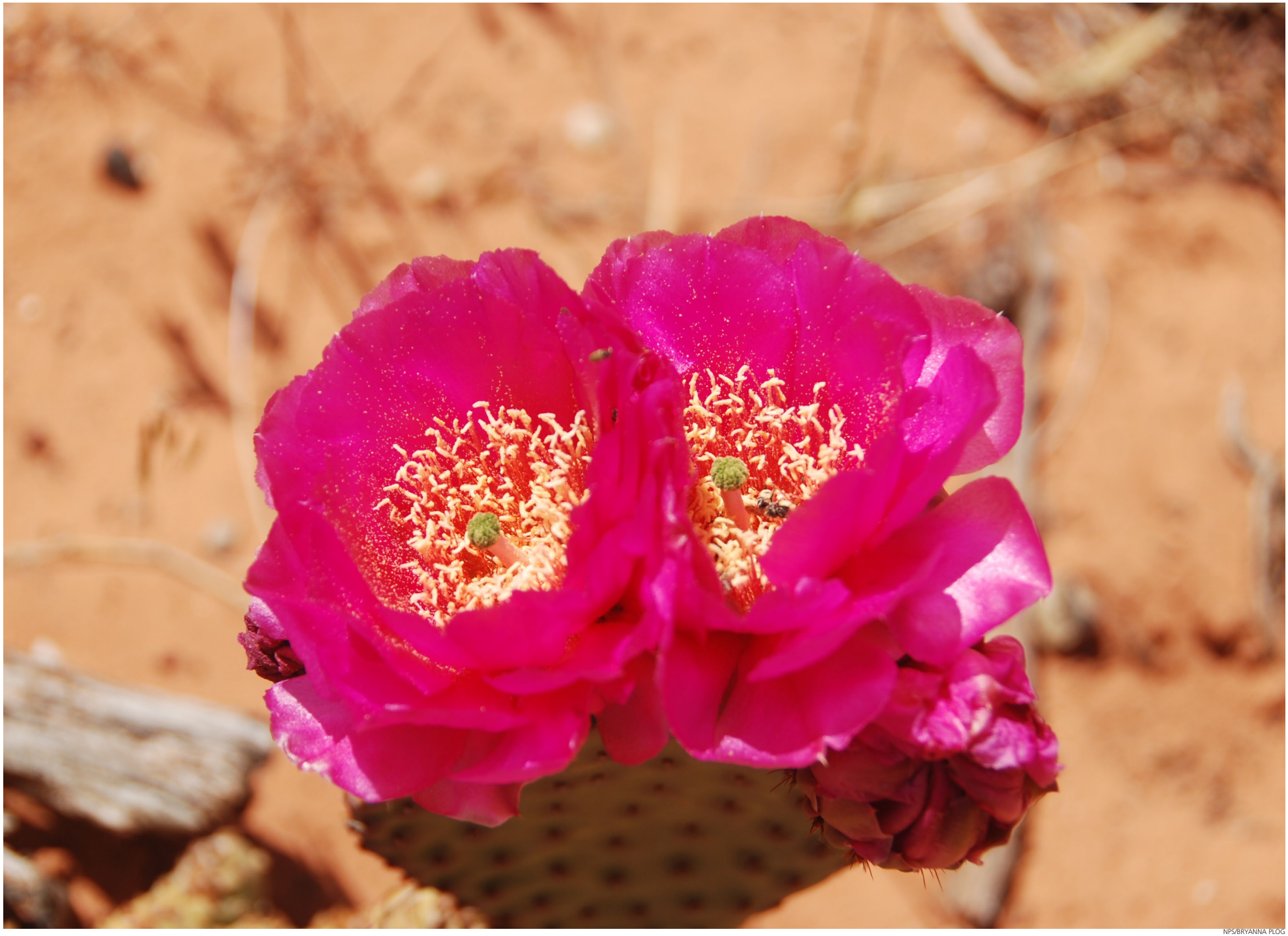

NPS/BRYANNA PLOG

Pink blooms on a pricklypear cactus *(Opuntia spp.)*

NPS/AMY GAIENNIE

Yellow blooms on a pricklypear cactus *(Opuntia spp.)*

NPS/BRYANNA PLOG

Peach bloom on a pricklypear cactus *(Opuntia spp.)*

Name:

Crossing Cacti Worksheet

For this activity, different-colored bean pairings represent different colors of pricklypear cactus blooms in Zion National Park. Each partner should have one well-mixed container with fifty red beans and fifty white beans.

1. If each container represents a set of genes from one parent cactus, what does each individual bean represent? _____
2. How many combinations are possible using two kinds of beans?_____

   _____
3. What percentage of probability do you expect each outcome/combination to occur?

   _____

Procedure:

In turn, each partner will draw one bean from their container without looking. Decide which partner will go first. This partner will *always* draw first (note: when you record your findings, there is a difference between red – white and white – red).

Why must a bean be chosen from each container? What does this represent?

_____

_____

Have each partner draw a bean, and lay bean pairs in rows. Record your results by placing tally marks in the appropriate category. Continue 100 times until all beans have been drawn.

Red - Red	Red - White	White - Red	White - White

Using the formula below, calculate the probability for which each gene pair was represented.

Formula:

$$\frac{\text{Observed number of pairs}}{\text{Total pairs drawn}} \times 100 = \%\ \text{probability}$$

Example:

$$\frac{22\ \text{Red-Red}}{100\ \text{pairs}} \times 100 = 22\%\ \text{probability}$$

Show your calculations here:

Probability for Red-Red:_____ Probability for White-Red:_____

Probability for Red-White:_____ Probability for White-White: _____

How do the probability percentages compare to your answers in question three? _____

_____

Conclusion

1. Why is it necessary to have so many beans in each container and select so many pairs?

   _____

   _____

   _____

2. The red beans represent pink cactus flowers and the white beans represent yellow cactus flowers. There is also the possibility of peach-colored cactus flowers. What combinations of bean pairs (genes for cactus colors) have to occur to get each color?

   Pink: _____ Yellow:_____Peach:_____

3. What genetic principles have you discovered through this activity?

   _____

   _____

   _____

4. How does chance selection of genes, as shown with this bean lab, create the variation in organisms?

   _____

   _____

   _____

5. What are some advantages for cross-breeding in cacti? What advantages are there for having a variety of different colored blooms?

   _____

   _____

   _____

Name:

Crossing Cacti Answer Key

For this activity, different-colored bean pairings represent different colors of pricklypear cactus blooms in Zion National Park. Each partner should have one well-mixed container with fifty red beans and fifty white beans.

1. If each container represents a set of genes from one parent cactus, what does each individual bean represent?

   Each bean represents an allele.

2. How many combinations are possible using two kinds of beans?

   Four: red/red, red/white, white/red, white/white.

3. What percentage of the time would you expect each outcome/combination to occur?

   25% for each combination.

Procedure:

In turn, each partner will draw one bean from their container without looking. Decide which partner will go first. This partner will *always* draw first (note: when you record your findings, there is a difference between red – white and white – red).

Why must a bean be chosen from each container? What does this represent?

Each container represents one parent, each of whom contributes one allele to the offspring. This activity represents sexual reproduction in animals or plants.

Have each partner draw a bean, and lay bean pairs in rows. Record your results by placing tally marks in the appropriate category. Continue 100 times until all beans have been drawn.

Red - Red	Red - White	White - Red	White - White

Using the formula below, calculate the percentage of time each gene pair was representated.

Formula:

$$\frac{\text{Observed number of pairs}}{\text{Total pairs drawn}} \times 100 = \%\ \text{probability}$$

Example:

$$\frac{22\ \text{Red-Red}}{100\ \text{pairs}} \times 100 = 22\%\ \text{probability}$$

Show your calculations here:
Answers will vary depending on trial results.

Percentage for Red-Red:_____ Percentage for White-Red:_____

Percentage for Red-White:_____ Percentage for White-White: _____

How do the ratio percentages compare to your answers in question three?

Results should be similar, but close to 25%. It is rare for a group match 25% exactly for each combination.

Conclusion

1. Why is it necessary to have so many beans in each container and select so many pairs?

   This shows the many different outcomes, and general probability of chance for each, that can come from just two different alleles in two parents. There needed to be so many beans and trials to represent the variability in outcomes that can occur.

2. The red beans represent pink cactus flowers and the white beans represent yellow cactus flowers. There is also the possibility of peach-colored cactus flowers. What combinations of bean pairs (genes for cactus colors) have to occur to get each color?

   Pink: red/red Yellow: white/white Peach: red/white, white/red

3. What genetic principles have you discovered through this activity?

   Mendel's Theory of Segregation, cross-breeding, hybridization

4. How does chance selection of genes, as shown with this bean lab, create the variation in organisms?

   Variability is determined by how the alleles combine, whether a gene pairing is dominant, recessive, or a cross-bred. Because of chance, different genetic combinations will be passed on to different offspring. One gene only accounts for one small part of an organism's appearance and many different genes may also affect appearance. In the chance selection of a cross-bred organism, the gene combination creates even more variability (i.e. creating the entirely new color of peach in cactus flowers).

5. What are some advantages for cross-breeding in cactus? What advantages are there for having a variety of different colored blooms?

   Cross-breeding can allow the best traits from different individuals or different species to be passed on; a cactus can get the best colors (or other traits such as size of needles, size of pads, etc.) it might need to better survive. Having a variety of different-colored blooms can help attract different pollinators. In the case of climate change, disease, or natural disaster, a variety of blooms would increase the likelihood of pollination, making the plant more adaptive.