Biology Lesson Plan:

Connecting Meiosis and Inheritance

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Topic: Connecting Meiosis to Inheritance

Enduring Understandings:

1. Parents contribute gametes that combine to form a zygote with a combination of traits from both parents.
2. The traits of an organism are dependent on its combination of dominant and recessive alleles.

Essential Question:

1. How do offspring get their characteristics?

Lesson Objectives:

Students will be able to:

- explain how traits are passed from parents to offspring.
- use proper terminology when describing the genetic makeup of an organism.

Pa. State Standards for Science and Technology:

3.3.7 C. Know that every organism has a set of genetic instructions that determines its inherited traits.

- Identify and explain inheritable characteristics.
- Identify that the gene is the basic unit of inheritance.
- Identify basic patterns of inheritance (e.g., dominance, recessive, co-dominance).
- Describe how traits are inherited.

Audience:

This lesson is intended for use in science classes from grades seven through ten. It could easily be modified for use with younger students to give an introduction to inheritance.

Prior Knowledge:

This lesson would follow units on DNA, mitosis, and meiosis. Students would have an understanding of the structure of DNA and how it functions. They would also have an understanding of the processes and products of mitosis and meiosis. This lesson is intended to last two class periods. The first day would consist of a brief class discussion introducing inheritance and connecting it to meiosis. Students will complete up to step four in the Reebop Lab. The second class period should start with a class review of genetics using the Power Point concept questions followed by a continuation of the Reebop Lab and conclusion questions.

RATIONALE:

Students need to have a basic knowledge of genetics, traits, and chromosomes. Examining specific plant and animal traits and learning how they are passed on from one generation to the next begins in middle school. This exploration should help students grasp the relationship between genotypes and phenotypes and the role of meiosis in the inheritance of traits.

There are many misconceptions associated with the study of genetics. Some students think that if they look more like one parent, they have more of that parent's genes. They do not understand that they inherit genes from both parents for every characteristic. Another misconception that can arise is that some students think that the physically stronger parent or the

one with the more dominating personality will have their characteristics expressed in the offspring, not because some traits are dominant and others are recessive. Some students believe that boys get their traits from their fathers and girls get their traits from their mothers. Another problem often encountered during the study of genetics is that students do not make the connection between meiosis and the inheritance of traits. They do not realize that during gamete formation, whole chromosomes are separated into gametes and these gametes give the offspring genes for every trait, with each parent contributing an equal amount of information.

Addressing student misconceptions and monitoring their progress is essential for the conceptual understanding of science. The teacher should act as a facilitator and guide students to a better understanding of concepts through self-discovery and experience. In this activity the students are working in groups, discussing and making observations while constructing their Reebop offspring that model the laws of inheritance. They will be making predictions, observations, questioning, and drawing their own conclusions. During the second class period the teacher can assess the students' understanding thus far through the Power Point review and clarify any misconceptions that are still prevalent.

Mating the Reebops will provide students with a hands-on introduction to the inheritance of traits. They will be able to see that each parent contributes an equal amount of genetic information to the offspring and that chance determines the combination. While observing the offspring they will be able to visualize dominant and recessive phenotypes and homozygous and heterozygous genotypes.

Teacher Information for Reebops Genetics Activity

Background Information

This activity is designed as a way to reinforce the idea that children inherit their traits from both of their parents and that these traits come from alleles that are formed by the parents during meiosis. Students often do not make this connection and think that children get some genes from their mother and some from their father, not a gene for each trait from both parents. It will also reinforce the fact that this process is random and that many different combinations of alleles are possible.

Students will begin the activity with pairs of homologous chromosomes, which constitute the genome of an imaginary creature called a Reebop. Each parent Reebop that the students begin the activity with is heterozygous, or possess one dominant allele and one recessive allele for seven different autosomal traits and a pair of sex chromosomes (that are the same as humans). All the traits are either dominant or recessive, but the activity can be modified to illustrate incomplete dominance by creating colors and numbers of humps that exhibit a phenotype that is half-way between the two homozygous phenotypes. Only the dominant alleles will be expressed in the initial parent Reebops because they start with heterozygous genotypes. Inform that some traits in humans are inherited this way such as tongue rolling, hitchhikers thumb, and attached ear lobes.

Once the students pair up their homologous chromosomes, they should independently assort the alleles into gametes. Remind the students that this is very simplified, but the end result is the same as what is produced by meiosis in humans, and that is haploid cells with one copy from each pair of homologous chromosomes, producing haploid gametes. Take some time to compare the outcome in the activity (2 gametes produced) to what really happens in humans (4 gametes). Once the student pairs have combined their chromosomes, draw attention to the fact that the full diploid compliment of chromosomes was restored.

Just like in humans, problems may arise during meiosis and some Reebops may have extra or missing chromosomes. Use these mutants to illustrate nondisjunction which results in anuploidy, a condition that causes disorders such as Down Syndrome in humans.

Glossary of Terms:

allele: different forms of a gene

anuploidy: condition that results from nondisjunction during meiosis in which an individual has extra chromosomes or is missing chromosomes; an example in humans is trisomy 21 (Down Syndrome)

autosomal trait: trait coded by a gene located on a non-sex chromosome

autosome: non-sex chromosomes

diploid cell: cell containing two copies of each chromosome, one copy coming from the mother and one copy from the father; condition found in body cells (somatic cells)

dominant allele: form of a gene that masks the expressed of recessive alleles when present together; represented with a capital letter ex. A, H or B

fertilization: union of the egg and sperm; results in the restoration of the diploid state of the organism from the combination of the mother's and father's chromosomes

gametes: sex cells; ex. eggs and sperm

genome: all the chromosomes found in an organism

genotype: the combination of alleles present in an organism; usually represented with two letters ex. Aa or hh

haploid: cell containing half the number of chromosomes; condition found in gametes

heterozygous: having two different alleles for a trait; represented with a capital letter and a lower case letter ex. Tt or Aa

homologous chromosomes: chromosomes that are the same size and shape and code for the same traits

homozygous: having two of the same alleles for a trait ex. AA, tt, BB or ee

incomplete dominance: inheritance in which neither allele is dominant over the other and a heterozygous individual will show a phenotype that is half-way between the two homozygous conditions ex. noses of Reebops could be red (RR), orange (Rr), and yellow (rr)

independent assortment: the process by which alleles separate into gametes during meiosis; resulting in haploid cells

meiosis: cell division that produces gametes

nondisjunction: incorrect separation of chromosomes during meiosis that results in cells with extra or missing chromosomes

phenotype: physical expression of an organism's genotype ex. red nose, red legs, curly tail

recessive allele: allele that will not be expressed when present with the dominant allele; represented with a lower case letter ex. t, a or e

CLASSROOM PREPARATION:

a. Instructional Materials (for a class of 24)

- Mother and Father Reebop (already constructed)
- 12 envelopes with sets of female chromosomes
- 12 envelopes with sets of male chromosomes
- Small nails
- White large marshmallows
- Green miniature marshmallows
- Pipe cleaners
- Push pins
- Toothpicks
- Orange miniature marshmallows
- Thumbtacks

b. Management and grouping patterns

Each student would be paired with a partner with a reebop of the opposite sex.

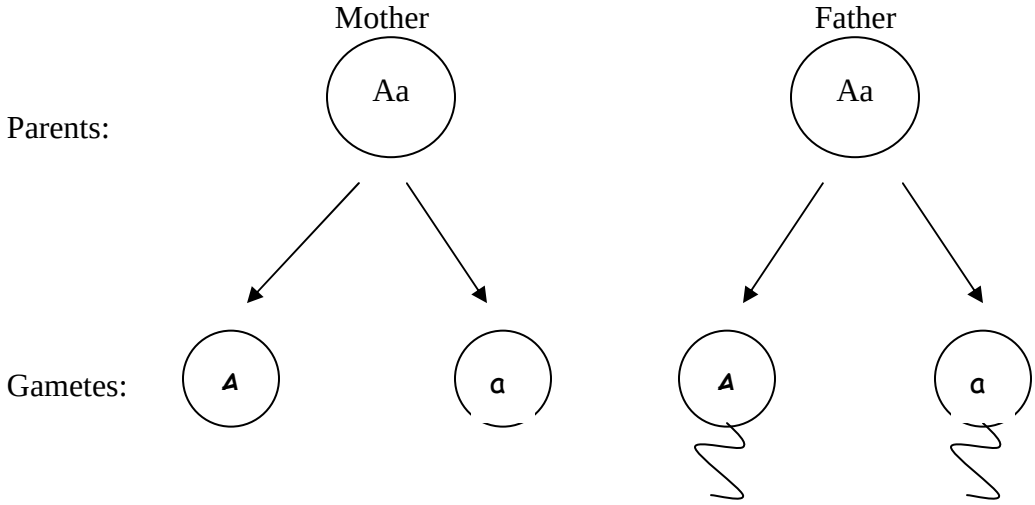
c. Lab Preparation:

Before the lab construct a mother and father reebop that is heterozygous for all traits (see student pages for picture). These models match the genotypes that the students will start with. Copy 12 sets of mother chromosomes on red paper and 12 sets of father chromosome on green paper (it is not necessary to use exactly red and green, as long as there are two different colors). Laminate the chromosomes (if you plan to reuse them) and cut out the individual chromosomes. Place each set in a separate envelope and label as mother or father.

Lesson Plan:

1. Distribute the envelopes containing Reebop chromosomes to the students so that each student has one envelope.
2. Pair students up with a partner of the opposite Reebop sex.
3. Have students examine the chromosome sets.
4. Compile a list, on the blackboard or overhead, of the different gene pairs and inform the students of what the genes code for. For example A = antennae, D = number of body segments.
5. Discuss how the gene letters compare. (All the gene combinations consist of a "big" letter and a "little" letter.) Explain to them that this is called heterozygous.

6. Draw diploid cells with some Reebop genes on the board.



7. Ask students what would go into the gametes from the mother and father. (The mother will produce eggs with either A or a and the father will produce sperm with either A or a.)

8. Ask them what this process is (meiosis) and why is it necessary (to keep the number of chromosomes in the offspring the same as the parents, so that when the sperm fertilizes the egg the number of chromosomes does not double.)

9. Ask student what possible pairing could occur from the gametes. (AA, Aa, aa; NN, Nn, nn)

10. Use the possible outcomes to show examples of homozygous gene combinations.

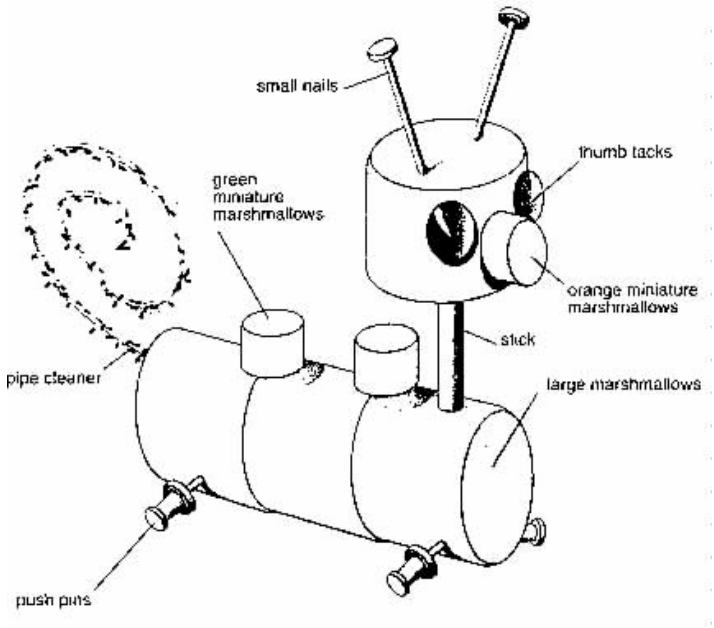
11. Explain to the students that for each characteristic, one trait is dominant and the other trait is recessive; these are called alleles. Explain that a dominant allele is one that will mask the expression of a recessive allele when they are together, it is the one that will show. A recessive allele is one that will be expressed only when it is present with itself (homozygous) and will be masked if present with a dominant allele.

12. Have students follow the Reebop procedure.

Name:____Answer Key_____

Partner:_____

Reebop Lab



BACKGROUND:

Reebops are tiny creatures that live inside discarded soda cans. In the wild they are very hard to see because they are extremely fast. They are easy to breed and are extremely prolific and thrive in captivity with minimal care and space. Reebops also inherit their genes the same way as people and the traits are easy to observe, these characteristics make them excellent subjects for studying genetics.

PROCEDURE

1. You and your lab partner will receive an envelope that contains 14 red chromosomes that belong to Mom Reebop and 14 green chromosomes that belong to Dad Reebop.
Decide which of you will act as Mom and which will act as Dad.

2. Place your chromosomes on the table in front of you, letter side down. Your lab partner should do the same with the other set of chromosomes.

2. Arrange the mother's 14 chromosomes into pairs by length and width. Select one chromosome from each of her seven pairs and place all seven in a special mother "gamete" (egg or sperm) pile. Do the same for the father. The leftover chromosomes should now be returned to the correct envelopes.
What type of cell division has just occurred? _____meiosis_____

How do the gametes produced compare to the original set of chromosomes? Explain.

_____the gametes have half the chromosomes of the original cells (haploid)

_____

3. Combine the seven red and seven green chromosomes from the two gamete piles to form a "baby" pile. Now each Reebop baby will have 16 chromosomes just like Mom and Dad did. But half will be red and half green, indicating that half came from Mom and half from Dad.

4. Line up the chromosomes contributed to the baby by Mom and Dad in pairs of similar size, letter side up. You will see that each chromosome in a pair carries a gene of similar type (same letter of the alphabet). Some chromosome pairs might carry the same allele (either both capital letters or both lower case), indicating that the baby is homozygous (has two alleles of the same type) for the kind of gene carried on that chromosome. Other chromosome pairs might carry one dominant (capital letter) allele and one recessive (lower-case) allele, indicating that the baby is heterozygous (has two alleles of different type) for the kind of gene carried on that chromosome. The combination of genes carried on these seven chromosome pairs defines your Reebop baby's genotype (genetic constitution). Record this genotype in the chart below.

Trait	Genotype	Phenotype
Body Segments		Answers will
Antennae		vary.
Nose Color		
Eyes		
Humps		
Tail		
Legs		
Sex		

5. Refer to the Reebop Genotype-Phenotype Conversion Table to determine your baby's phenotype. Record the phenotype in the table above.

6. You are now ready to construct your Baby Reebop. Collect the body parts that you will need and return to your desk to build your baby.

7. When your Reebop baby is complete, place it in the nursery area designated by your teacher.

8. Make some observations about the Reebop offspring. (What characteristics do they have in common? Are any identical? What traits are the most common? etc.)

Answers will vary.

REEBOP REVIEW

1. Define the following terms and give an example of each from this activity.

allele: __alternate forms of a gene_ ex. curly tail (T) and straight tail (t)_____

genotype: _the combination of alleles present in an organism ex. Tt _____

phenotype: __physical expression of an organism's genotype ex. red nose, red legs, curly tail_____

homozygous: _____having two of the same alleles for a trait ex. AA, tt, BB or ee__

heterozygous: ___having two different alleles for a trait; represented with a capital letter and a lower case letter ex. Tt or Aa_____

2. How much genetic material did each parent contribute to the offspring? __one half__

3. What processes were involved in the production of the offspring's genetic makeup?

_____answers may vary, but should include meiosis, fertilization, and independent assortment_____

Give it a try, make some predictions:

4. If a Reebop female with a red nose and a Reebop male with a yellow nose marry and have children, what genotype and phenotype for nose color will their children have?

genotype _all Nn or ½ Nn and ½ nn_____ phenotype ____all red or red and yellow depending on the parent genotypes that were assigned_____

5. If a Reebop female with one antenna and a Reebop male with no antennae marry and have children, what genotypes and phenotypes might their children have with respect to number of antennae?

genotypes __all Aa or ½ Aa and ½ aa_____ phenotypes _all with one antenna or 1/2 with one antennae and the other 1/2 with two antennae_____

6. If a Reebop female with one antenna and a Reebop male with one antenna marry and have children, what is the probability that they will have a baby with no antennae?

___If both parents are heterozygous, then the chances are 25%; if the parents are homozygous, then it is 0%; if one parent is homozygous and the other is____ heterozygous, then it is 0%_____

7. If a Reebop female with two green humps and a Reebop male with two green humps marry and have children, what is the probability that their first baby will have two green humps?

_____100%_____

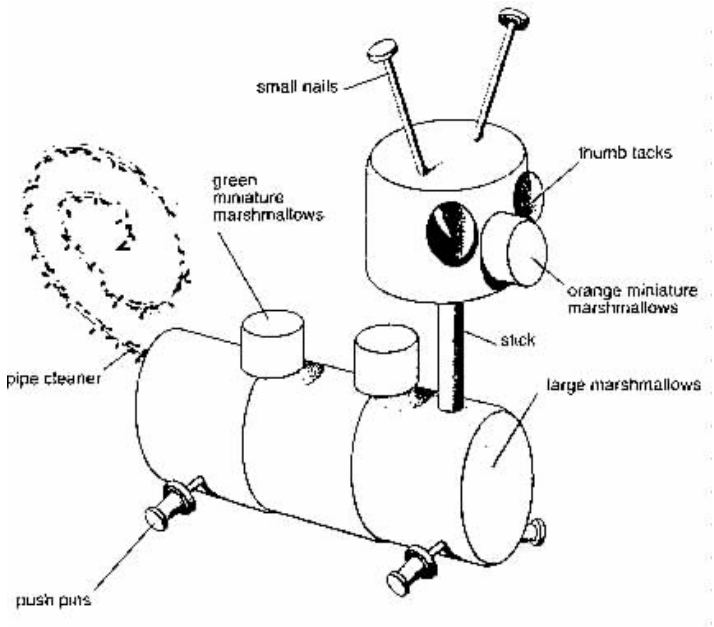
8. If a Reebop baby has a straight tail, but both of his parents have curly tails, what are genotypes of the two parents?

_____both parents are heterozygous (Tt)_____

Name:_____

Partner:_____

Reebop Lab



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What type of cell division has just occurred? _____

How do the gametes produced compare to the original set of chromosomes? Explain.

_____

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REEBOP REVIEW

1. Define the following terms and give an example of each from this activity.

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_____

genotype: _____

_____

phenotype: _____

_____

homozygous: _____

_____

heterozygous: _____

_____

2. How much genetic material did each parent contribute to the offspring? _____

3. What processes were involved in the production of the offspring's genetic makeup?

_____

_____

_____

_____

_____

Give it a try, make some predictions:

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genotype _____ phenotype _____

5. If a Reebop female with one antenna and a Reebop male with no antennae marry and have children, what genotypes and phenotypes might their children have with respect to number of antennae?

genotypes _____ _____ phenotypes _____ _____

6. If a Reebop female with one antenna and a Reebop male with one antenna marry and have children, what is the probability that they will have a baby with no antennae?

_____

7. If a Reebop female with two green humps and a Reebop male with two green humps marry and have children, what is the probability that their first baby will have two green humps?

_____

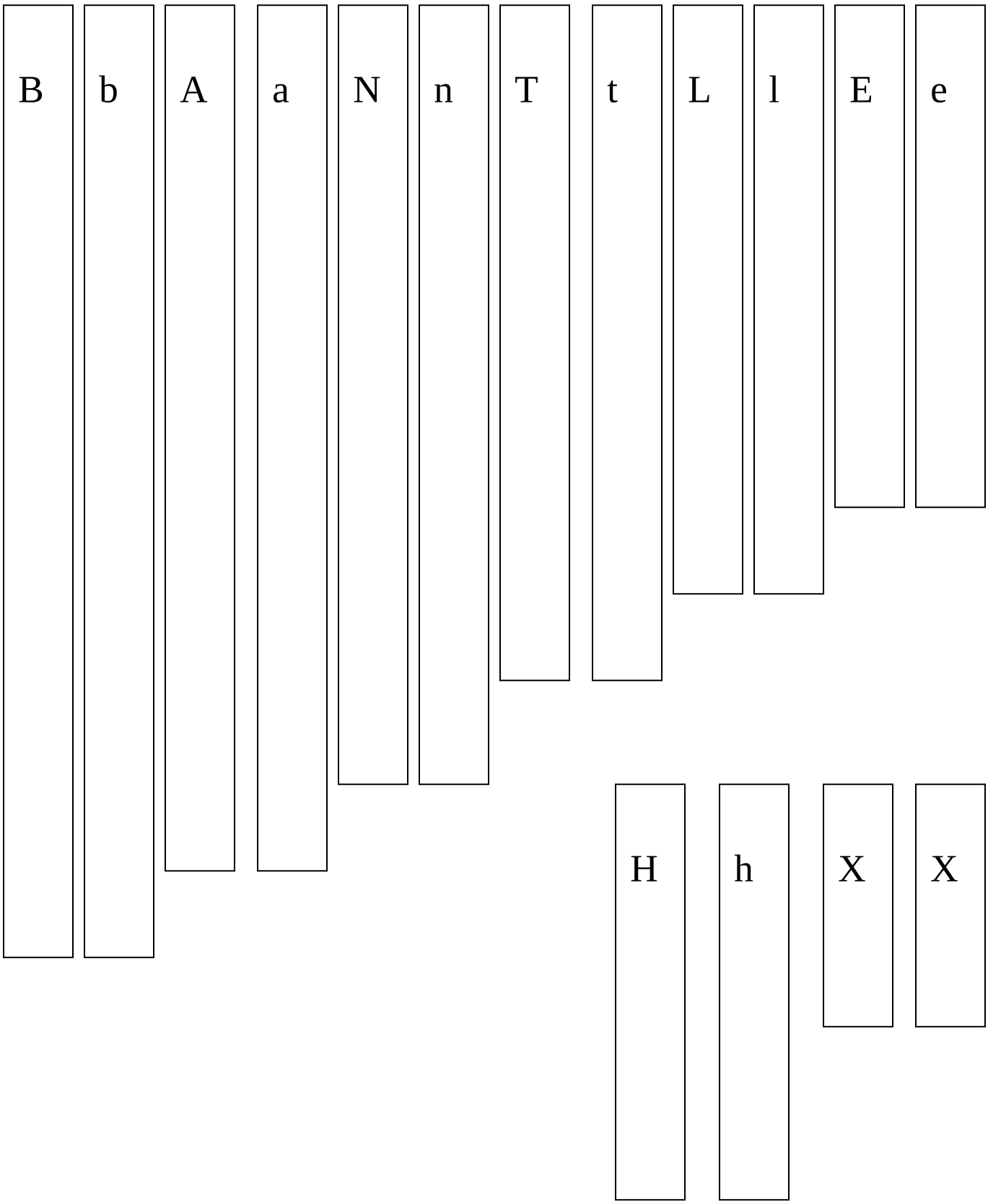
8. If a Reebop baby has a straight tail, but both of his parents have curly tails, what are genotypes of the two parents?

_____

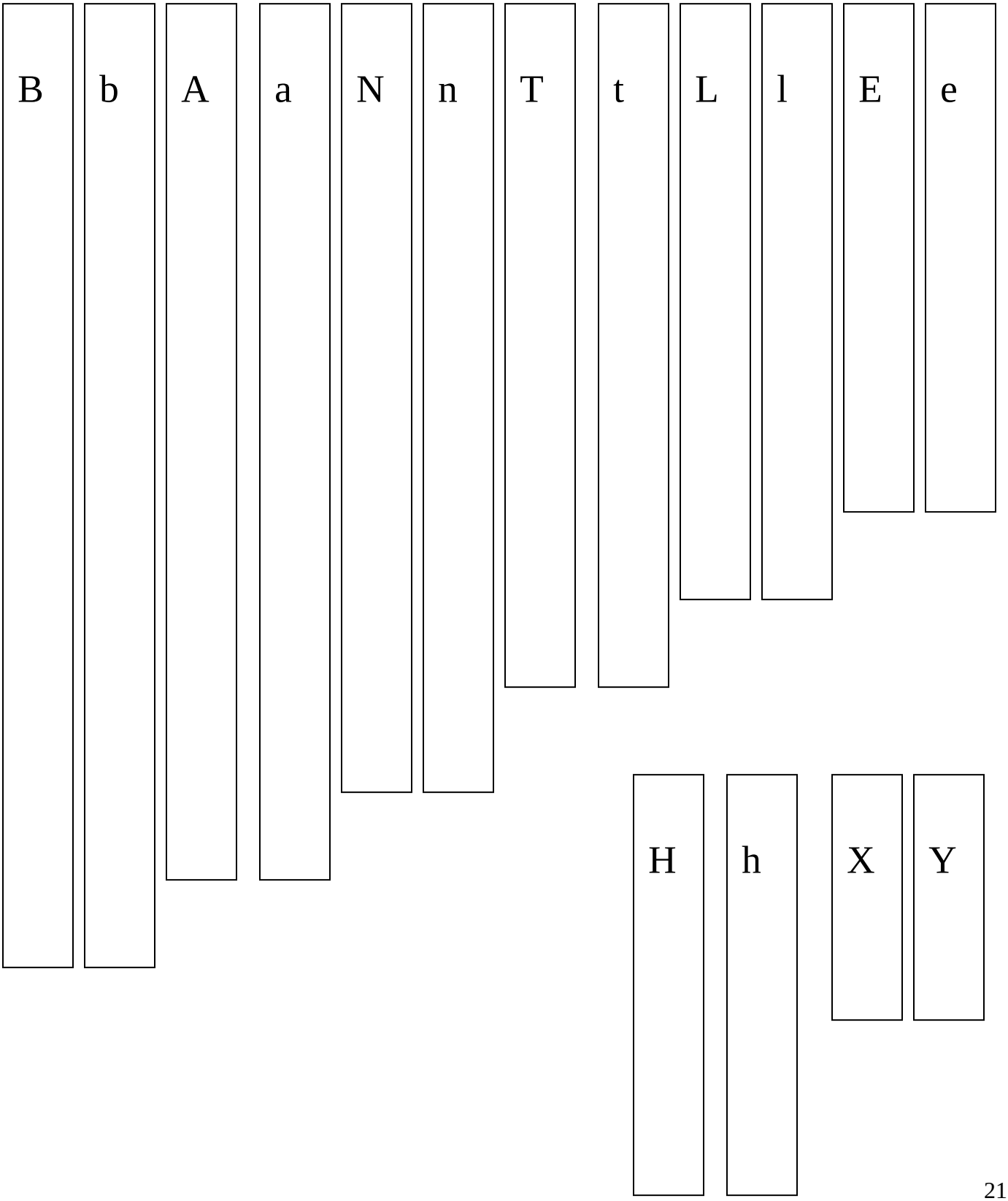
Reebop Genotype-Phenotype Conversion Table

Genotype	Phenotype
BB	3 Body Segments
Bb	3 Body Segments
bb	2 Body Segments
AA	1 Antenna
Aa	1 Antenna
aa	2 Antenna
NN	Red Nose
Nn	Red Nose
nn	Yellow Nose
TT	Curly Tail
Tt	Curly Tail
tt	Straight Tail
LL	Blue Legs
Ll	Blue Legs
ll	Red Legs
EE	2 Eyes
Ee	2 Eyes
ee	1 Eye
HH	1 Hump
Hh	1 Hump
hh	2 Humps
XX	Sex - Female
XY	Sex - Male

Female Reebop Chromosomes



Reebop Male Chromosomes



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