Grade Level	Content Area	Course Title	Unit Title
10th Grade	Mathematics	Math 2	The Probability of Genetics: Why Do I Look This Way?

Length of Unit	Time of Year Taught	Expected Prior Knowledge
Five 1.5 hour class sessions	2nd Quarter, in conjunction with lessons in genetics in biology	Students will have learned genetics-related vocabulary from biology class (e.g., homozygous, heterozygous, dominant, recessive, test cross, Punnett square, genotype, phenotype, allele)

Unit Description

Students are completing these math activities in conjunction with a unit on genetics in their biology class. Students will explain how genotypic variation occurs and results in phenotypic diversity through genetics problems. They will use Punnett squares and Pedigree analysis to understand the relationship between mating pairs and offspring. They will determine the genotypic and phenotypic ratios of offspring from several different mating pairs. They will determine the probability of an offspring's likelihood of acquiring a specific trait.

Strand(s), Concept(s), and PO(s)	HSMS2-C2-PO2. Determine the theoretical probability of events, estimate probabilities using experiments, and compare the two. HSMS5-C2-PO1. Analyze a problem situation, determine the question(s) to be answered, organize given information, determine how to represent the problem, and identify implicit and explicit assumptions that have been made.
Summative Assessment	Students will demonstrate analysis of theoretical and experimental probability by solving genetics problems.
Assessment Scoring	Genetics Summative Assessment
Materials/Resources Needed	Bikini Bottom Genetics Activities 1 and 2, Pedigree Problem, SpongeBob Genetics Quiz and answer key

	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
PO Focus	HSM2-C2-PO2 HSM5-C2-PO1	HSM2-C2-PO2 HSM5-C2-PO1	HSM2-C2-PO2 HSM5-C2-PO1	HSM2-C2-PO2 HSM5-C2-PO1	HSM2-C2-PO2 HSM5-C2-PO1
Lesson Instruction	**Objective**: Determine a phenotype given a genotype. Determine the probability of results from a test cross. **Teacher Input**: Review concepts of homozygous dominant, homozygous recessive and hetero-zygous. Review how to set up a Punnett square.	**Objective**: Determine a genotype given a phenotype. Determine the probability of results from a test cross. **Teacher Input**: Review how genotypes determine phenotypes and vice versa. Hand out Bikini Bottom Genetics Activity 2 to	**Objective**: Determine the genotypes based on the phenotypes of individuals in a pedigree. Determine the probability of results from a test cross. **Teacher Input**: Review how phenotypes may result from different	**Objective**: Determine the genotypes based on the phenotypes of individuals in a pedigree. Determine the probability of results from a test cross. **Teacher Input**: Review the symbols and relationships in a pedigree. Demonstrate how to use "backwards thinking" to deduce what genotype an individual has, based on the offspring it has produced with its mate. Watch demonstration of solving a Pedigree	**Objective**: Demonstrate mastery of the concepts and POs. **Teacher Input**: Hand out the Genetics Assesment.

	Hand out Bikini Bottom Genetics Activity 1 (adapted from lessons by T. Trimpe, 2003) and go over instructions for each section. Allow time for students to work with a partner to complete activity. Instruct students to complete the Punnett squares in their notebooks. Walk around the room to each group of students to check for understanding.	the students. Go over instructions for each section. Allow time for students to work with a partner to complete activity. Instruct students to complete the Punnett squares in their notebooks. Walk around the room to each group of students to check for understanding.	genotypic combinations. Model how to do a dihybrid test cross on the board. Using information from the Bikini Bottom Genetics Activities 1 and 2, create scenarios for students to work through in their notebooks involving different genotypic combinations.	chart using alternative hypotheses: www.youtube.com/watch?v=HblHjsn5cHo Hand out Pedigree Activity sheet to students. Allow time for students to assign genotypes phenotypes to all individuals in the pedigree. Talk through each pairing within the pedigree chart; students at the board label each part and explain the results observed in children. The class resolves the problem.	Direct students to complete The Genetics Assessment individually.

	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Student Activities	**Using the Bikini Bottom Genetics Activity 1**: Students determine if a genotype is homozygous dominant, homozygous recessive or heterozygous. Students determine the phenotype of an individual given a specific genotype. **Using a Punnett Square**: Students determine the possible genotypes and phenotype of mating pairs and offspring given different scenarios from the Bikini Bottom activity. Students determine the ratios of genotypes and phenotypes from the data in their Punnett squares.	**Using the Bikini Bottom Genetics Activity 2**: Students determine traits based on given geno-types. Students write genotypes based on a given traits. **Using a Punnett square**: Students determine genotypes based on different scenarios. Students determine the probability of certain traits in offspring given different mating scenarios.	**Using the Bikini Bottom Genetics Activities 1 & 2:** Students determine the genotypes that are necessary to put into a Punnett square to result in the specified traits of offspring. **Using a Punnett square:** Students determine the genotypes and phenotypes and phenotypic ratios of offspring given different mating pair scenarios.	**Using Pedigree Problem**: Students determine the genotypes and phenotypes of each individual listed in the pedigree. **Using a Punnett square**: Students discuss the Pedigree Problem and the relationship between Pedigree analysis and Punnett square analysis. Students determine the probability of each mating pair's ability to pass along a trait to its offspring. Students determine if the actual offspring from each mating pair is predisposed to a certain trait using probability.	Students complete the SpongeBob Genetics Assessment.

Bikini Bottom Genetics I ACTIVITY Name _____

Scientists at Verona University in Bikini Bottoms have been investigating the genetic makeup of the organisms in this community. Use the information provided and your knowledge of genetics to answer each question.

1. For each genotype below, indicate whether it is a heterozygous (He) OR homozygous (Ho).

TT _____ Bb _____ DD _____ Ff _____ tt _____ dd _____

Dd ____ ff _____ Tt _____ bb ____ BB _____ FF _____

Which of the genotypes in #1 would be considered purebred? _____

Which of the genotypes in #1 would be hybrids? _____

2. Determine the phenotype for each genotype using the information provided about SpongeRomeo.

Yellow body color is dominant to blue.

YY _____ Yy _____ yy _____

Square shape is dominant to round.

SS _____ Ss _____ ss _____

3. For each phenotype, give the genotypes that are possible for Pink Paris.

A tall head (T) is dominant to short (t).

Tall = _____ Short = _____

Pink body color (P) is dominant to yellow (p).

Pink body = _____ Yellow body = _____

4. SpongeRomeo Squarepants recently met SpongeJuliet Roundpants at a dance. SpongeRomeo is heterozygous for his square shape, but SpongeJuliet is round. Create a Punnett square to show the possibilities that would result if SpongeRomeo and SpongeJuliet had children.

A. List the possible genotypes and phenotypes for their children.
B. What are the chances of a child with a square shape? ____ out of ____ or ____%
C. What are the chances of a child with a round shape? ____ out of ____ or ____%

5. Pink Paris met Patti at the dance. Both of them are heterozygous for their pink body color, which is dominant over a yellow body color. Create a Punnett square to show the possibilities for Paris and Patti's children.

A. List the possible genotypes and phenotypes for their children.
B. What are the chances of a child with a pink body? ____ out of ____ or ____%
C. What are the chances of a child with a yellow body? ____ out of ____ or ____%

6. Everyone in PrinceSquiddy's family has light blue skin, which is the dominant trait for body color in Squid Valley. His family brags that they are a "purebred" line. He recently married a nice girl who has light green skin, which is a recessive trait. Create a Punnett square to show the possibilities for Squiddy and his new bride's children. Use B to represent the dominant gene and b to represent the recessive gene.

A. List the possible genotypes and phenotypes for their children.
B. What are the chances of a child with light blue skin? ____%
C. What are the chances of a child with light green skin? ____%
D. Would Squiddy's children still be considered purebreds? Explain!

7. Assume that one of PrinceSquiddy's sons, who is heterozygous for the light blue body color, married a girl that was also heterozygous. Create a Punnett square to show the possibilities that would result if they had children.

A. List the possible genotypes and phenotypes for their children.
B. What are the chances of a child with light blue skin? ____%
C. What are the chances of a child with light green skin? ____%

8. Krabbs, the Apothecary, and his wife recently had a Lil' Krabbs, but it has not been a happy occasion for them. Mrs. Krabbs has been upset since she first saw her new baby who had short eyeballs. She claims that the hospital goofed and mixed up her baby with someone else's baby. Mr. Krabbs is homozygous for his tall eyeballs, while his wife is heterozygous for her tall eyeballs. Some members of her family have short eyes, which is the recessive trait. Create a Punnett square using T for the dominant gene and t for the recessive one.

A. List the possible genotypes and phenotypes for their children.
B. Did the hospital make a mistake? Explain your answer.

Answer Key

1. Ho He Ho He Ho Ho
He Ho He Ho Ho Ho

Purebreds - TT, DD, BB, FF, ff, dd, bb, tt
Hybrids - Dd, Bb, Ff, Tt

2. Yellow body Square shape | Yellow body Square shape | Blue body Round shape

3. Tall - TT or Tt Short - tt
Pink - PP or Pp Yellow – pp

4.

	S	s
S	Ss	Ss
s	ss	ss

A. SS - square shape, Ss - square shape, and ss - round shape
B. 2 out of 4 or 50%
C. 2 out of 4 or 50%

5.

	P	p
P	PP	Pp
p	Pp	pp

A. PP - pink body, Pp - pink body, and pp - yellow body
B. 3 out of 4 or 75%
C. 1 out of 4 or 25%

6.

	b	b
B	Bb	Bb
B	Bb	Bb

A. Bb - light blue skin
B. 100%
C. 0%
D. Squiddy's children would not be considered purebred, since each would have a gene pair made up of a dominant gene and a recessive gene.

7.

	T	t
T	TT	Tt
T	TT	Tt

A. TT - tall eyeballs or Tt - tall eyeballs
B. The hospital must have made a mistake, since the genotype "tt" would not be possible based on the genotypes of Mr. and Mrs. Krabbs.
NOTE: Students may come up with other possible scenarios, such as Mr. Krabbs not really a homozygous tall-eyed crab or a mutation.

Bikini Bottom Genetics 2 Activity **Name** _____

1. Use the information for SpongeRomeo's traits to write the phenotype (physical appearance) for each item.

Characteristic	Dominant Gene	Recessive Gene
Body Shape	Squarepants (S)	Roundpants (s)
Body Color	Yellow (Y)	Blue (y)
Eye Shape	Round (R)	Oval (r)
Nose Style	Long (L)	Stubby (l)

(a) LL-_____ (e) Rr-_____
(b) yy-_____ (f) ll- _____
(c) Ss-_____ (g) ss- _____
(d) RR - _____ (h) Yy -_____

2. Use the information in the chart in #1 to write the genotype (or genotypes) for each trait below.
(a) Yellow body - _____ (e) Stubby nose - _____
(b) Roundpants - _____ (f) Round eyes - _____
(c) Oval eyes - _____ (g) Squarepants - _____
(d) Long nose - _____ (h) Blue body - _____

3. Determine the genotypes for each using the information in the chart in #1.
(a) Heterozygous round eyes -_____ (c) Homozygous long nose - _____
(b) Purebred squarepants - _____ (d) Hybrid yellow body - _____

4. One of SpongeRomeo's cousins, SpongeBenvolio, recently met a cute squarepants gal, SpongeGerdy, at a local dance and fell in love. Use your knowledge of genetics to answer the questions below.

(a) If SpongeGerdy's father is a heterozygous squarepants and her mother is a roundpants, what is her genotype? Complete the Punnett square to show the possible genotypes that would result to help you determine Gerdy's genotype.
What is Gerdy's genotype? _____

(b) SpongeBenvolio is heterozygous for his squarepants shape. What is his genotype? _____

(c) Complete the Punnett square for Benvolio & Gerdy's children.

(d) List the possible genotypes and phenotypes for the kids.
(e) What is the probability of kids with squarepants? _____ %
(f) What is the probability of kids with roundpants? _____ %

5. SpongeRomeo's's aunt and uncle, SpongeWilma and SpongeWilbur, have the biggest round eyes in the family. Wilma is believed to be heterozygous for her round eye shape, while Wilbur's family brags that they are a pure line. Complete the Punnett square to show the possibilities for SpongeWilma and SpongeWilbur's children.
(a) Give the genotype for each person. Wilma - _____ Wilbur - _____
(b) Complete the Punnett square to show the possibilities that would result if they had children.
(c) List the possible genotypes and phenotypes for the kids.
(d) What is the probability that the kids would have round eyes? ____ %
(e) What is the probability that the kids would be oval eyes? ____ %

6. SpongeRomeo's mother, Lady Montague, is so proud that SpongeRomeo and his new blue wife, SpongeJuliet, are expecting a little sponge. She suspects that they have a 50% chance of having a little roundpants, but is also wondering if the new arrival will be blue (a recessive trait) like SpongeJuliet and many members of her family. If SpongeRomeo is heterozygous for his yellow body color, what are the chances that the baby sponge will be blue? Create a Punnett square to help you answer this question.

Answer Key: **Bikini Bottom Genetics 2**

1. A - long nose, B - blue body, C - squarepants, D - round eyes, E - round eyes, F - stubby nose, G - roundpants, h - yellow body

2. A - Yy & YY, B - ss, C - rr, D - LL & Ll, E - ll, F - RR & Rr, G - SS & Ss, H - yy

3. A - Rr, B - SS, C - LL, D - Yy

4A - See square at right, Gerdy's genotype = Ss,
4B - Benvolio's genotype = Ss
4C - SS & Ss = squarepants and ss = roundpants
4D - 75%
4E - 25%

4A	S	s
s	Ss	ss
s	Ss	ss

4C	S	s
S	SS	Ss
s	Ss	ss

5A - Wilma = Rr, Wilbur = RR
5B - See square at right
5C - RR & Rr = round eyes
5D - 100%
5E - 0%

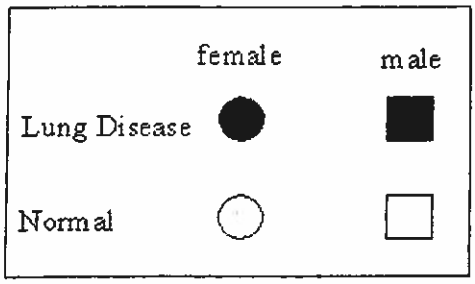
5	R	r
R	RR	Rr
R	RR	Rr

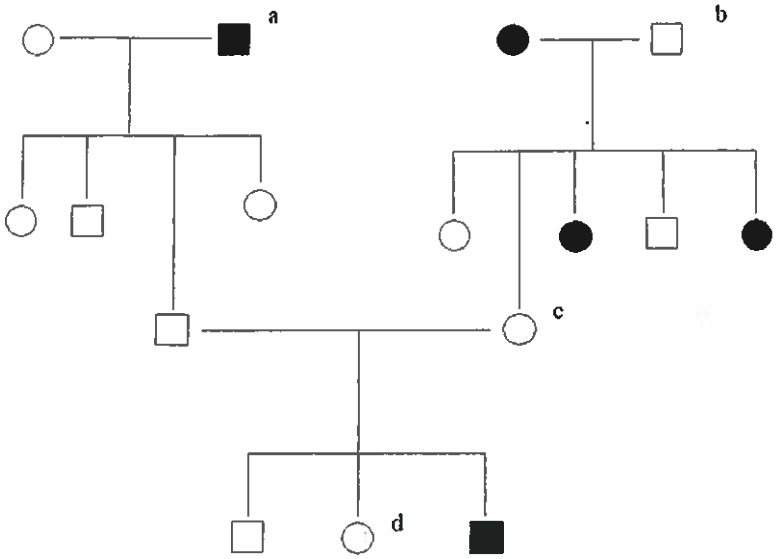
	y	y
Y	Yy	Yy
y	yy	yy

6. The Punnett square shows that they would have a 50% chance (2 out of 4) for a little sponge with a blue body color.

Pedigree Problem

Below is a pedigree for an inherited lung disease.
Provide the **phenotypes** and **genotypes** of each of the individuals marked with lower case letters. Use "L" for normal and "l" for affected.





SpongeRomeo and SpongeJuliet Genetics Assessment

Name _____

(5 points) 1. For each genotype below, indicate whether it is a heterozygous (He) OR homozygous (Ho).
TT __ Pp ___ dd ___ Ff ___ Tt ___

(5 points) 2. Which of the genotypes listed above would be considered purebred?

(5 points) 3. In Squiddy's family, a blue body color (B) is dominant to green (b). Determine the phenotype for each genotype below based on this information.
BB _____ Bb _____ bb _____

(5 points) 4. If tall eyeballs (T) are dominant to short eyeballs (t), give the genotypes that are possible for members of Mr. Krabbs' family.
Tall eyeballs = Short eyeballs =

5. SpongeRomeo is known for his big round eyes (R), which is dominant over an oval eye shape (r). If she is heterozygous for her round eye shape and marries SpongeJuliet with oval eye shape, think about the type of eyes their children might have:

(5 points) A. List the genotypes for each: Heterozygous round eyes ____ Oval eyes – _____

(20 points)B. Complete a Punnett square to show the possibilities that would result if SpongeRomeo had children with an oval-eyed SpongeJuliet.

Scoring Rubric:
- Answer clearly addresses the question.
- Punnett square shows a minimum of two possibilities.
- An accompanying explanation clearly outlines how the problem is represented.
- Implicit and explicit assumptions are clearly explained.
- Possibilities are accurately assessed.

(5 points) C. List the possible genotypes and phenotypes for their children.
(5 points) D. What are the chances of a child with a round eye shape? _____%
(5 points) E. What are the chances of a child with an oval eye shape? _____%

6. Paris recently married Patti, a cute girl he met at a local dance. He is considered a purebred for his tall head shape (T), which is dominant over a short head (t). If Patti is a short-headed woman, think about the type of heads the children might have. (see below)

(5 points) A. List the genotypes for each: Paris ____ Patti ____

(20 points)B. Complete a Punnett square to show their possible offspring.

Scoring Rubric:
- Answer clearly addresses the question.
- Punnett square shows a minimum of two possibilities.
- An accompanying explanation clearly outlines how the problem is represented.
- Implicit and explicit assumptions are clearly explained.
- Possibilities are accurately assessed.

(5 points) C. Which type of head is most likely: tall or short? Explain.

(10 points) D. Would the children be considered purebreds? Explain.

(ANSWER KEY/RUBRIC) SpongeRomeo and SpongeJuliet Genetics Assessment

Name _____

Outcome: The students will demonstrate analysis of theoretical and experimental probability by solving genetics problems. (100 points possible = 100%)

(5 points) 1. For each genotype below, indicate whether it is a heterozygous (He) OR homozygous (Ho).
TT **(Ho)** Pp **(He)** dd **(Ho)** Ff **(He)** Tt **(He)** FF **(Ho)**

(5 points) 2. Which of the genotypes listed above would be considered purebred? **TT, dd, FF**

(5 points) 3. In Squiddy's family, a blue body color (B) is dominant to green (b). Determine the phenotype for each genotype below based on this information.
BB **(blue)** Bb **(blue)** bb **(green)**

(5 points) 4. If tall eyeballs (T) are dominant to short eyeballs (t), give the genotypes that are possible for members of Mr. Krabbs' family.
Tall eyeballs = **(TT, Tt)** Short eyeballs = **(tt)**

5. SpongeRomeo is known for his big round eyes (R), which is dominant over an oval eye shape (r). If he is heterozygous for his round eye shape and marries SpongeJuliet with oval eye shape, think about the type of eyes their children might have:

(5 points A. List the genotypes for each: Heterozygous round eyes - **(Rr)** Oval eyes – **(rr)**

(20 points)B. Complete a Punnett square to show the possibilities that would result if SpongeRomeo had children with an oval-eyed SpongeJuliet.

Scoring Rubric:
- Answer clearly addresses the question.
- Punnett square shows a minimum of two possibilities.
- An accompanying explanation clearly outlines how the problem is represented.
- Implicit and explicit assumptions are clearly explained.
- Possibilities are accurately assessed.

(5 points) C. List the possible genotypes and phenotypes for their children. **(Rr, rr)**
(5 points) D. What are the chances of a child with a round eye shape? **(50)%**
(5 points) E. What are the chances of a child with an oval eye shape? **(50)%**

6. Paris recently married Patti, a cute girl he met at a local dance. He is considered a purebred for his tall head shape (T), which is dominant over a short head (t). If Patti is a short-headed woman, think about the type of heads the children might have. (see below)

(5 points) A. List the genotypes for each: Paris – **(TT)** Patti – **(tt)**

(20 points)B. Complete a Punnett square to show their possible offspring.

Scoring Rubric:
- Answer clearly addresses the question.
- Punnett square shows a minimum of two possibilities.
- An accompanying explanation clearly outlines how the problem is represented.
- Implicit and explicit assumptions are clearly explained.
- Possibilities are accurately assessed.

(5 points) C. Which type of head is most likely: tall or short? Explain. **(Tall, 100% are Tt)**
(10 points) D. Would the children be considered purebreds? Explain. **No they are not purebred because each would have a dominant and a recessive gene.**