Predicting Inheritance Pattern: Using Probability Rules and Trees

MODULE 1-A: SINGLE-CHARACTER INHERITANCE
INSTRUCTOR-LED ACTIVITY

Monohybrid Cross 1
In garden pea, round seed (R) is dominant to wrinkled seed. A heterozygous dominant plant is crossed with a homozygous recessive plant. Use a probability rules and probability tree diagram to show all possible genotypes of the resulting offspring. Give the offspring phenotypes and their phenotypic ratio.

The parent phenotype and genotype are presented in Figure 1. What do you notice?

![Figure 1](image)

Genotype:
Phenotype:

Step 1. Gamete formation: Predicting the probability and types of gametes for each parent based on the law of segregation and law of independent assortment
Look at the genotype of the P-Female and P-Male (Figure 2) and determine how many different types of gametes can form from each parent according to law of segregation and predict their probability. Represent the outcomes as branching pattern with probabilities labeled on the branches and types of gametes at the ends of the branches.

![Figure 2](image)
Step 2. Fertilization: Predicting the combined probabilities of the genotypes of offspring resulting from random fertilization of each trait

Draw a probability tree by connecting the branches from Step 1. Represent the gamete of P-Male as the first set of options and the gamete of P-Female as the consecutive second set of options at the end of each P-Female branch.

What happens when you reverse the order of branching?

Step 3. Outcome: Calculating the outcome, genotype, and phenotypes of the offspring, of the cross using multiplication, and/or addition rules of probability

Use the probability tree from Step 2 to find the type and frequency of the offspring genotype by multiplying the probabilities across the branches. The genotypes of the offspring are calculated by multiplying the allele combinations and the frequencies along the branches. If there are branches with same results, the frequencies of those branches are added.

<table>
<thead>
<tr>
<th>Genotype and its probability</th>
<th>Phenotype and its probability</th>
</tr>
</thead>
</table>

MODULE 1-B: SINGLE-CHARACTER INHERITANCE

STUDENT GROUP ACTIVITY

In garden pea, round seed (R) is dominant to wrinkled seed. A genetic cross between two heterozygous plant is conducted. Use probability rules and a probability tree diagram to show all possible genotypes of the resulting offspring. Give the offspring phenotypes and their phenotypic ratio.

Draw the phenotype and genotype of parents as shown in Figure 3 and go through the three steps described in the Activity 1-A.
Step 1. Gamete formation
Based on the genotype of the parents (Figure 4) construct a probability tree to see the types and frequencies of gametes formed from each parent.

![Figure 4](image)

Step 2. Fertilization
Draw a probability tree using the branches from Step 1 to represent the different combinations of an egg and a sperm.

Step 3. Predicting the probability of the genotype and phenotype of the offspring
Use your probability tree from Step 2 to calculate the probability of the genotype and phenotype of the offspring by multiplying the allele combinations and the frequencies along the branches. Notice that some branches result in the same outcome. Add the frequencies of those branches.

<table>
<thead>
<tr>
<th>Genotype and its probability</th>
<th>Phenotype and its probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MODULE 2: TWO-CHARACTER OR DIHYBRID CROSS

In garden pea, round seed (R) is dominant to wrinkled seed and purple flower is dominant to white flower. A genetic cross between heterozygous P-Female with homozygous recessive P-Male plant is conducted. Use probability rules and a probability tree diagram to show all possible genotypes of the resulting offspring. Give the offspring phenotypes and their phenotypic ratio.

![Figure 5](image)

Figure 5. Flower color and seed shape: P-Female (FfRr) and P-Male (Ffrr)
Use the law of independent assortment to separate each trait.

![Diagram](image)

**Figure 6**

**Steps 1 & 2. Gamete formation and fertilization**

Use the law of segregation and the probability rules to predict the types of gamete for each character.

Flower color:

Seed shape:

**Step 3. Combined probability of the genotype and phenotype of the offspring**

Use the law of independent assortment and the probability tree you created in the previous step to answer the following questions.

<table>
<thead>
<tr>
<th>Flower color</th>
<th>Seed shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype and its probability</td>
<td>Phenotype and its probability</td>
</tr>
</tbody>
</table>

1. What is the probability of having an offspring with purple flower and round seed?

2. What is the probability of having an offspring with ffrr genotype?

**MODULE 3: THREE-CHARACTER OR TRIHYBRID CROSS**

**EXTENSION ACTIVITY**

In garden pea, tall plant (T) is dominant over short plant, round seed (R) is dominant to wrinkled seed and purple flower is dominant to white flower. A genetic cross is conducted between a heterozygous P-Female, all three characteristics, with a P-Male that is heterozygous for plant height and flower color but homozygous for seed shape. Use probability rules and a probability tree diagram to show all possible genotypes of the resulting offspring. Give the offspring phenotypes and their phenotypic ratio.
Genotype of parent plants: plant height, flower color, and seed shape

P-Female (TtFfRr)
P-Male (TtFfrr)

Steps 1 & 2: Gamete formation and fertilization

Use the law of segregation and the probability rules to predict types of gametes for each trait.

![Gamete Formation and Fertilization](image)

Probability tree for plant height:

Probability tree for flower color:

Probability tree for seed shape:

Step 3. Combined probability of the genotype and phenotype of the offspring

Use multiple and addition rules to complete the following table.

<table>
<thead>
<tr>
<th>Plant height</th>
<th>Flower color</th>
<th>Seed shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genotype and its probability</td>
<td>Phenotype and its probability</td>
<td>Genotype and its probability</td>
</tr>
</tbody>
</table>

1. What is the probability of forming a short plant with purple flowers and round seeds?

\[ P(\text{short plant and purple flower and round seeds}) = P(\text{short plant}) \times P(\text{purple flower}) \times P(\text{round seeds}) \]

2. What is the probability of forming an offspring with genotype TtFfrr?

\[ P(\text{Tt and WW and rr}) = P(\text{Tt}) \times P(\text{FF}) \times P(\text{rr}) \]