

SI Genetics- Full Discipline Demo

Patterns of Inheritance

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Genetics - Full Discipline Demo
Course	SI Genetics- Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

⚡ Genotype

⚡ Autosomal recessive allele

⚡ Phenotype

⚡ X-linked dominant allele

⚡ Polygenic inheritance

Only expressed in homozygous individuals

The sum of all genes that can be passed from parent to offspring

Observable characteristics of an organism

Expressed in all female offspring of a male carrier

Involves traits controlled by multiple independent genes

1

2

3

4

5

Correct answers:

- 1 Autosomal recessive allele 2 Genotype 3 Phenotype
4 X-linked dominant allele 5 Polygenic inheritance

Identify each statement as true or false.

True	False
1	2

⚡ A p-value is used to determine which traits are dominant.

⚡
A chi-square (X^2) test is a statistical analysis that compares observed data to the expected results to determine the association between variables.

⚡
A Punnett square for diagramming two independent, dominant/recessive traits consists of 20 cells.

⚡ Punnett squares diagram the possible genotypes and phenotypes of offspring.

Correct answers:

1

A chi-square (X^2) test is a statistical analysis that compares observed data to the expected results to determine the association between variables.

Punnett squares diagram the possible genotypes and phenotypes of offspring.

2

A p-value is used to determine which traits are dominant.

A Punnett square for diagramming two independent, dominant/recessive traits consists of 20 cells.

Exploration

Offspring inherit one allele from each parent in many organisms.

- ☒ True
- ☐ False



Simple autosomal dominant/recessive inheritance patterns involve traits controlled by a single gene with ____ allele(s).

- ☐ one
- ☒ two ✓
- ☐ three
- ☐ four

Male offspring expressing X-linked recessive alleles can only inherit the condition from their female parent.

- ☒ True ✓
- ☐ False

Polygenic traits in humans include ____.

- ☐ eye color
- ☐ skin color
- ☐ height
- ☒ All of the above ✓

____ describes a pattern of inheritance whereby heterozygous phenotypes display both alleles.

- ☐ Simple dominance
- ☐ X-linked dominance
- ☐ Incomplete dominance
- ☒ Codominance ✓

Only the phenotypic ratios of offspring can be determined from Punnett squares.

- ☐ True
- ☒ False ✓

A chi-square test can be used to compare the predictions of a Punnett square to what is observed in a population.

☒ True



☐ False

Exercise 1

How do simple dominant/recessive inheritance patterns differ between autosomal and X-linked traits? How were these differences observed in the results of this exercise?

Simple autosomal dominant/recessive inheritance patterns involve traits controlled by a single gene with two alleles, one of which is completely dominant to the other, that are not influenced by the sex of the parent or offspring. Autosomal dominant alleles are expressed in the phenotype of both homozygous and heterozygous individuals. Autosomal recessive alleles are only expressed in the phenotype of homozygous individuals. X-linked dominant alleles are expressed in all female offspring of a male carrier and all male and female offspring receiving the dominant allele from a female carrier. X-linked recessive alleles are expressed in all male offspring since they only have one copy, but the alleles are only expressed in female offspring that are homozygous for the trait.

The results from the crosses in this exercise support the differences in these inheritance patterns produced by crosses between heterozygous parents. In the autosomal trait, 25% of all offspring exhibited the Rh- phenotype, whereas only male offspring inheriting the color-blindness allele from their mother exhibited the color-blind phenotype.

Were the Punnett squares created in this exercise a good predictor of offspring phenotypes resulting from the crosses performed using the digital genetics bench? Reference Photos 1 and 2 and the results recorded in Data Tables 3 and 6 in your explanation.

Note to instructors: the digital genetics bench produces unique results between students, but when sufficient offspring are generated, results should agree with Punnett square predictions. For this reason, student results and answers will vary. All answers should be supported by Data Tables 3 and 6.

Yes, both Punnett squares in Photos 1 and 2 were a good predictor of the inheritance pattern results produced by the digital genetics bench. Both the autosomal and X-linked dominant/recessive results analyses in Data Tables 3 and 6 produced p values > 0.05 meaning the differences between the expected and observed values were the result of chance and not statistically significant.

Both autosomal and X-linked recessive phenotypes frequently skip generations. Did either of your crosses support this trend? Explain your answer by referencing both the parents and offspring in each of your crosses.

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Photo 1 : Rh Factor Punnett Square
(SAMPLE ANSWER BELOW)

	Rh+	Rh-
Rh+	Rh+ Rh+	Rh+ Rh-
Rh-	Rh+ Rh-	Rh- Rh-

Student Name
Date

Data Table 1: Expected Rh Factor Ratios
(SAMPLE ANSWER BELOW)

Phenotypic ratio	3:1
Genotypic ratio	1:2:1
Offspring expected to be Rh+ (%)	75
Offspring expected to be Rh- (%)	25

Data Table 2: Rh Factor Results
(SAMPLE ANSWER BELOW)

	Rh+	Rh-	Total
Observed number of individuals	14	4	18
Expected number of individuals	13.5	4.5	

Panel 1: Chi-square Calculation for Rh Factor Offspring
(SAMPLE ANSWER BELOW)

Student answers should use values from Data Table 3.

$$\chi^2 = \frac{(14-13.5)^2}{13.5} + \frac{(4-4.5)^2}{4.5} = 0.074$$

Data Table 3: Rh Factor Chi-square Test
(SAMPLE ANSWER BELOW)

Degrees of Freedom	1
p-Value Range	.950-.500
Conclusion	Difference between expected and observed is not statistically significant

Photo 2: Color Blindness Punnett Square
(SAMPLE ANSWER BELOW)

	X^C	X^c
X^C	$X^C X^C$	$X^C X^c$

Y	$X^C Y$	$X^c Y$
Student Name Date		

Data Table 4: Expected Color Blindness Ratios (SAMPLE ANSWER BELOW)	
Phenotypic ratio (M normal: M color blind: F normal: F color blind)	1:1:2:0
Genotypic ratio ($X^C Y$: $X^c Y$: $X^C X^C$: $X^C X^c$)	1:1:1:1
Male offspring expected to have normal vision (%)	25
Male offspring expected to be color blind (%)	25
Female offspring expected to have normal vision (%)	50
Female offspring expected to be color blind (%)	0

Data Table 5: Color Blindness Results (SAMPLE ANSWER BELOW)					
	Male normal vision	Male color blind	Female normal vision	Female color blind	Total

Observed number of individuals	10	11	15	0	36
Expected number of individuals	9	9	18	0	

Panel 2: Chi-square Calculation for Color Blindness Offspring
(SAMPLE ANSWER BELOW)

Student answers should use values from Data Table 6.

$$\chi^2 = \frac{(10-9)^2}{9} + \frac{(11-9)^2}{9} + \frac{(15-18)^2}{18} = 1.06$$

Data Table 6: Color Blindness Chi-square Test
(SAMPLE ANSWER BELOW)

Degrees of Freedom	2
p-Value Range	.950-.500
Conclusion	Difference between expected and observed is not statistically significant

Exercise 2

How do your results for the eye color cross support the characteristics of polygenic inheritance patterns? Reference Graph 1 in your explanation.

Polygenic inheritance patterns involve traits controlled by multiple independent genes that produce an additive effect on the phenotype of the individual. Polygenic inheritance patterns result in a normal bell curve distribution of phenotypes within a population. The results in Graph 1 support this pattern with most of the individuals in the expected population exhibiting green, hazel, and blue green eyes while relatively few individuals have brown or light blue eyes.

Was the Punnett square created for incomplete dominance in this exercise a good predictor of offspring phenotypes resulting from the crosses performed using the digital genetics bench? Reference Photo 4 and the results recorded in Data Table 10 in your explanation.

Note to instructors: the digital genetics bench produces unique results between students, but when sufficient offspring are generated, results should agree with Punnett square predictions. For this reason, student results and answers will vary. All answers should be supported by Data Tables 12.

Yes, the Punnett square in Photo 4 was a good predictor of the hair texture results produced by the digital genetics bench. The analyses in Data Table 10 produced a p value > 0.05 meaning the differences between the expected and observed values were the result of chance and not statistically significant.

How do the ABO blood type alleles exhibit both codominant and dominant/recessive inheritance patterns? Reference your results in Data Table 11 and Photo 5 in your explanation.

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Photo 3: Eye Color Punnett Square
(SAMPLE ANSWER BELOW)

	B_1B_2	B_1b_2	b_1B_2	b_1b_2
B_1B_2	$B_1B_1B_2B_2$	$B_1B_1B_2b_2$	$B_1b_1B_2B_2$	$B_1b_1B_2b_2$
B_1b_2	$B_1B_1B_2b_2$	$B_1B_1b_2b_2$	$B_1b_1B_2b_2$	$B_1b_1b_2b_2$
b_1B_2	$B_1b_1B_2B_2$	$B_1b_1B_2b_2$	$b_1b_1B_2B_2$	$b_1b_1B_2b_2$
b_1b_2	$B_1b_1B_2b_2$	$B_1b_1b_2b_2$	$b_1b_1B_2b_2$	$b_1b_1b_2b_2$

Student Name _____
Date _____

Data Table 7: Expected Eye Color Results
(SAMPLE ANSWER BELOW)

Phenotypic ratio	1:4:6:4:1
Genotypic ratio	1:2:1:2:4:2:1:2:1
Offspring expected to have brown eyes (%)	6
Offspring expected to have hazel eyes (%)	25
Offspring expected to have green eyes (%)	38
Offspring expected to have blue green eyes (%)	25
Offspring expected to have light blue eyes (%)	6

Graph 1: Polygenic Eye Color Distribution
(SAMPLE ANSWER BELOW)

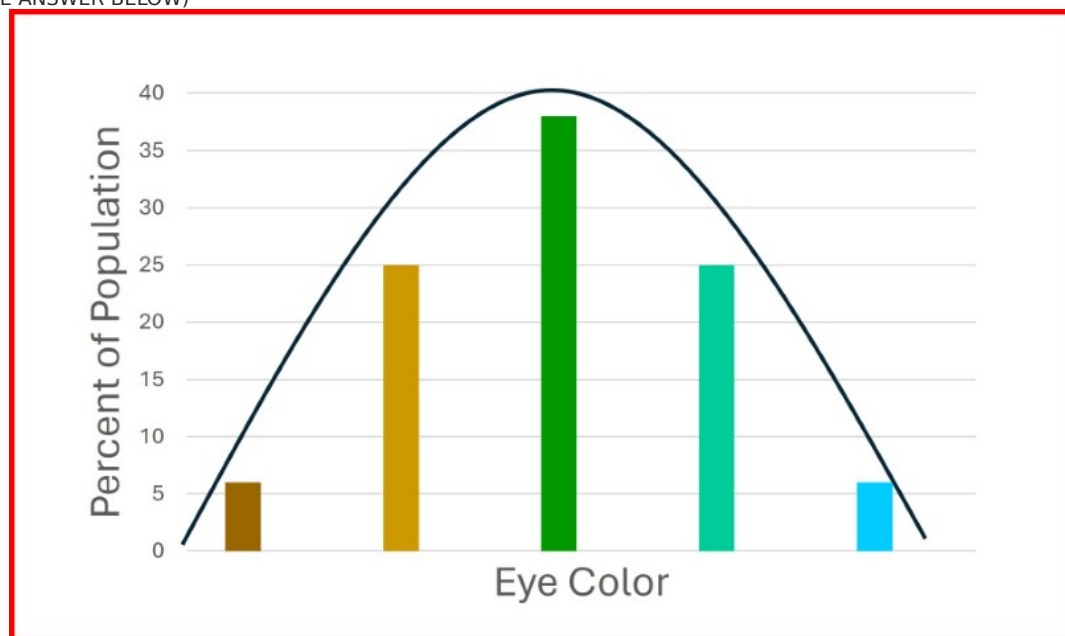


Photo 4: Hair Texture Punnett Square
(SAMPLE ANSWER BELOW)

	C	S
C	CC	CS
S	CS	SS

Student Name
Date

Data Table 8: Expected Incomplete Dominance Results
(SAMPLE ANSWER BELOW)

Phenotypic ratio	1:2:1
Genotypic ratio	1:2:1
Offspring expected to have curly hair (%)	25
Offspring expected to have wavy hair (%)	50
Offspring expected to have straight hair (%)	25

Data Table 9: Hair Texture Results
(SAMPLE ANSWER BELOW)

	Curly hair	Wavy hair	Straight hair	Total
Observed number of individuals	5	10	3	18
Expected number of individuals	4.5	9	4.5	

Panel 3: Chi-square Calculation for Hair Texture Offspring
(SAMPLE ANSWER BELOW)

$$\chi^2 = \frac{(5-4.5)^2}{4.5} + \frac{(10-9)^2}{9} + \frac{(3-4.5)^2}{4.5} = 0.667$$

Data Table 10: Hair Texture Chi-square Test
(SAMPLE ANSWER BELOW)

Degrees of Freedom	2
p-Value Range	0.950-0.500
Conclusion	$p > 0.05$ there is not a statistically significant difference between the expected and observed values.

Data Table 11: Blood Type Alleles
(SAMPLE ANSWER BELOW)

	Genotype	Phenotype
Codominant	AB	Type AB
Heterozygous dominant (2)	AO, BO	Type A, Type B
Homozygous recessive	OO	Type O

Photo 5: Blood Type Punnett Square
(SAMPLE ANSWER BELOW)

	A	O
B	AB	BO
O	AO	OO

Student Name _____
Date _____

Competency Review

Alleles are different versions of a gene that produce phenotypic variation in organisms.

- ☒ True ✓
- ☐ False

Examples of autosomal recessive genetic diseases include ____.

- ☐ sickle cell anemia
- ☐ cystic fibrosis
- ☐ phenylketonuria
- ☒ All of the above ✓

X-linked recessive alleles are most often expressed in male offspring.

- ☒ True ✓
- ☐ False

Polygenic inheritance patterns result in a(n) ____ distribution of phenotypes within a population.

- ☐ sine curve
- ☒ normal bell curve ✓
- ☐ logarithmic curve
- ☐ inverse

_____ describes a pattern of inheritance whereby heterozygous phenotypes appear intermediate to the two homozygous phenotypes for a given allele.

- ☐ Autosomal dominance
- ☐ X-link dominance
- ☒ Incomplete dominance ✓
- ☐ Codominance

The _____ produced by each parent are labeled on the horizontal and vertical axes of a Punnett square.

- ☒ alleles ✓
- ☐ genes
- ☐ offspring
- ☐ phenotypes

A significant X^2 value implies that the difference found between the expected and observed data is probably not due to chance alone.

- ☒ True ✓
- ☐ False

The digital genetics bench in the image below depicts a female parent that is ____ for Rh factor.

The screenshot shows a digital genetics bench interface. On the left is a sidebar with icons for Procedures, Live Data, Setup, Species, Lab Book, and Presets. The main panel is titled 'Experiment Type: Mendelian' (selected) and 'Population'. Under 'Traits - Human', several traits are listed: Hemophilia, Inter-Eye Distance, Rh Factor (highlighted), Sickle-Cell Anemia, Thumb Type, Tongue Folding, and Tongue Rolling. Below the traits is a 'Set Alleles' section with two columns: 'Male' and 'Female'. Each column has a 'Randomize' button. Under the 'Rh Factor' section, there are two rows of dropdown menus. The first row shows '1. Rh +' for both Male and Female. The second row shows '2. Rh +' for Male and '2. Rh -' for Female. At the bottom, there is a 'Number of Offspring' field set to '6' and three buttons: 'Cross', 'Next Generation', and 'Reset'.

- ☐ homozygous
- ☒ heterozygous
- ☐ recessive
- ☐ polygenic



The Punnett square below is predicting the results of a cross involving ____ alleles.

	X^C	X^c
X^C	$X^C X^C$	$X^C X^c$
Y	$X^C Y$	$X^c Y$

- ☐ autosomal dominant/recessive
- ☒ X-linked dominant/recessive ✓
- ☐ polygenic
- ☐ codominant

A χ^2 analysis of offspring from a series of crosses compared to predictions from a Punnett square produced a p value between 0.950-0.500. The offspring sample is ____ the expected results.

- ☐ identical to
- ☐ unrelated to
- ☐ significantly different from
- ☒ not significantly different from ✓

Extension Questions

Adam is considering fathering children but has concerns because his brother suffers from the X-linked recessive genetic disease hemophilia A. Adam visits a genetics counselor seeking advice regarding the risk of having children with hemophilia A. Apply your

knowledge of inheritance patterns to suggest how the genetics counselor should address the Adam's concerns.

(SAMPLE ANSWER BELOW)

The counselor should explain to Adam that X-linked recessive alleles such as those causing hemophilia A are expressed in the phenotypes of all male carriers because they only have one copy of the X allele. Since Adam is healthy, unlike his brother, his only X chromosome does not carry the recessive allele and he cannot transmit the genetic disease to his future children.