

# DRAGON GENETICS LAB

## -- Principles of Mendelian Genetics

*Dr. Pamela Esprivalo Harrell, University of North Texas, developed an earlier version of "Dragon Genetics" which is described in the January 1997 issue of Science Scope, 20:4, 33-37.  
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### BACKGROUND

Students will work in pairs in the lab to produce a dragon from the random mixing of genetic traits. Each student will be a surrogate dragon parent. They will pick up a complete set of dragon chromosomes. Surrogate dragon parent partners must be of the opposite sex, therefore one parent must pick up the double X chromosomes while the other must pick up the X/Y chromosomes. The homologous chromosomes will be separated according to Mendel's law of Independent Assortment. The genetic codes that are passed on to the baby will be recorded on the following pages. The surrogate parents must then decode the genes inherited by their *bundle of joy* to determine the phenotype traits of their baby. Using the pictures at the end of the handout, they will cut out these traits and paste them together to have a picture of their baby.

### PROCEDURE

1. Choose a partner carefully. You and your spouse will share the grade for this lab. Your instructor does not care which partner worked the hardest. This is a no divorce classroom. The lab must be completed on time.
2. Each partner must pick up five Popsicle sticks -- one of each color of autosome, and one sex chromosome stick. Each side of a stick represents a chromosome, and the two sides together represent a pair of homologous chromosomes.
3. For each color autosome and then for the sex chromosomes, each parent will randomly drop his or her stick on the table. The side of the stick that is up represents the chromosome that is passed on to the baby.
4. The alleles from each pair of homologous chromosomes will be recorded in the data chart on pages 3-4.
5. The decoding chart on page 2 indicates the phenotypic effect of each gene. The trait produced by each pair of alleles should be recorded in the data chart. Remember that a CAPITAL letter is dominant over a small letter [recessive] unless the decoding chart indicates those traits are codominant, sex-influenced, or sex-limited.
6. The students will cut out the traits for their baby. Fit them together and produce a picture of the baby. Students may trace the traits to produce their baby's picture or just glue them to the page.
7. The baby's colors will be added to the picture, if possible; otherwise indicate the baby's colors below the picture.

## DRAGON GENOME DECODING OF THE GENES

Chromosome	Dominant genes	Recessive genes
Green Autosome	A. no chin spike B. nose spike C. three head flaps D. no visible ear hole E. [see below]	a. chin spike b. no nose spike c. four head flaps d. visible ear hole
Red Autosome	F. long neck G. no back hump H. no back spikes I. long tail J. flat feet	f. short neck g. back hump h. back spikes i. short tail j. arched feet
Orange Autosome	K. red eyes L. spots on neck M. [see below] N. no fang O. spots on back	k. yellow eyes l. no spots on neck  n. fang o. no spots on back
Yellow Autosome	P. no spots on thigh Q. green body R. small comb on head [see below] S. [See below] T. [See below]	p. spots on thigh q. purple body r. large comb on head
Sex Chromosomes	U. regular thigh V. four toes W. no chest plate	u. pointed thigh v. three toes w. chest plate
X Chromosome Only	X. no. tail spike Z. long arms + non-fire breather	x. tail spike z. short arms - fire breather
Y chromosome only	Y. male sex	

### Codominant traits

E. eye pointed at each end	e. round eye	Ee. eye round at front only
S. Red spots	s. yellow spots	Ss. orange spots

### Sex-influenced traits

M. wings	m. no wings [dominant in presence of male hormone]
T. no elbow spike	t. elbow spike [dominant in presence of male hormone]

### Sex-limited traits

R or r Only males have the comb on the head.

## *Our Baby!*

Names \_\_\_\_\_  
 \_\_\_\_\_

### Green Autosomes

GENOTYPES Alleles in  
 MOM DAD Egg Sperm TRAIT---Phenotype of Baby



### Red Autosomes

GENOTYPES Alleles in  
 MOM DAD Egg Sperm TRAIT---Phenotype of Baby



### Orange Autosomes

GENOTYPES Alleles in  
 MOM DAD Egg Sperm TRAIT---Phenotype of Baby

Yellow Autosomes

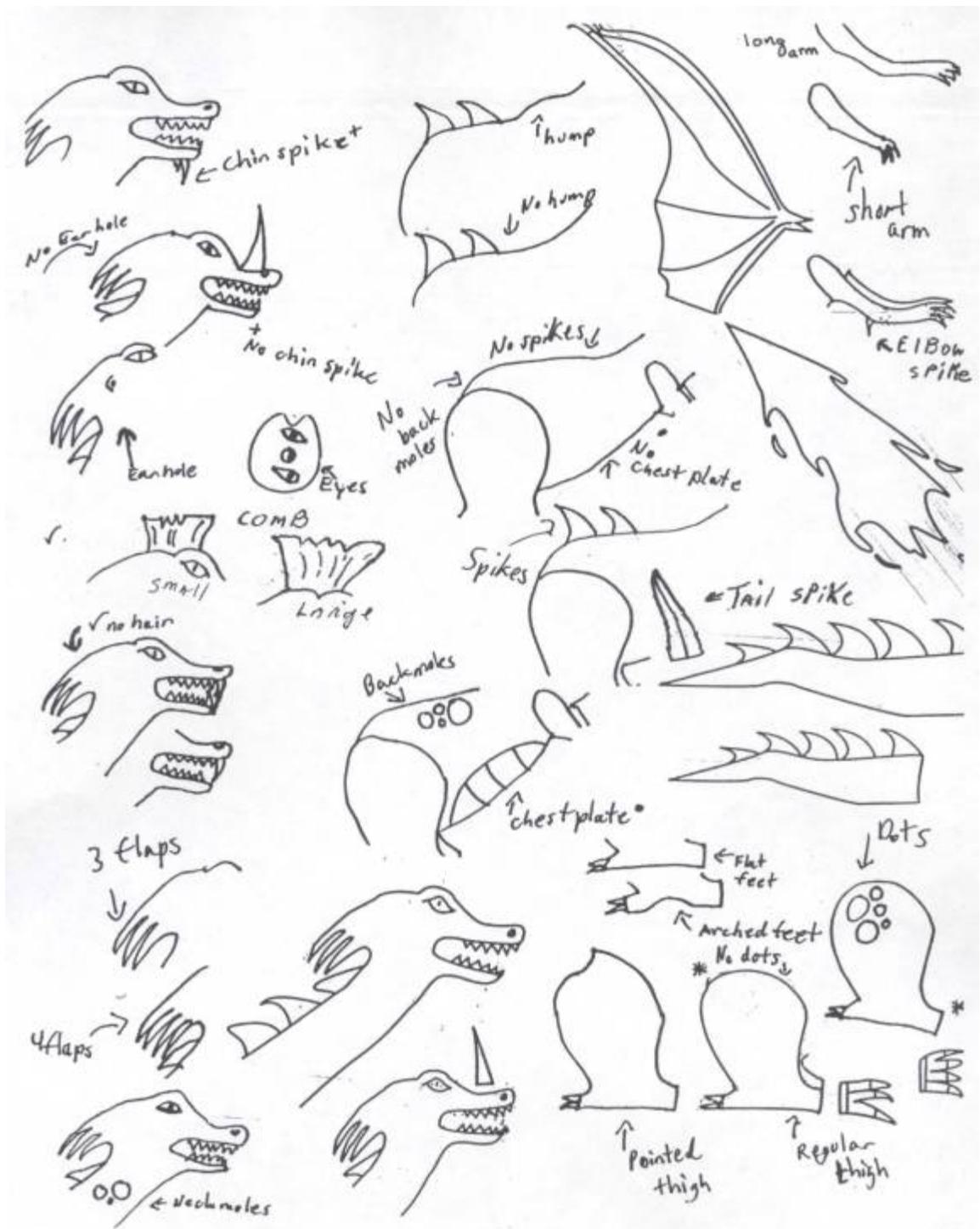
GENOTYPES Alleles in  
 MOM DAD Egg Sperm TRAIT---Phenotype of Baby


Sex Chromosomes

GENOTYPES Alleles in  
 MOM DAD Egg Sperm TRAIT---Phenotype of Baby


Questions

1. How does dropping the stick on the table and transcribing the letters on the sides facing up follow Mendel’s Law of Segregation? [First state the law.]
2. Explain how dropping the green, orange, and red sticks illustrates Mendel’s Law of **Independent** Assortment? [First state the law.]
3. The gene for fangs is recessive, yet most of the dragons have fangs. How can this happen? [Hint. The gene that causes dwarfism (achondroplasia) in humans is dominant.]
4. What is the sex of your baby?
5. What traits are *sex-linked*? [First define “sex-linked”.]
6. Identify any gene deletions or inversions in the chromosomes you have.
- 7a. What traits are *more likely* to be found in males? [Consider sex-linked, sex-influenced and sex-limited traits.]
- 7b. How might these be an advantage to this sex? [Be creative in your answers.]
- 8a. What traits are *more likely* to be found in females?
- 8b. How might these be an advantage to this sex?



## **Teacher Preparation Notes for Dragon Genetics Lab -- Principles of Mendelian Genetics**

### Materials

- colored paper (2 each of orange, green, red, and yellow, and 1 each of blue and pink or purple)
- print out the page of genes for each type of autosome and sex chromosome (given at the end of these instructions)
- rubber cement or Elmer's glue
- popsicle sticks (5 for each student in the class)

### Instructions for Preparing Chromosomes

Each popsicle stick should be prepared to represent a pair of homologous chromosomes. You will want to have a complete set of five popsicle sticks for each student in your class. Xerox or print two copies of each page of autosome genes on the appropriate color paper and one copy of each page of sex chromosome genes on the appropriate color paper. This will provide enough popsicle sticks for 36 students (18 dragon mothers and 18 dragon fathers). Each page of autosome genes (given at the end of these instructions) intentionally includes some gene deletions and inversions.

For each page of genetic traits, cut out the strips, each with a vertical column of letters representing the genes in one chromosome. (There are 12 strips in each section of the page, for a total of 36 strips per page.) Apply rubber cement or Elmer's glue to both sides of a popsicle stick, and glue strips on both sides of the popsicle stick, continuing this until all the strips have been used to make popsicle stick chromosomes. For the autosomes and for the sex chromosomes for females, you can use any two strips from the same page. For the sex chromosomes for males, be sure to include an X-chromosome on one side and a Y chromosome on the other side of each popsicle stick.

### Comments for Discussion with Students

For codominant traits (Ee and Ss), there are the same number of both alleles, so that the teacher can show a class ratio of 1:2:1. Other traits such as fangs/no fangs (N = no fangs, n = fangs) are set up to show that a recessive trait can be the predominant trait in the population. This can be discussed in terms of the need for fangs for survival, but the possible advantage of no fangs if meat is not available and plants begin to play a larger part in the diet.

The sex-linked traits also can stimulate the students to come up with some interesting theories. Males tend to fight more and therefore need protection of the chest plate (W = no chest plate, w = chest plate), and the same may be said of tail spikes (X/x). Short arms may be more powerful, while females may benefit from longer arms to hold/care for babies (Z/z).

The sex-influenced traits also lead to some theories. Female tend to have wings (M/m) which allows them to get away from those pesky males or to flee danger with their babies. Elbow spikes (T/t) are found in males and may relate to fighting.

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The most confusing trait for students is the comb (R/r). Only males have a comb, although females have the genes for the comb. This usually leads to a discussion that you can inherit secondary sexual traits from either parent.

GREEN AUTOSOMES

A	A	a	a	a	a	a	A	A	A	A	A
B	b	B	B	B	b	b	b	b		b	B
C	c	c	C	C	C	C	c	c	C	c	C
D	d	d	D	d	d		D	D	d	d	D
E	e	E	E	e	e	e	e	E	e	e	E

A	A	A	A	A	A	a	a	a	a	a	a
B	B	B	b	b	b	b	b	b	B	B	B
C	C	c	c	c	C	C	C	c	c	c	c
D	d	D	d	D	d	D		d	D	d	d
E	e	e	E	E	e		E	e		e	E

a	a	a	a	a	a		A	A	A	A	A
b	b	b	b	B	D	B	b	b	c	b	b
c	c	c	C	C	c	C	c	C	b	C	C
d	d	D	D	d	B	d	D	d	d	D	d
e	E	E	E		E	e	e	e	e	e	e

RED AUTOSOMES

F	F	F	F	F	H	f	f	f	f	h	F
G	G	g	g	g	G	G	G	G	g	G	g
H		h	H	F	h	h	H	H	F		h
I	I	i	i	I	i	i		I	I	I	i
J	j	j	j	j	j	j	j	j	J	J	J

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f	f	f	f	f	g	f		f	F	F	F
G	g	g	g	G	G	G	G	g	g	g	g
H	h	h	h	h	h	j	H	H	h	h	H
I	I	I	I	I	I	H	i	i	i	i	i
J	j	J	J	J	j	i	j	J	J	J	j

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F	f	f		F	F	F		f	f	F	F
G	g	g	g	g	G	G	G	g	g	g	G
H	h	H	H	H	H	h	h	h	h	H	H
I	I	I	i	i	i	i		I	I	I	I
J	J	J	j	j	j	j	J	j	J	J	j

## Orange Autosomes

K	K	K	K	K	k	k	k	k	k	k	k
L	l	l	L	L	L	L	l	l	l	L	L
M	m	m	m	M	p	m	m	M	M	M	M
N	n	N	n	n	O	n	n	n	n	n	n
O	o	o	O	o	n	O	O	O		o	O

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K	k	k	k	k	k	K	K	K	K	K	K
L	l	L	l	L	l	l	l	L	L	l	l
M	m	m		m	M	m	m	M		M	M
N	n	n	n	o	N	n	n	n	n	n	n
O	O	o	o	n	O	O	o	o	O	O	O

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K	k	K	k	k	K	K	k	K	k	K	k
L	l	l	L	L	l	L	l	L	l	L	l
M	m	m	M	M	m	m	M	m	M	M	m
N	n	n	n	n	n	N	n	n	n	N	N
O	o	o		O	O	O	O	o	O	o	O

## Yellow Autosomes

P	p	p	P	P	P	p	p	p	P	P	p
Q	q	q	q	q	q	r	Q	q	q	q	Q
R	r	R	R	r	r	Q	r	R	r	r	R
S	s	S	s	S	s	S	s	S	s	S	s
T	T	t	T	t	t	T	t	T	t	t	

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P	p	p	P	p	P	p	P	P	p	P	p
Q	q	q	q	q	Q	Q	Q	Q	Q	q	q
R	R	r	r	r	R	R	R	r	r	r	R
S	s	t	s	s	S	S	s	S	s	s	S
T	t	s	T	t	t	T	T	T	T	t	t

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P	p	p	p	p		P	P	P	P	P	P
Q	Q	Q	Q	Q	s	q	q	q	q	q	q
R	r	r	r		r	R	R	r	t	r	R
S	S	s	s	S	q	s	S	S	S	s	s
T	t	t	t	T	t	T	T	T	r	t	t

SEX CHROMOSOMES—X/X chromosomes [pink or purple]

U	U	U	U	U	U	u	u	u	u	u	u
V	v	v	v	V	V	V	v	v	v	v	V
W	w	w	w	W	w	w	w	w	w	w	W
X	x	x	x	X	X	X	x	x	x	x	X
Z	z	z	Z	z	z	z	Z	Z	Z	z	z
-	-	-	-	+	+	+	+	+	-	-	-

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U	U	u	u	u	u	U	U	U	u	u	U
V	v	v	v	v	v	V	V	V	V	V	V
W	W	w	w	w	w	w	w	w	w	w	w
X	x	x	X	X	X	X	x	x	x	x	x
Z	z	z	z	z	Z	Z	Z	Z	z	z	z
+	-	+	-	+	-	+	-	-	-	+	+

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U	u	u	u	u	u	U	U	U	U	U	U
V	v	v	v	V	V	V	v	v	v	v	v
W	w	w	w	w	w	w	w	w	W	W	w
X	X	X	x	x	x	x	x	X	X	X	x
Z	z	z	z	z	z	z	Z	Z	Z	Z	z
+	+	+	-	-	-	-	+	+	-	+	-

SEX CHROMOSOMES --X/Y chromosomes [blue]

U	u	u	u	u	u	u	u	u	u	u	u
V	v	v	V	V	V	V	V	V	V	V	v
W	W	W	W	W	W	Y	Y	Y	Y	Y	Y
X	x	x	X	X	X						
Z	z	z	Z	Z	Z						
+	-	+	-	+	-						

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u	u	u	u	u	u	u	u	u	u	u	u
v	v	v	v	v	v	v	v	v	V	V	V
w	W	W	W	w	w	Y	Y	Y	Y	Y	Y
X	X	x	x	x	x						
Z	z	z	y	Z	Z						
-	-	-	-	+	+						

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U	U	U	U	U	u	u	u	u	u	u	u
V	v	v	v	v	v	v	V	V	V	V	V
W	W	w	w	w	w	Y	Y	Y	Y	Y	Y
X	x	X	X	X	x						
Z	z	Z	Z	z	z						
+	+	+	+	-	-						

Grading Rubric for Dragon Genetics Album

**Grading Rubric for Dragon Genetics Album**

Front cover: Sturdy material or clear plastic report cover	3.3	_____
Decorated with one three dimensional sticker	3.3	_____
Five appropriately themed stickers	16.5	_____
Both parents names on front cover	6.6	_____
Inside: Information pages and answers to Questions	39.6	_____
Themed pages	13.2	_____
Pages decorated and journaled	13.2	_____
Spelling and Grammar	4.3	_____