

**MIDDLE SCHOOL**

**Biotechnology**

**Punnett Square of Possibilities**

**Pre-requisite Knowledge**: genes, alleles, dominant and recessive traits, genotypes, phenotypes, Punnett square

**Goals**:

* To understand that an organism’s phenotype depends on the parents’ genotypes.
* To gain knowledge that in order to stop diseases, like Polycystic Kidney Disease (PKD) and Neonatal Isoerythrolysis, the genotypes of parents is needed.
* To create a kitten based on dominant and recessive genes.

**Objectives**: Students will…

* Read about PKD and Neonatal Isoerythrolysis.
* Complete Punnett Squares to find out Sparky and Lucky’s offspring’s chances are of inheriting the diseases.
* Create a kitten based on using trait chips that match the parents’ genotypes.
* “Build” their kitten.

**Materials**: (per group)

* PKD and Neonatal Isoerythrolysis Sheets (save paper- copy back to back)

**Time Required**: 2- 45 – 60 minute class period

**Standards Met:**

* Life Science Standards: Structure & function in living systems
* Life Science Standards: Reproduction & heredity

**Procedure:**

Day One

* If students need a review or an explanation of punnett squares, play Chickens and Lemmings ( a fun and interesting tutorial) <http://www2.edc.org/weblabs/Punnett/punnettsquares.html>
* Explain to the class that now that we know who the father is, we know that Persians are at high risk for carrying Polycystic Kidney Disease (PKD)
* Furry Friends ran the tests and he is positive for PKD.
* Pass out the PKD Sheet and read through it
* Walk students through the completion of the punnett square
* Ask the students what % of kittens will be affected with PKD. 50%
* Give students the NI sheet
* Read through the NI side together
* Complete the Punnett square. Ab. bb. Ab. bb
* Ask the students what % of kittens will be affected with NI. 50%
* Continue reading.
* Ask why it is so important to find out the blood type before the kittens are born.
* Is there anything that can be done for the 50% of kittens who may get PKD?
* Discuss the breeders’ responsibility.

Day 2

* Review the meaning of genotype and phenotype
* Inform the students that they are each going to create one of Sparky and Lucky’s kittens based on the parents’ genotypes.
* Pass a Trait Kit out to each group.
* Students will take two chips, one that matches Sparky’s genotype and one that matches Lucky’s, and put these in the cup.
* They will then shake the two chips and dump them on the table.
* The alleles that are face up are the kitten’s genotype. These will be recorded.
* The charts on the bottom of the page show the phenotype for each genotype.
* These will be recorded in the chart.

**Assessment:**

* Class participation in PKD and NI discussion
* Accurate completion of Create a Kitten

**Punnett Square of Possibilities: *What Is PKD?***

Polycystic Kidney Disease is an [inherited](javascript:popupWin1('/dictionary_term.cfm?term=inherited',%2050,%2050,%20350,%20300))disease in Persian and Persian-cross cats. It is a slowly progressive, irreversible disease. Even though affected kittens are born with abnormal kidneys, signs of the disease usually do not appear until the cat is between 3-10 years old. The kidneys of kittens with PKD contain small [cysts](javascript:popupWin1('/dictionary_term.cfm?term=cyst',%2050,%2050,%20350,%20300)). As the cat ages, the cysts become larger and more numerous. As the kidneys become more cystic, they are unable to function properly. Kidney failure occurs when the kidneys can no longer keep up with the body's demands. The most common signs of kidney failure include: changes in urinary habits such as urinating a lot, increased water consumption, anorexia, depression, weight loss and poor coat. The cysts, themselves, cannot be treated and surgical removal is not feasible since they can be so small and numerous

Directions: Are Sparky and Lucky’s Kittens at risk for PKD? Complete the Punnett Square below to determine the percentage of kittens at risk.

**Sparky is pp and Lucky is Pp**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Genotype | | Phenotype | | |
| PP | | PKD | | |
| Pp | | PKD | | |
| pp | | No PKD | | |
| **P=Gene for PKD p=No gene for PKD** | | | **Lucky**  **With PKD (Pp)** | | | **Offspring with a P gene and PKD** |
| **P** | | **p** |
| **Sparky**  **with No PKD (pp)** | | p |  | |  | \_\_\_\_\_% |
| p |  | |  |

Cat breeders can stop the occurrence of this disease. To prevent PKD, cats used for breeding should be PKD negative (pp). All cats used for breeding should have an ultrasound examination of the kidneys, and only cats without cysts should be bred. Should animals found to have cysts should be spayed/neutered?

**Punnett Square of Possibilities: PKD Punnett Square Answer Key**

|  |  |  |  |
| --- | --- | --- | --- |
| Genotype | Phenotype | | |
| PP | PKD | | |
| Pp | PKD | | |
| pp | No PKD | | |
| **P=Gene for PKD p=No gene for PKD** | | | | **Lucky**  **Heterozygous for PKD (Pp)** | | | **Offspring with a P gene and PKD** |
| **P** | | **p** |
| **Sparky**  **with No PKD (pp)** | | | p | Pp | | pp | 50% |
| p | Pp | | pp |

**Lucky Brand Genes – NI Punnett Square Answer Key**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Genotype | Blood Group   |  |  |  | | --- | --- | --- | | **Breed** | Type B | Type AB | | Domestic shorthair | 8% | 2% | | Domestic longhair | 7% \* 2 | 14% \*1 | | Persian | 12% \*1 |  |   Knottenbelt et al, 19991 or Callan & Giger, 19942.  (phenotype) |
| AA | A |
| bb | B |
| Ab | A\* |

|  |  |  |
| --- | --- | --- |
| Lucky’s     genotype | Sparky’s genotype  There is a 50% chance that each kitten will have NI | |
| A | b | |
| b | Ab | bb | |
| b | Ab | bb | |

**Punnett Square of Possibilities: neonatal isoerythrolysis (NI)**

**What is neonatal isoerythrolysis?**  
A recently recognized cause of fading kittens in pedigree cats is neonatal isoerythrolysis, where kittens have a different blood type from their queen, and, on suckling her milk, receive antibodies against their own red blood cells. The antibodies cause destruction of the kittens’ red blood cells which leads to jaundice, brown urine, and rapid death. In less severe cases, the tail tip drops off.

Are Sparky and Lucky’s Kittens at risk for NI? Complete the Punnett Square below to find out!

Sparky is Ab and Lucky is bb

|  |  |  |
| --- | --- | --- |
| **Breed** | Type B | Type AB |
| Domestic shorthair | 8% | 2% |
| Domestic longhair | 7% \* 2 | 14% \*1 |
| Persian | 12% \*1 |  |

Knottenbelt et al, 19991 or Callan & Giger, 19942.

|  |  |
| --- | --- |
| Genotype | Blood Group  (phenotype) |
| AA | A |
| bb | B |
| Ab | A\*  Offspring with type B blood:  \_\_\_\_\_\_\_% |

|  |  |  |
| --- | --- | --- |
| Lucky’s     genotype | Sparky’s genotype | |
| A | b | |
| b |  |  | |
| b |  |  | |

Type B kittens are born healthy and begin to nurse. Within the milk of their type A mother are antibodies specifically created to destroy type B blood. As the type B kitten nurses, he absorbs anti-B antibodies from his mother. The red blood cells of the kitten are rapidly destroyed. This results in serious illness and death and most kittens die within the first 48 hours of life.

Type B kittens must not be allowed to nurse from their type-A mother for the first 48 hours of life. These kittens should be either fostered with a nursing type B queen or hand fed with kitten milk replacement. After 48 hours, the kitten's gastrointestinal tract can no longer absorb large proteins and it can be returned to his mother. Any type-A kittens can be left with their mother.

<http://www.dr-addie.com/>