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ABSTRACT

Some concepts in genetics are difficult for many students to understand. This document provides hands-on, cost efficient, fun activities for students to help them better understand abstract concepts in genetics. Each activity includes: purpose, introduction, materials, procedures, results and conclusion. Some of the topics explored are: (1) dominant and recessive genes; (2) genetic code; (3) Punnett Squares; (4) phenotype and genotype; (5) allele traits; (6) human genetic disorders; and (7) forensics and genetics. (ZWH)

LOW BUDGET BIOLOGY: GENETICS UNIT

Bert and Lynn Marie Wartski

1993

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Biology With Junk: Personal Trait Activity
Teacher Prep

Purpose: This activity will introduce students to the concept of Dominant and Recessive genes, traits, and that genes code for traits in pairs.

Introduction: While exploring their own bodies, students will understand what traits are dominant and recessive genes and that genes code for traits in pairs.

Hand out the student sheet and let them do the rest.

Note: You may need to answer trait questions.

Materials:

Pen/pencil: to record results.

Student sheet: used to learn about human genetics.

Personal Trait Activity

Purpose: In this activity, you'll learn about traits, Dominant and Recessive genes, and that genes code for traits in pairs.

Materials:

Student sheet
Pen/pencil

Procedures:

1) Look at the list of human traits and check off the traits you display.

2) Once your traits are checked off, record the genes that coded for those traits.

Information:

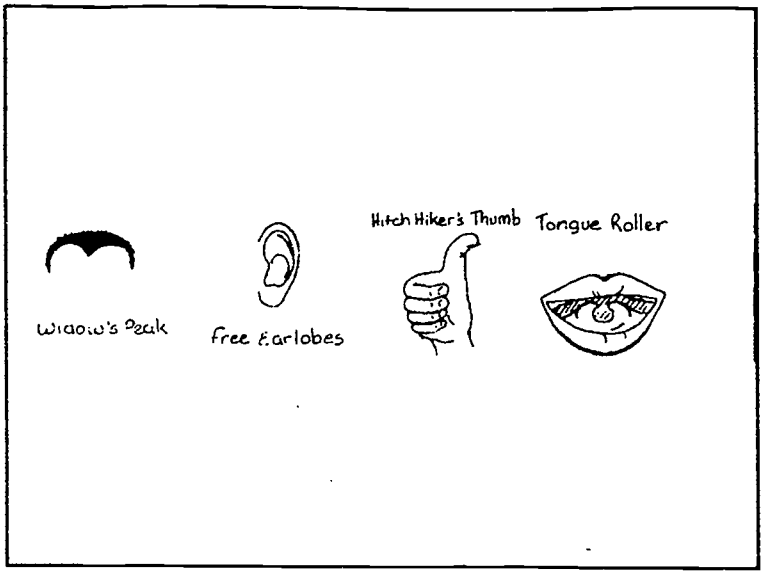
Gene: A gene is a specific piece of chromosome that is a single direction for the cell or body. Your gene tells your cells and body what to do and how to look. You have genes for tongue rolling, widow;'s peak, and ear lobe type

Trait: A trait is something that you show or have; for example, tongue type, ear lobe type, and widow's peak. Each and every trait is coded by, at least, two genes. One gene comes from your mom's egg and the other gene comes from your dad's sperm.

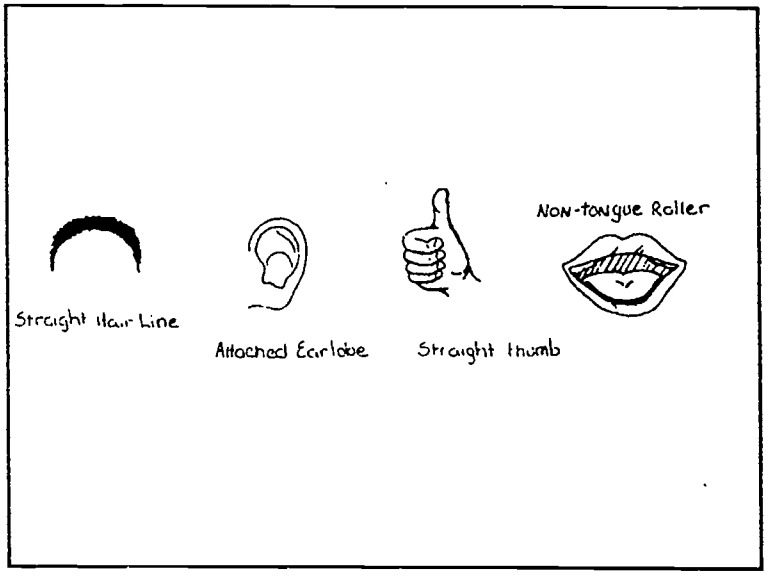
One type of gene is for Dominant/Recessive traits. A dominant gene is always expressed. If you have two dominant genes, you will express the dominant trait. If you have two recessive genes, you will express the recessive trait. If you have a dominant gene and a recessive gene, you will express the dominant trait. For example W is a dominant gene that codes for a widow's peak, while w is a recessive gene that codes for a straight hair line.

WW = widow's peak, Ww = widow's peak, and ww = straight hair line.

Dominant traits:



Recessive traits:



Record if you display the trait:

Check here if you have the dominant trait	Dominant Trait	Check here if you have the recessive trait	Recessive Trait
	Dark Hair (DD or Dd)		Light Hair (dd)
	Widow's Peak (WW or Ww)		Straight Hair Line (ww)
	Free Ear Lobes (EE or Ee)		Attached Ear Lobes (ee)
	Freckles (FF or Ff)		No Freckles (ff)
	Right Handed (HH or Hh)		Left Handed (hh)
	Hitch-hikers thumb (TT or Tt)		Straight Thumb (tt)
	Tongue Roller (RR or Rr)		Non-tongue Roller (rr)

In the table below, list your genes for the following traits.

Genes for the trait	Trait
	Hair Color
	Hair Line
	Type of Ear Lobes
	Freckles
	Handedness
	Type of Thumb
	Type of Tongue

Questions:

1) If you have a dominant gene and recessive gene, what trait would you show?

2) In hair color, if a person has dark hair, what are their possible genes?

3) If you have no freckles, what are your genes?

4) If you can roll your tongue, what are your possible genes?

Biology With Junk: Human Trait Activity
Teacher Prep

Purpose: To have students investigate genetic traits and practice punnett squares.

Introduction: When students practice Punnett squares, teachers often give them problems involving plants or small mammals. Students may enjoy finding out about some of their traits. This information can be used to practice their Punnett squares.

For this exercise, all dominant traits will be heterozygous. This will make the square results a little more interesting, save time and save paper. After the students determine their traits and their genes, they will 'mate' with their partner. It is not necessary to have male-female partners. For each trait, the partners will set up and complete a Punnett square and determine the phenotypic ratio of the offspring.

If you or the students need help in determining what the traits look like, refer to the create-a-baby lab or the personal trait activity. The pictures will help you out.

NOTE: You may want to review the following terms before the activity: Dominant, Recessive, Heterozygote, Homozygote, Phenotype, Genotype and Ratios.

Materials:

Partner: the 'mate'

Tables 1 and 2: for data

pen/pencil

Human Trait Activity

Purpose: You and a partner will determine the genotype of certain human traits that you two possess, and you and your partner will practice punnett squares using these traits.

Materials:

Partner
Tables 1 and 2
pen/pencil ,

Procedure:

1) Check off your traits on table 1.

2) Determine and record your gene make up in table 2.

3) Check off your partner's traits on table 1.

4) Determine your partner's genetic make up in table 2.

5) Using the information in table 2, set up and complete a Punnett square for each of the traits.

6) Determine the **phenotypic** ratio for each trait.

Results:

Table 1: Your Phenotype and Your Partner's Phenotype (**Remember: a Dominant trait is automatically heterozygous for this activity.** This saves time and paper.) Record the Genotypes in table 2.

Dominant Traits			Recessive Traits		
You	Partner	Trait	You	Partner	Trait
		Dark Hair (Dd)			Light Hair (dd)
		Widows' Peak (Ww)			Straight Hair (ww)
		Free Ear Lobes (Ee)			Attached Ear Lobes (ee)
		Freckles (Ff)			No Freckles (ff)
		Right Handed (Rr)			Left Handed (rr)
		Straight Thumb (Ss)			Hitch-hikers Thumb (ss)
		Tongue Roller (Tt)			Non-tongue Roller (tt)

Table 2: Gene Make Up

Trait	Your genes	Partner's genes
Hair Color		
Hair Line		
Ear Lobes		
Freckles		
Hand Preference		
Thumb		
Tongue		

Punnett squares:

Phenotypic Ratio:_____

Phenotypic Ratio:_____

Phenotypic Ratio:_____

Phenotypic Ratio:_____

Phenotypic Ratio:_____

Phenotypic Ratio: _____

Phenotypic Ratio: _____

Biology With Junk: Create-A-Baby Lab
Teacher Prep

Purpose: To demonstrate that genes and traits are passed on from generation to generation. The concepts of dominance, genotype and phenotype, and incomplete dominance will be illustrated.

Introduction: In order to determine the genotype of the baby, pennies will be flipped. If a head comes up, that is a dominant gene for that gamete. If a tail comes up, that is a recessive trait for that gamete. For each part of the baby's face, the pennies will be used to determine the genotype. Upon completion of the genotype, students will draw the phenotype of the baby. Remember, this is a baby that is to be drawn, not a 14 year old child.

Materials:

Colored Pencils: Used to draw the baby.

Two Pennies: Used to determine the traits.

Procedure:

1) Assign two students to a group. One student will be the 'mother' and the other student will be the 'father.'

Create A Baby Lab

Purpose: To demonstrate that genes and traits are passed on from generation to generation. The concepts of dominance, genotype, phenotype, and incomplete dominance will be illustrated.

Materials:

Colored pencils/Crayons
Two pennies

Procedure:

1) Your teacher will assign two students per group. One student will be the 'mother' and the other student will be the 'father.'

2) Determine the genotype for each trait of the baby, by flipping the pennies.

Note: Heads are Dominant
Tails are Recessive

3) Record the genotype and trait on table 1. REMEMBER: 1 gene is from "dad" and 1 gene is from "mom."

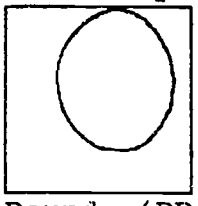
4) Upon completion of the genotype and phenotype, draw a baby with the colored pencils/crayons. It is important that you remember to draw a BABY not a child or adult.

Characteristics:

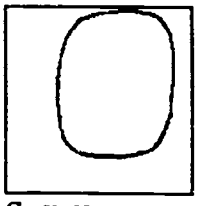
Gender: Gender is determined by 2 chromosomes. Males have an X and a Y chromosome. Females have two X chromosomes. The father can give either an X or a Y chromosome to his child, while the mother can only give the X chromosome to her child. Knowing this, the gender of the baby is determined by the father. For this characteristic **only the 'father'** flips the penny. If heads comes up, the father gave the Y chromosome to the baby. If tails is flipped, the father gave the baby the X chromosome. Now, you have the responsibility of naming the child.

Dominant/recessive Traits:

Face Shape:

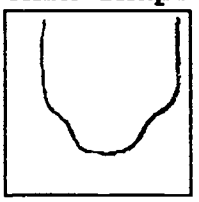


Round (RR or Rr)

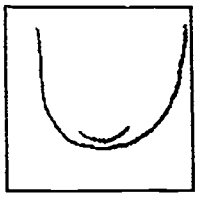


Square (rr)

Chin Shape:

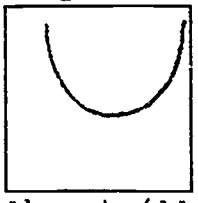


V e r y
Noticeable
(NN or Nn)

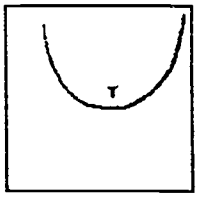


L e s s
Noticeable
(nn)

Dimple in Chin:

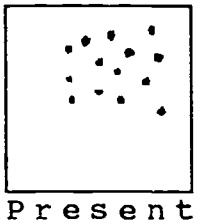


Absent (AA
or Aa)

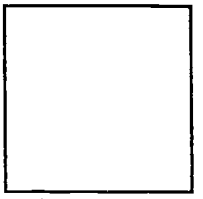


P r e s e n t
(aa)

Freckles:

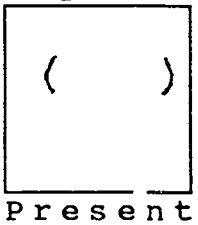


P r e s e n t
(FF or Ff)

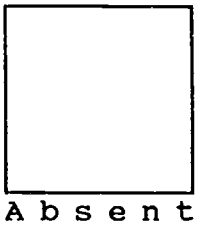


A b s e n t
(ff)

Dimples in Cheek:

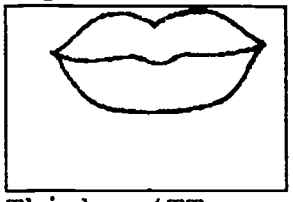


P r e s e n t
(DD or Dd)

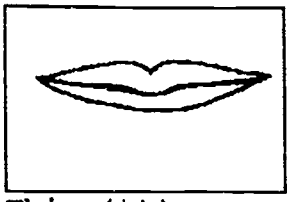


A b s e n t
(dd)

Lip Thickness:

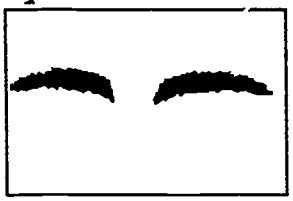


Thick (TT or Tt)

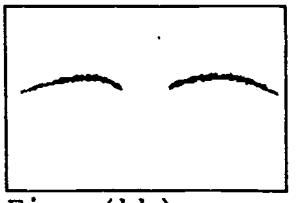


Thin (tt)

Eye Brows:

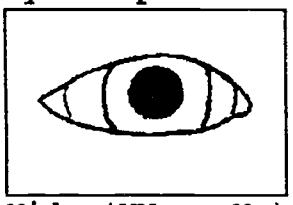


Bushy (BB or Bb)

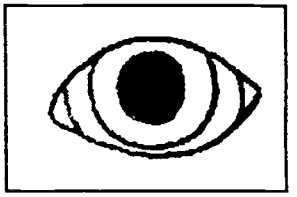


Fine (bb)

Eye Shape:

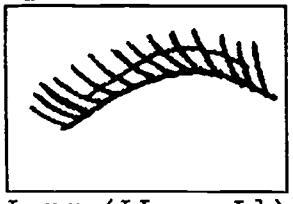


Wide (WW or Ww)

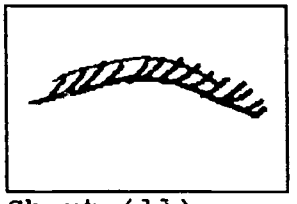


Round (ww)

Eyelashes:

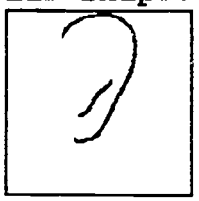


Long (LL or Ll)

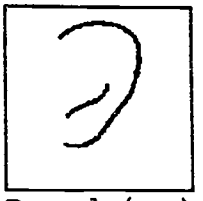


Short (ll)

Ear Shape:

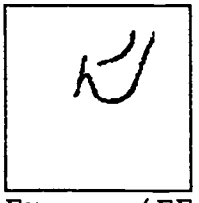


Long (RR or Rr)

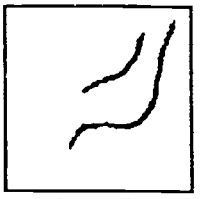


Round (rr)

Ear Lobes:



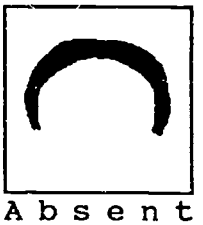
Free (FF or Ff)



Attached (ff)

Widow's Peak:

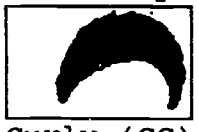
Present (WW or Ww)



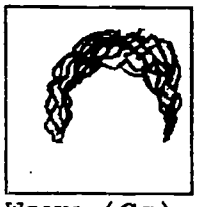
Absent (ww)

<u>Partial Dominant Traits:</u>

Hair Shape:



Curly (CC)



Wavy (Cc)

Straight (cc)

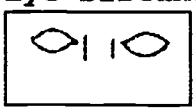
Color of Eyebrows:

Darker than Hair (DD)

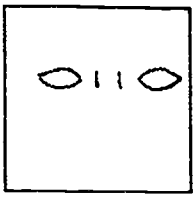
Same color as hair (Dd)

Lighter than hair (dd)

Eye Distance:



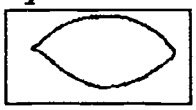
Close Together (CC)



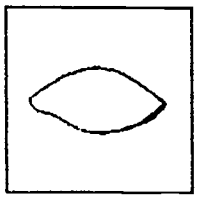
Average Distance (Cc)

Far Apart (cc)

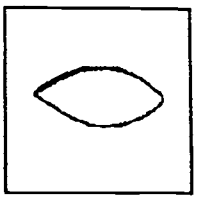
Eye Size:



Large (SS)

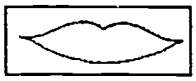


Medium (Ss)

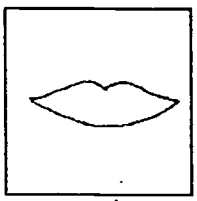


Small (ss)

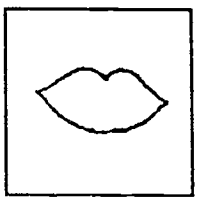
Mouth Size:



Long (LL)

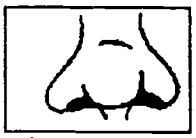


Medium (Ll)

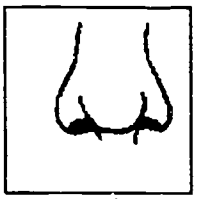


Small (ll)

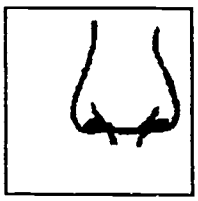
Nose Size:



Big (NN)



Medium (Nn)



Small (nn)

Birth Mark (mole):

On Left Cheek (MM) On Right Cheek (Mm) Absent (mm)

Multiple Allele (Gene) Traits:

For this lab, we will assume that only two gene pairs control for hair and eye color. For the first gene pair, flip the pennies and record the results (AA,Aa,aa). For the second gene pair, again flip your pennies and record your results (BB,Bb,bb). Now combine the two gene pairs.

Hair Color:

Gene Pairs	Hair Color	Gene Pairs	Hair Color
AABB	Black	Aabb	Regular Blond
AABb	Black	aaBB	Dark Blond
AAbb	Red	aaBb	Regular Blond
AaBB	Brown	aabb	Pale Blond
AaBb	Brown		

Eye Color:

Gene Pairs	Eye Color	Gene Pairs	Eye Color
AABB	Deep Brown	Aabb	Gray-Blue
AABb	Deep Brown	aaBB	Green
AAbb	Brown	aaBb	Dark Blue
AaBB	Greenish Brown	aabb	Pale Blue
AaBb	Brown		

Results: Complete table 1 and draw a picture of the baby.

Conclusion: Answer the questions

1) How many genes for a Dominant/Recessive trait does it take to code for freckles? How many genes do the parents give for this Dominant/Recessive trait?

2) Define Genotype:
Define Phenotype:

3) What percentage of the genotype does each parent give to the offspring?

4) Mouth size is a trait that demonstrates partial dominance. For mouth size, what trait is expressed for the following gene combinations?

Homozygous Recessive:
Heterozygous:
Homozygous Dominant:

Results: Table 1.

Father's Name:_____ Mother's Name:_____
Child's Name:_____

Trait	Father's Genes	Mother's Genes	Resulting Traits
Gender		X	
Face Shape			
Chin Shape			
Dimple in Chin			
Freckles			
Dimples in Cheek			
Lip Thickness			
Eye Brows			
Eye Shape			
Eyelashes			
Ear Shape			
Ear Lobes			
Widow's Peak			
Hair Shape			
Color of Eyebrows			
Eye Distance			
Eye Size			
Mouth Size			
Nose Size			
Birth Mark (mole)			
Hair Color			
Eye Color			

Draw a picture of your baby.

Biology With Junk: Corn Lab
Teacher Prep

Purpose: using corn or the paper corn, students will determine the genotypes and the phenotypes of the grandparents and parents of the corn cob.

Introduction: In corn plants, seed (kernels) traits for color (purple or yellow) and texture demonstrate Mendel's law of segregation. These traits are easy to observe, identify and count. Purple is the dominant trait, and Yellow is the recessive trait. (Use A = purple and a = yellow.)

It is important to remember that each seed (kernel) on the corn cob is a child that will grow up to be a parent. The corn cob is a collection of children from two parents.

Upon counting the types of seeds, students will observe a ratio between 2 different kernel phenotypes: Purple and Yellow.

With the resulting phenotypic ratio, one should be able to tell the type of parental cross that occurred, show the punnett square as proof, and predict the type of grandparents that were necessary to produce the parents (with the corresponding punnett squares).

Materials:

Corn Cobb: students will count the kernels on either real corn cobs or the paper cobs provided.

Pencil and Paper

Hints:

1) The paper corn standardizes the numbers and takes less time to count the kernels. We keep an ear of corn around to show the students. The students often thank us when we pass out the paper corn.

2) You may want to take the class through each step. Depending on the class, we will either walk through the steps with the class or introduce the lab and let them work by themselves.

3) If you have access to a laminator, laminate the paper corn.

Answers to the Corn Lab:

Table 1: Actual Phenotype Totals.

Phenotype	3:1 ratio corn	1:1 ratio corn
Purple (black)	145	102
Yellow (white)	53	96
Total	198	198

Percentages:

3:1 Corn:
Purple = .73 or 73%
Yellow = .27 or 27%

1:1 Corn:
Purple = .52 or 52%
Yellow = .48 or 48%

Expected Numbers of Kernels:

3:1 Corn:
Purple = 148.5
Yellow = 49.5

1:1 Corn:
Purple = 99
Yellow = 99

Parents:

3:1 Corn:
Aa X Aa

1:1 Corn:
Aa X aa

Grandparents:

3:1 Corn:
AA X aa and AA X aa

1:1 Corn:
AA X aa and aa X aa

Percent Error:

3:1 Corn:
Purple = 2.4%
Yellow = 6.6%

1:1 Corn:
Purple = 4.9%
Yellow = 3.1%

Genotypes and Phenotypes of Parents:

3:1 Corn:
Aa and Aa
Purple and Purple

1:1 Corn:
Aa and aa
Purple and Yellow

Phenotypes of Grandparents:

3:1 Corn:
1) Purple and Yellow
2) Purple and Yellow

1:1 Corn:
1) Purple and Yellow
2) Yellow and Yellow

Corn Lab

Purpose: to determine grandparental and parental genotypes through phenotypic ratios.

Introduction: In corn plants, seed (kernels) traits for color (purple or yellow) and texture demonstrate Mendel's law of segregation. These traits are easy to observe, identify and count. Purple is the dominant trait, and Yellow is the recessive trait. (Use A = purple and a = yellow.)

It is important to remember that each seed (kernel) on the corn cob is a child that will grow up to be a parent. The corn cob is a collection of children from two parents.

Upon counting the types of seeds, you will observe a ratio between 2 different kernel phenotypes: Purple and Yellow.

With the resulting phenotypic ratio, you should be able to tell me the type of parental cross that occurred, show me the punnett square as proof, and predict the type of grandparents that were necessary to produce the parents (with the corresponding punnett squares).

Materials:

Corn Cobb
Pencil and Paper

Procedure:

1) Count the kernels of corn and record the numbers of each phenotype in table 1.

2) Determine the actual percentage of purple (black) and yellow (white) kernels.

3) Figure out the expected percentage of purple and yellow kernels(either a 50% to 50% (1:1) ratio or a 75% to 25% (3:1) ratio) and the expected totals of the above phenotypes. Record data in table 2.

4) With the expected phenotypic ratios, determine the parents needed to produce the expected ratio of the children (kernels). Prove your hypothesis with a punnett square.

5) With the parental crosses, determine the grandparental crosses (that would produce the parents). Prove your hypothesis with the corresponding punnett squares. (Remember, you will have two grandparents per parent). Hint: the result of the grandparent cross should always result in your parents.

Results:

Table 1: Actual Phenotype Totals

Phenotype	Number Counted
Purple	
Yellow	
Total	

Actual Phenotypic Percent (Ratio):

% of purple kernels = $\frac{\text{\# of purple kernels}}{\text{total \# of kernels}}$ X 100 _____ %

% of yellow kernels = $\frac{\text{\# of yellow kernels}}{\text{total \# of kernels}}$ X 100 _____ %

Expected Phenotypic Percent (Ratio): (either 50% to 50% (which is a 1:1 ratio) or 75% to 25% (which is a 3:1 ratio) to which percentage is your corn closer?)

Your expected percentage is _____.

Your expected ratio is _____.

Table 2: Expected Phenotype Totals

Phenotypes	Expected Totals
1) Purple	
2) Yellow	
Total	

1) Multiply the expected percent of purple kernels by your total number of kernels.

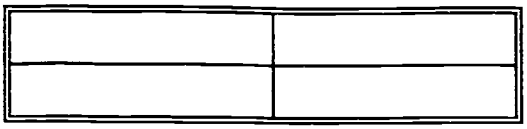
2) Multiply the expected percent of yellow kernels by your total number of kernels.

Parental Genotypes: Prove your hypothesis with the punnett square below.

_____ X _____

You may need to complete a few punnett squares to complete this section. Remember, you are working with 1 trait (2 genes).
Punnett Square of Parental Crosses: Make sure that the children will fall into the expected phenotypic ratio.

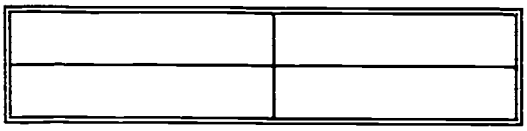
Parent Punnett Square:



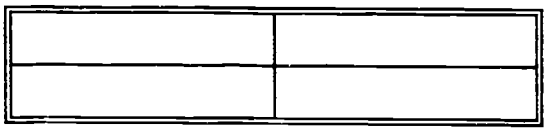
Genotypes of Grandparents:

1) _____ X _____ 2) _____ X _____

Punnett Square for the first set of grandparents: **All** (100%) the children of the grandparent cross should be the genotype of the first parent.



Punnett Square for the second set of grandparents: **All** (100%) the children of the grandparent cross should be the genotype of the second parent.



Conclusion:

1) What is the percent error for the purple phenotype total?

$$\frac{|\text{Expected \# of purple} - \text{Actual \# of purple}|}{\text{Actual Total}} \times 100 = \% \text{ Error}$$

2) What is the percent error for the yellow phenotype total?

$$\frac{|\text{Expected \# of yellow} - \text{Actual \# of yellow}|}{\text{Actual Total}} \times 100 = \% \text{ Error}$$

3) What are the parental genotypes and phenotypes?
Genotype of Parents: _____ and _____

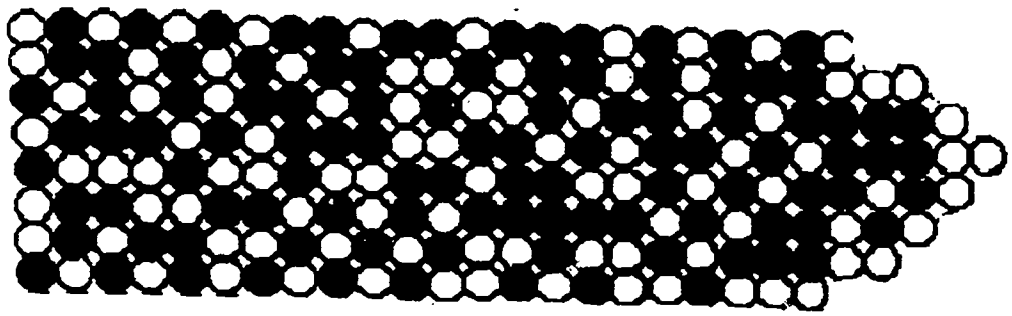
Phenotype of Parents: _____ and _____

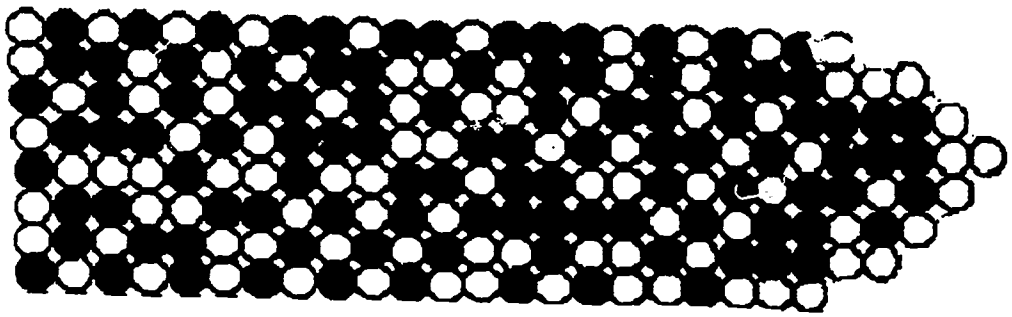
4) What are the genotypes and phenotypes of the grandparents?
Genotypes of Grandparents:
1) _____ and _____

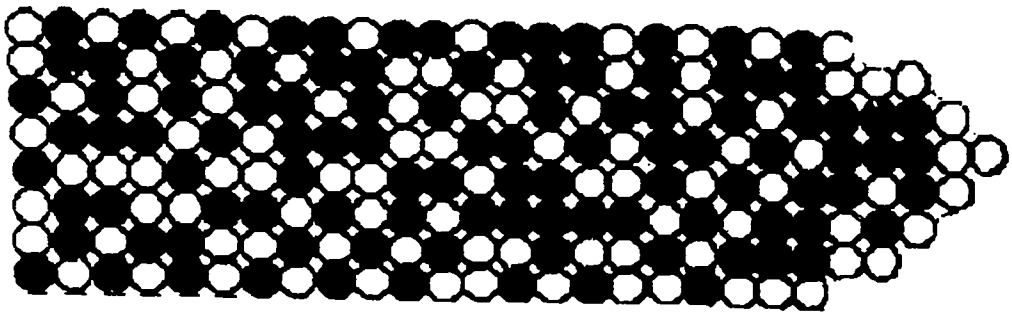
2) _____ and _____

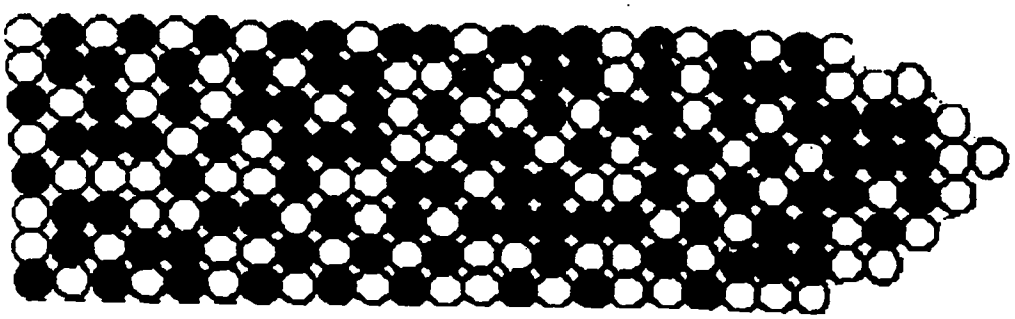
Phenotypes of Grandparents:
1) _____ and _____

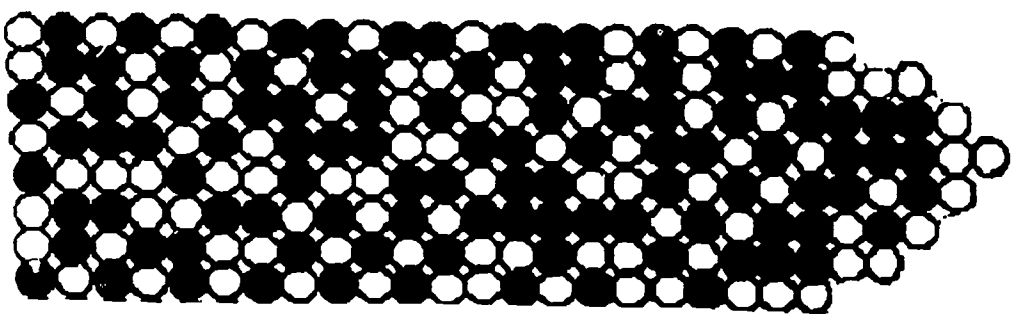
2) _____ and _____

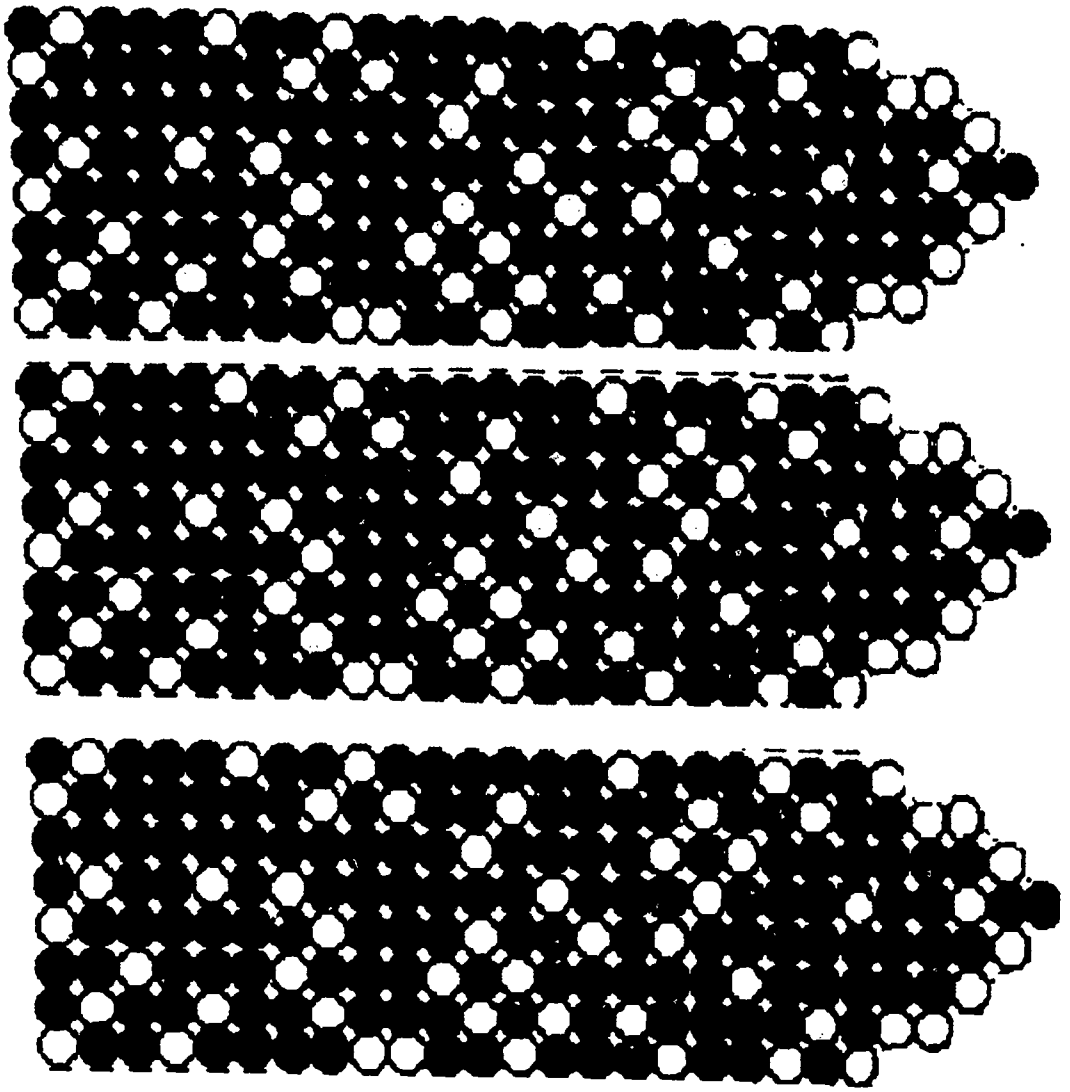


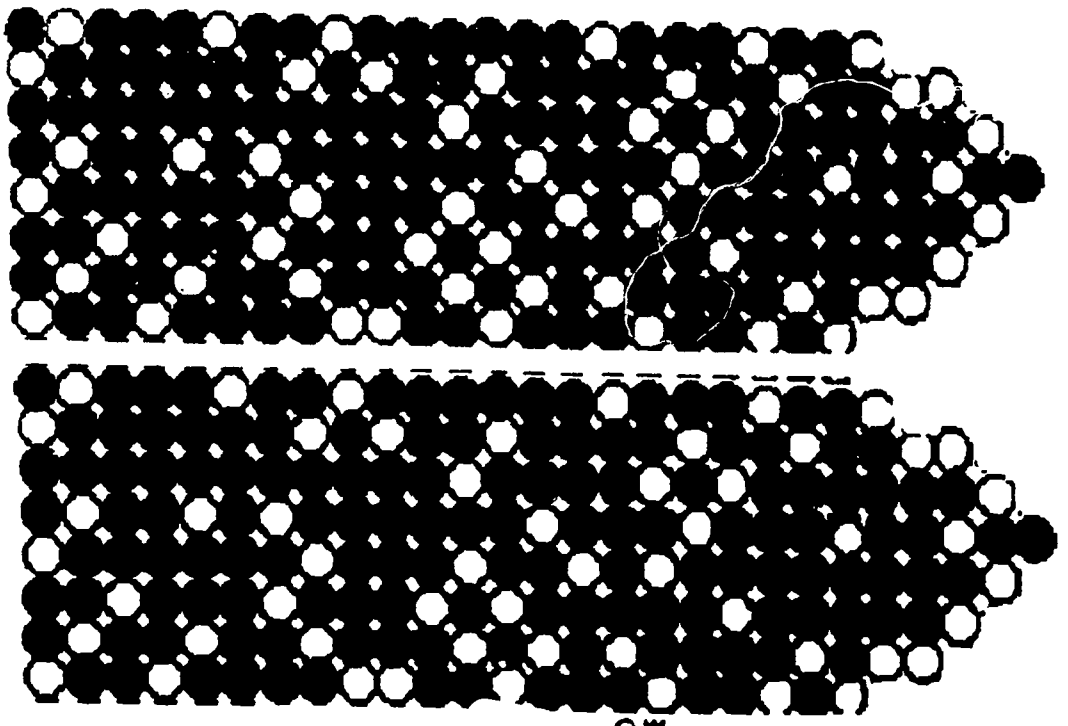












Biology With Junk: Genetic Disorders and Oral Reports
Teacher Prep

Purpose: Students will learn about human genetic disorders through peer oral reports.

Introduction: Genetic disorders are one of the most fascinating parts of biology class. Students seem to listen attentively to all of the things that can go wrong with the human genome. This morbid interest in this subject could be a spring board into oral reports. Below is a list of 13 human genetic conditions. A group of students (no more than 4 per group) are given their own genetic condition that they must present to the class.

Each group must answer four questions and every student is responsible for the information on all the disorders. All students must participate. As long as all the information is given in an easy to understand manner, the group should get an A. If someone is absent or does not participate, then s/he will receive no grade.

After a brief introduction about genetic conditions, assign students to a group and a genetic condition. Lend out the information sheets for a class period so the students can answer the four questions. Students are then given a little extra time to prepare their oral presentations.

Here are the questions I ask my students:

1) What is your disease and what are the symptoms?
2) How is your disease passed on?
3) Who can be affected by this disease?
4) Are their any cures, treatments and/or tests?

Put a time limit on the presentations to make them go a bit faster. This is a great way to make the students responsible for their own material and a wonderful way of having them learn from each other.

You may make a few copies of the genetic disorders to use as class sets. Have the students write the information obtained from the sheets in their notebooks for future reference.

Genetic Disorders:

Thalassemia:
Thalassemia is a common inherited blood disease that affects people of Italian, Greek, Middle Eastern, Southern Asian and African ancestry. There are two types of Thalassemia: Alpha and Beta, depending on which protein is missing on the red blood cell. You will do your report on Beta Thalassemia, since it is the most common form of the disease.

There are four types of Beta Thalassemia.

1) Thalassemia major: the most serious and harmful form.
2) Thalassemia intermedia: is a mild case of the major form.
3) Thalassemia minor: there is almost no change in the blood.
4) Thalassemia minima: causes no effect on the person, but may show up in a blood test.

A child with severe thalassemia appears healthy at birth, but during the first year or two, the child will become listless, pale, fussy, have a poor appetite and may get sick easily. They are physically underdeveloped and aren't able to keep up with their peers.

Without treatment the spleen, liver and heart will become enlarged. The spleen may get so big that it may have to be removed. Since the spleen is the organ which filters the blood and helps fight infections, this leaves the child prone to infections. Heart failure and infections are the leading causes of death for people with thalassemia.

If left untreated, the bones of a person with thalassemia become brittle and thin. The facial bones will become distorted. This makes all children with thalassemia look alike.

Frequent blood transfusions lessen the effects of thalassemia.

Children get this disease by receiving a recessive gene from both parents.

A test can be done to see if the unborn child will have thalassemia. Fluid from an amniocentesis can be examined for thalassemia genes.

Tay Sachs:
Tay Sachs is a disease that affects people of Central and Eastern European Jewish descent. Almost one in 25 Jews carries the Tay Sachs gene.

A child that has Tay Sachs develops normally until six months of age. The healthy baby stops smiling, crawling, turning over and loses the ability to grasp or reach out. The baby will eventually become blind, paralyzed, and unaware of the surroundings. Death occurs before the child is four years old.

A chemical that is in the blood is missing in Tay Sachs babies. This chemical is necessary for breaking down fatty deposits in brain and nerve cells. The cells become clogged and are unable to work. Eventually, the whole nervous system shuts down.

Tay Sachs is caused by a recessive gene.

A test has been developed to determine if some one is a carrier of the disease. It seems that carriers have half of the chemical needed to break down the fat in their blood than people that have two normal genes. Also tests can be done with the samples from the CVS (Chorionic Villus Sampling test) and the Amniocentesis which will allow the parents to know if their child will be born with Tay Sachs.

Spina Bifida:

Spina Bifida is a birth defect of the backbone (spine) and is often called 'open spine.' The disease occurs mostly in Ireland and Wales, but occurs 1 in 1,500 babies born in the United States.

There are three types of Spina Bifida:

1) A small opening of the spine which is so small only an X-ray will detect it.

2) A cyst (lump) that contains part of the spinal cord, covers the open backbone area. The lump can be as small as a walnut or as large as a grapefruit. This lump can be surgically removed allowing for normal baby development.

3) A cyst which holds a lot of nerves from the spinal cord. The cyst has no skin or muscle covering it. Spinal fluid may be leaking from the cyst and the area may be covered with sores. The cyst may be removed surgically, but since there are a lot of nerves present, the baby's legs are paralyzed and poor bladder and bowel control will become a problem.

Hydrocephalus (water on the brain) becomes a problem for 70-90% of all spina bifida children. The spinal cord fluid is unable to leave the brain and enter the spinal column. The fluid collects around the brain which places pressure on the brain and causes the head to enlarge. The fluid has to be drained regularly or brain damage and death will occur. This draining is done by a tube that goes from the brain, under the skin, to the stomach.

A child with spina bifida may need surgery to remove the cyst, braces, crutches or a wheel chair.

Spina bifida is caused by a combination of genes and the environment. Without the proper combination, spina bifida will not occur.

Sickle Cell Anemia:

Sickle cell anemia is a recessive genetic disorder which affects about 1 in every 400-600 blacks, and 1 in every 1,000-1,500 hispanics every year in the United States. The disease also affects people of Arabian, Greek, Maltese, Sicilian, Sardinian, Turkish and south Asian descent.

The red blood cells, which are normally round and flexible, under certain conditions change into a crescent or sickle shape. These cells are trapped in the spleen or elsewhere and are destroyed. A shortage of red blood cells is the result. The cells can become stuck in tiny blood vessels. When this happens, other blood cells pile up behind the stuck cell. The piled up cells lose oxygen and start to sickle. This may cause the entire blood vessel to be blocked. Cells that sickle in this way, may deprive important tissues of oxygen which can be very painful and destroy tissue. The 'crisis' may damage vital organs (brain, kidneys, lungs etc.), and lead to disability or death.

A person with sickle cell anemia tends to be pale, short of breath, tire easily, prone to infection, the whites of their eyes are often yellow.

A test called hemoglobin electrophoresis can identify people who have the disease or who carry the sickle cell trait.

Cleft Lip and Palate:

1 out of every 700 children born in the United States are born with either a cleft lip, palate or both. Cleft describes a split of the lip or palate (roof of the mouth) where the parts fail to grow together. Some children are born with a cleft lip, some are born with just a cleft palate, and 40% are born with both. This disease is more prevalent in Orientals and some American Indian tribes than in white Americans.

Scientists believe that this disorder is caused by a combination of genes and environmental factors such as drugs, disease, and malnutrition.

The cleft lip may involve one side or both sides of the upper lip and may even extend into the nostril. The cleft palate usually involves the soft palate and may extend forward into the hard palate.

The treatment usually involves a combination of surgery, speech therapy, dental corrections and psychological help. Feeding is the first problem to be overcome. A split in the mouth and lip makes it difficult for a child to suck and feed. Also food may enter the nasal compartment (due to a split in the palate) and may cause the baby to choke. Parents are taught to feed the child in an upright manner using a large nippled bottle or a syringe. Defective speech is another problem that needs to be worked on with the help of speech therapists.

Marfan Syndrome:

Marfan syndrome is a dominant genetic disorder that affects about 20,000 people each year. This disease affects all races and both sexes equally.

The defective gene (may be a mutation) is believed to form a weaker protein that usually makes connective tissue strong and tough. Connective tissue is the material that holds the body tissues together.

A person with Marfan syndrome is usually tall, slender, and loose-jointed. They may have very long arms and legs, a curved spine (scoliosis) and a face that is long and narrow. 50% of the people have their eye lens off center and they are prone to lung collapse.Their heart and heart valves (prevents the back flow of blood into a chamber) are affected to the point that they have a heart murmur. Also affected is their aorta. The aorta is the largest blood vessel in the body. A defective aorta can split in places and allow blood leaks or burst and cause instant death.

Patients with Marfan are warned to stay away from heavy exercise, contact sports and lifting heavy objects. Affected women who become pregnant are high-risk due to the possibility that the strain may split their aorta.

There is no single test to determine if a person has marfan. The suspected person must go through a battery of tests because not every person has all the symptoms.

Neurofibromatosis:

Neurofibromatosis is one of the most common genetic disease. It affects about 100,000 people a year. One in every 3,000 babies are born with NF every year in the United States.

NF is caused by a dominant gene which may be the result of a new mutation.

An early sign of NF is six or more large tan spots on the skin (cafe-au-lait or coffee with milk spots) these spots may increase in size and become darker with age. As time goes on, small begnin tumors appear under the skin (these tumors appear around puberty). The tumors are made of nerve and other types of cells and are called neurofibromas. There can be 1 up to 1,000 neurofibromas. Small tumors may grow on the auditory and optic nerve causing deafness and blindness respectively. People with NF may have scoliosis, and children may be overactive and have learning disabilities. Some affected children and adults have large heads.

This disease can be severely disabling (as in the case of John Merrick or the 'elephant man'), mildly disfiguring or undetected.

The tumors can be removed, but there is a danger of the tumors growing back in greater numbers.

Cystic Fibrosis:
Cystic fibrosis is a disease of the exocrine glands (which secrete products into body spaces, tubes or skin). The disorder causes the secretions to be abnormal--thick and sticky. This causes the ducts (holes that allows the secretions to enter their proper place) to be plugged.

When the pancreatic ducts (which lead from the pancreas to the small intestine which allows the digestive enzymes to break down the food) are plugged, the digestive enzymes cannot enter the bowel to digest the food, and the food is not digested properly. In fact, the digestive enzymes start to digest the pancreas and the patient will develop diabetes later on.

The lung is another organ that is affected. Mucous secretions that moisten the lungs and help in removing particles become thick and sticky and plug the lungs. The mucous is also a great place for bacteria to grow, so pneumonia is a result. The lungs are plugged and slowly destroyed by bacteria.

The same thing happens in males which makes them sterile-- the vas deferens are plugged and no sperm can get out of the testicles. The bile duct is plugged in the liver and leads to cirrhosis (destruction of the liver)

The disease is caused by a recessive gene and is always fatal. People with the disease can take digestive enzymes to help digest their food and antibiotics to prevent pneumonia relapses. Physical therapy to the chest to unplug the lungs is needed daily. With the current technology, people with CF can live into their late twenties.

Cystic fibrosis is present in 1 in 1600 white births. In fact, 1 out of every 20 white people carry the gene.

Down Syndrome:
Down Syndrome is one of the most common forms of mental retardation in the population (1 in every 700 births). The disorder is due to an extra 21st chromosome.

People with Down syndrome exhibit the following physical and mental traits. All affected people are short, have an underdeveloped brain and mental retardation (IQ about 50), have heart defects, are susceptible to infections and leukemia, have a single crease along the palm of their hands and simple fingerprints, have a flat nose, down sloping eyes, a thick tongue, a thick neck, and their ears are underdeveloped. The infant mortality rate is high due to the heart defects and survival past 40 is rare.

A person with Down syndrome will be able to do the things that a normal 6-7 year old can. Down people can be trained to their full potential and survive outside of institutions. Down Syndrome affects all races and both sexes.

Achondroplasia:
Achondroplasia is a genetic disorder which is caused by a dominant gene (may be a mutation) which affects one in every 25,000-40,000 births. It occurs in all races and both sexes.

In Greek, Achondroplasia means 'without cartilage formation.' Actually the cartilage layers (growth plates) at the ends of the bones are present but grow poorly. This means that a child with achondroplasia will be a dwarf.

A child with Achondroplasia has a normal torso and short arms and legs. The head is large and the forehead is prominent. The nose is flat at the bridge, and the teeth may be crowded and crooked. The achondroplasiac has a straight upper back with a curved lower spine. Their lower legs bow out and their feet are short, broad and flat. People with achondroplasia are of normal intelligence.

If two dwarfs marry and decide to have children they have a 25% chance of having a normal child, a 50% chance of having a dwarf child (heterozygote) and a 25% chance of having a child with a 'double dose' (homozygous dominant). A child with the 'double dose' usually dies in early infancy due to severe skeletal abnormalities.

The condition may be diagnosed during pregnancy using ultrasound.

Treating achondroplasia with human growth hormone yields disappointing results. The height is not substantially increased. The bowlegs can be treated with surgery if severe.

Huntington Chorea:
Almost all of the cases involving Huntington Chorea in the United States can be traced back to two families. One family settled in Quebec (Canada) in 1644 and moved across the country finally ending up in the U.S. midwest in the 1800's. The other family came to the U.S. from England in 1637.

Huntington Chorea is a progressive neurodegenerative disease. This means the nerve cells prematurely die because the cerebral enzymes and neurotransmitters are reduced.

People with Huntington Chorea suffer a deterioration of intellect and spastic body movements. People with this disease are first thought to be alcoholics. Huntington Chorea is a fatal illness which can last up to 20 years. The first signs of the disorder appear around the age of 35 after the reproductive years.

Huntington chorea is a dominant disorder which occurs if 5 out of every 10,000-100,000 people. This disease can affect all races and both sexes.

Fragile X Syndrome:
This disorder appears predominantly in males. People who have this condition have varying degrees of mental retardation, are short, and have a large head with long and narrow faces. Some people have large and prominent ears. If someone does not display these physical characteristics, you cannot eliminate the fragile X syndrome as a cause of mental retardation.

Chromosome analysis shows that people with fragile X syndrome appear to have a broken X chromosome. Females can carry the chromosome but will appear normal due to their second X chromosome.

Fragile X syndrome is the second leading cause of mental retardation in newborns in the United States. There is no specific treatment for this disease.

Phenylketonuria (PKU):
PKU occurs in 1 out of 14,000 births which is caused by a recessive gene which can cause the child be become severely retarded.

Children with PKU are unable to convert phenylalanine (an amino acid) into tyrosine. It seems as if they are missing the enzyme phenylalanine hydroxylase. If this enzyme is missing, there is a build up of phenylalanine in the blood. The build up of phenylalanine affects the proper development of the nervous system.

Children with PKU appear normal during the first few months. Untreated, they lose interest in their surroundings at three to five months. By the time they are one year old, they are mentally retarded. PKU children are irritable, restless and destructive. They have a musty odor, dry skin and rashes, and may have seizures.

A test can be done at birth to see if the child has PKU. If the child does, s/he is put on a phenylalanine free diet. This will allow the nervous system to develop normally.

PKU affects all races and both sexes.

Biology With Junk: Karyotyping Lab
Teacher Prep

Purpose: Students will cut out a prepared karyotype, arrange the chromosomes in the proper place and identify the sex of the person, and if the person has a chromosomal disease.

Introduction: Instead of talking about karyotyping, have the students do a simple karyotype. Included with the lab are 6 different karyotypes. Pass out the chromosome spreads, have the students cut out the chromosomes and secure the chromosomes onto the Karyotype key, and have the students identify the sex and chromosomal disease of his/her chromosomal spread. If you like, have your students do a brief write up on the chromosomal disease that he/she has just determined.

Hint: When the students are cutting out their chromosomes. Have them cut out the chromosomes one at a time and glue that chromosome in the proper place. If the student cuts out a lot of chromosomes, invariably, chromosomes are lost in one sneeze.

Also, the key is set up with 23 pairs of chromosomes. Make sure you review that humans have 46 chromosomes. If we have 46 chromosomes, then we have 23 pairs of chromosomes.

Materials:

Scissors: to cut out the chromosomes.

Tape/Glue: used to secure the chromosomes on the key.

Chromosomes/Chromosomal Disease Guide: the lab centers around these items.

Procedures:

1) Hand out the materials.

2) Have students cut out chromosomes one at a time and secure the chromosome in the proper place on the key.

3) Repeat step 2 until all the chromosomes are cut out and secured on the key.

4) Identify the chromosomal disease and sex of the individual.

5) Write a brief description of the chromosomal disease on the back of the key.

Results and Conclusion:

The completed karyotype and disease description.

Teacher Key:

Karyotype #	Chromosomal Disease:	Sex:
1	Down Syndrome	Female
2	Fragile X Syndrome	Male
3	Kleinfelters Syndrome	Male
4	Edwards Syndrome	Female
5	Crit du Chat	Male
6	Normal	Female

Karyotype Key: **Chromosomal Spread #_____**

Glue the chromosomes in the proper place. For example, chromosome number 12 will be glued to the #12 line.

1	1	2	2	3	3	4	4
5	5	6	6	7	7	8	8
9	9	10	10	11	11	12	12
13	13	14	14	15	15	16	16
17	17	18	18	19	19	20	20
21	21	22	22	X	X	Y	

Gender of Person:_____

Chromosomal Abnormality? Yes or No _____

If there is a chromosomal abnormality, then what is the chromosomal disease that this person has?_____. On the back of this key, describe the disease.

Chromosomal Disease Guide

Down Syndrome:
Down Syndrome is one of the most common form of mental retardation in the population (1 in every 700 births). The disorder is due to an extra 21st chromosome.

People with Down syndrome exhibit the following physical and mental traits. All affected people are short, have an underdeveloped brain and mental retardation (IQ about 50), have heart defects, are susceptible to infections and leukemia, have a single crease along the palm of their hands, flat noses, down sloping eyes, a thick neck and a thick tongue, simple fingerprints, and their ears are underdeveloped. The infant mortality rate is high due to the heart defects and survival past 40 is rare.

A person with Down syndrome will be able to do the things that a normal 6-7 year old can. Down people can be trained to their full potential and survive outside of institutions. Down Syndrome affects all races and both sexes.

Fragile X Syndrome:
This disorder appears mostly in males. People who have this condition are mentally retarded, short, and have very large heads with long and narrow faces. Some people have large and prominent ears. If someone does not display these characteristics, the fragile X syndrome cannot be eliminated as a cause of the mental retardation.

The karyotype shows that people with fragile X syndrome appear to have a broken X chromosome. Females can carry the chromosome but will appear normal due to their second X chromosome.

Fragile X syndrome is the second leading cause (1 in 1,000 to 2,000 males) of mental retardation in newborns in the United States. There is no specific treatment for the disease.

Kleinfleters Syndrome:
This syndrome occurs in 1 out of 1,000 males. This chromosomal disorder is caused by an extra X chromosome in males (XXY).

Kleinfelters is first discovered in males at puberty. The affected males tend to be taller than average, lanky and tend have feminine muscle development. In fact, there may be some breast enlargement. The testicles in these males do not fully develop causing the affected males to be sterile.

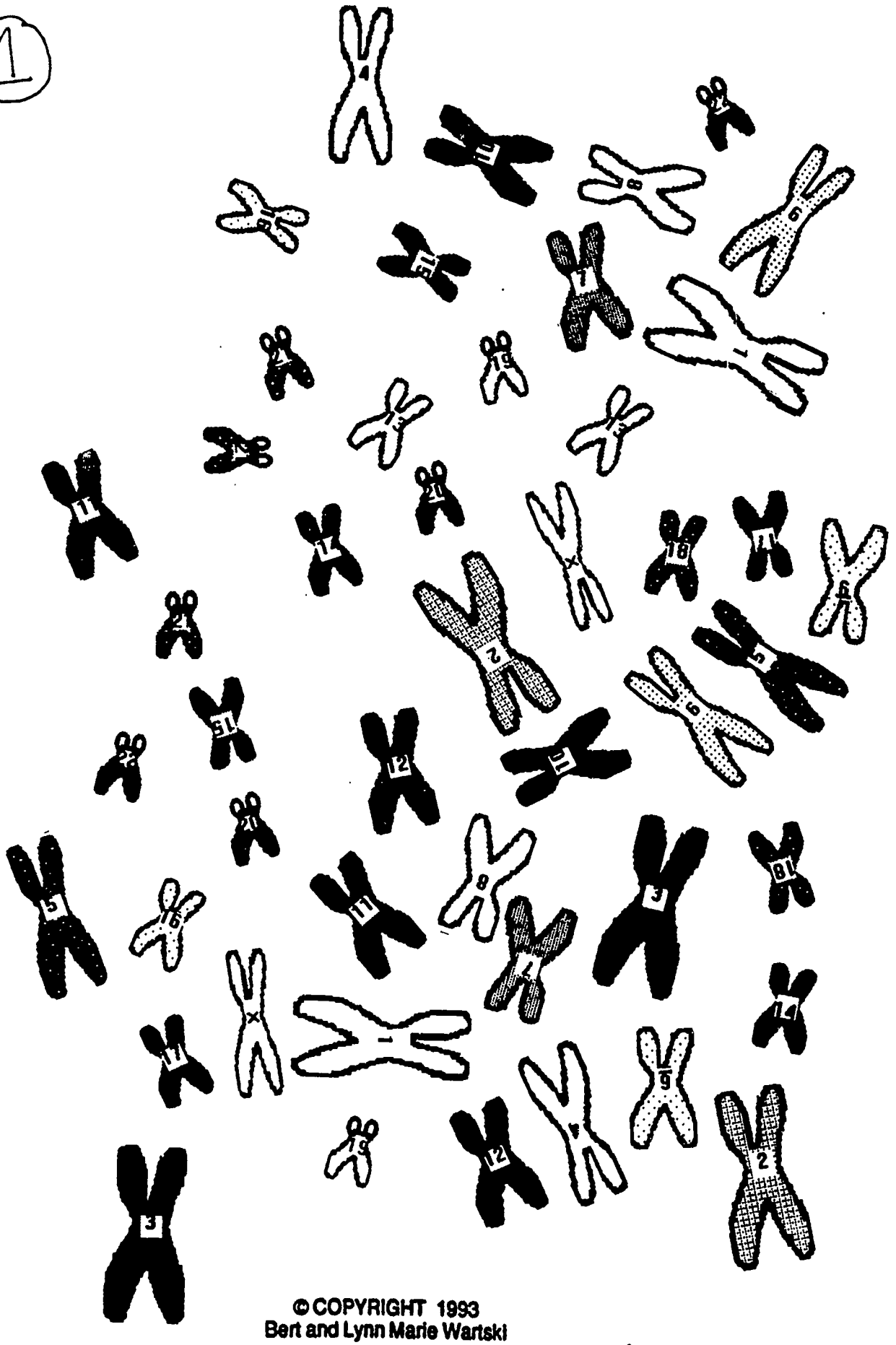
Edwards Syndrome:
Edwards syndrome occurs when there are three #18 chromosomes instead of two. About 1 in 8,000 babies are born with Edwards syndrome; however, most of these children die within the first two months of life.

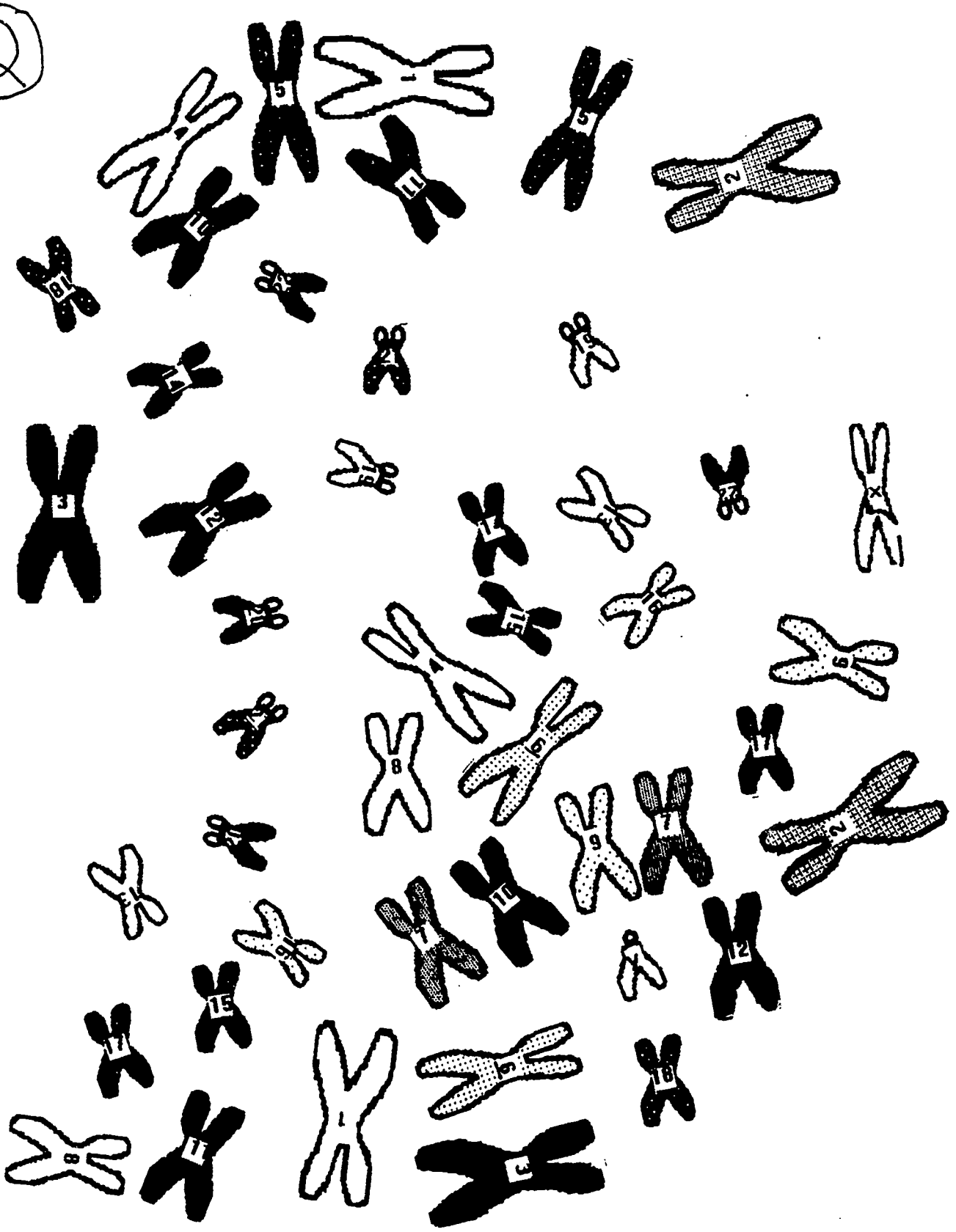
People with Edwards syndrome are born with the following characteristics: mental retardation, receding jaw, low set ears, clenched fists, and heart abnormalities.

Crit du chat:
Crit du chat in french means 'cry of the cat.' People born with crit du chat often have a cat-like cry.

This genetic disorder can be traced to chromosome #5. The upper arm of one of the chromosome pairs is missing.

Crit du chat victims are mentally retarded, have small heads, wide spread eyes, low set chins, small mouths and chins, and low birth weights.





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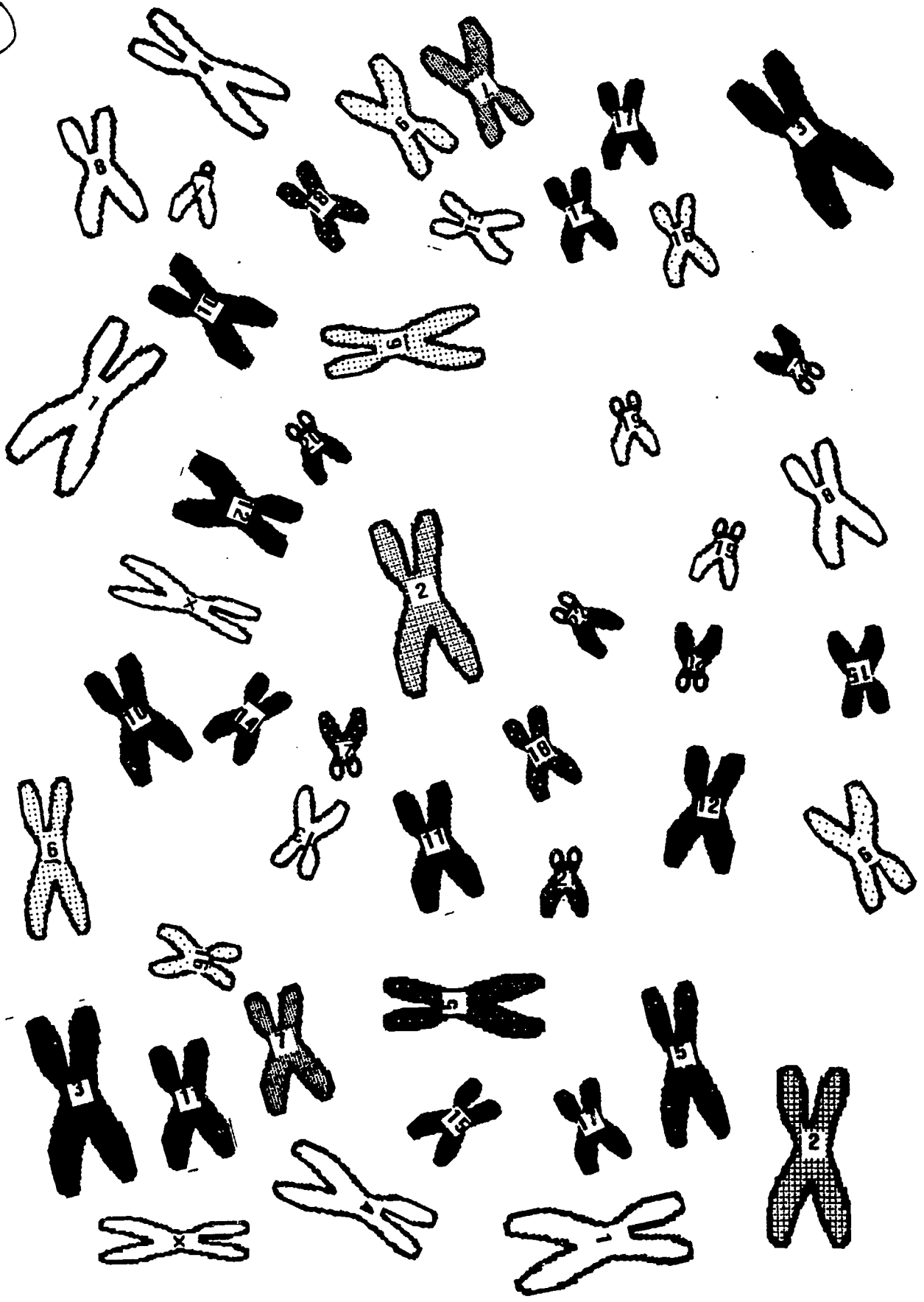

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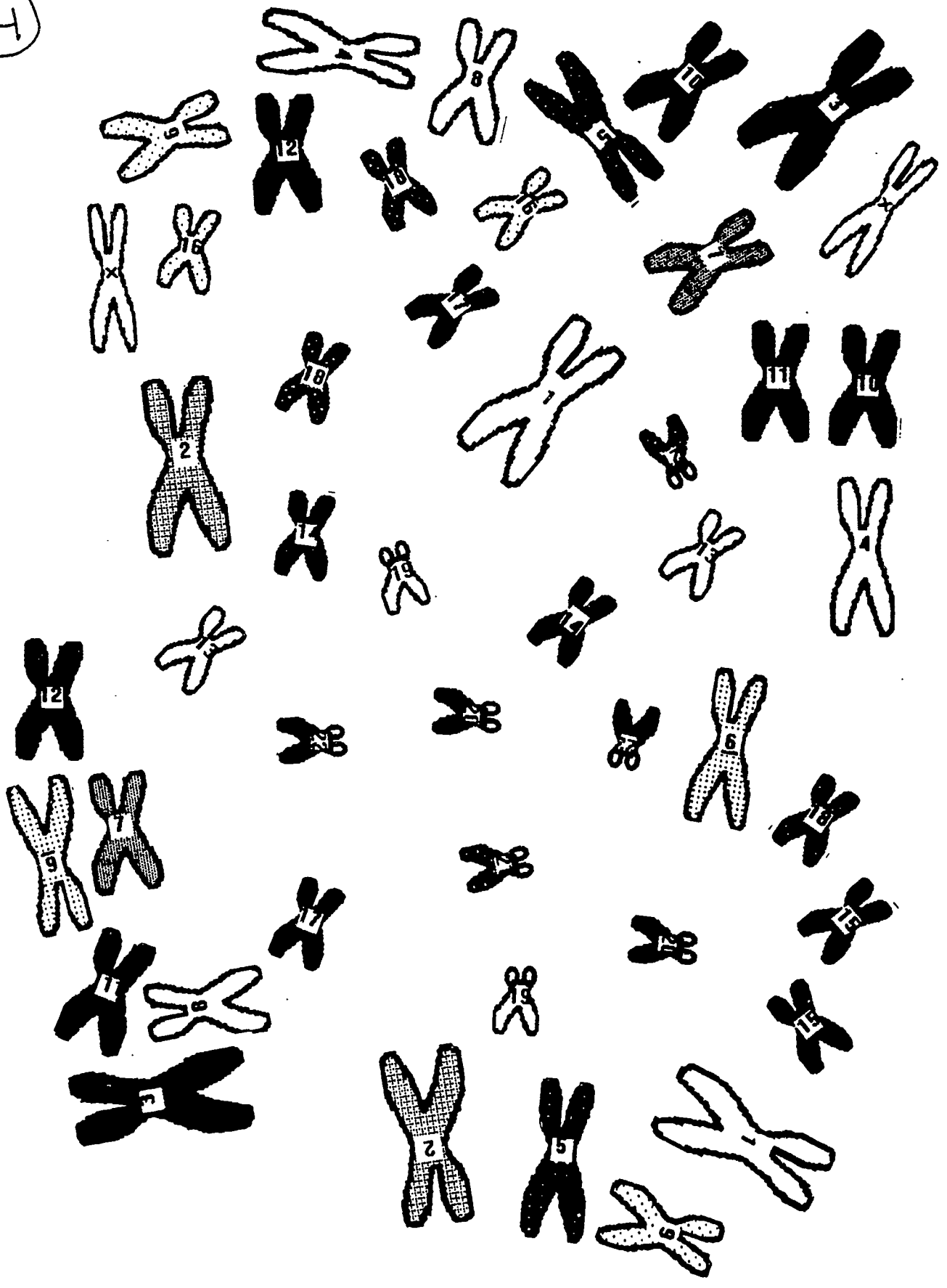

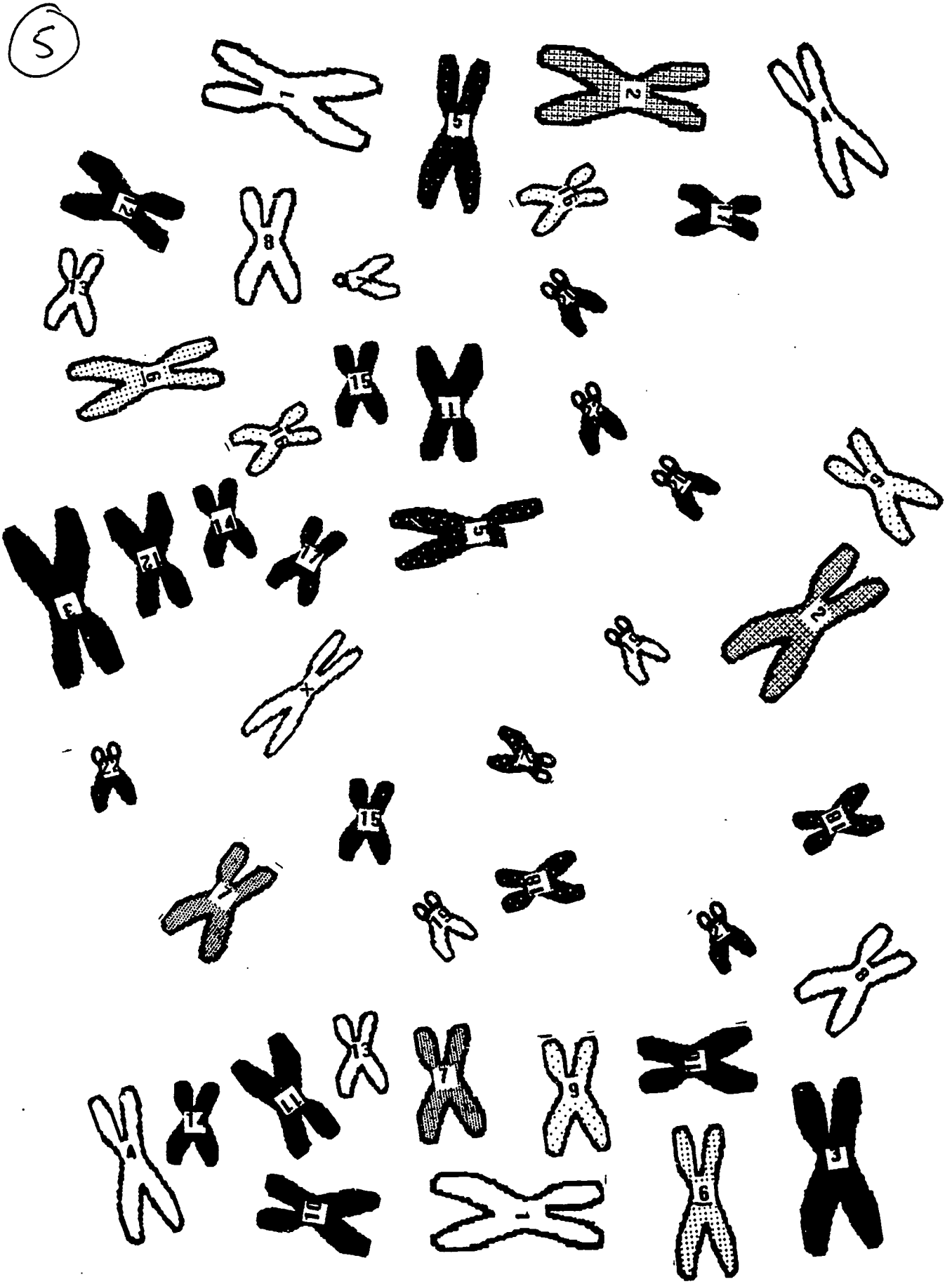

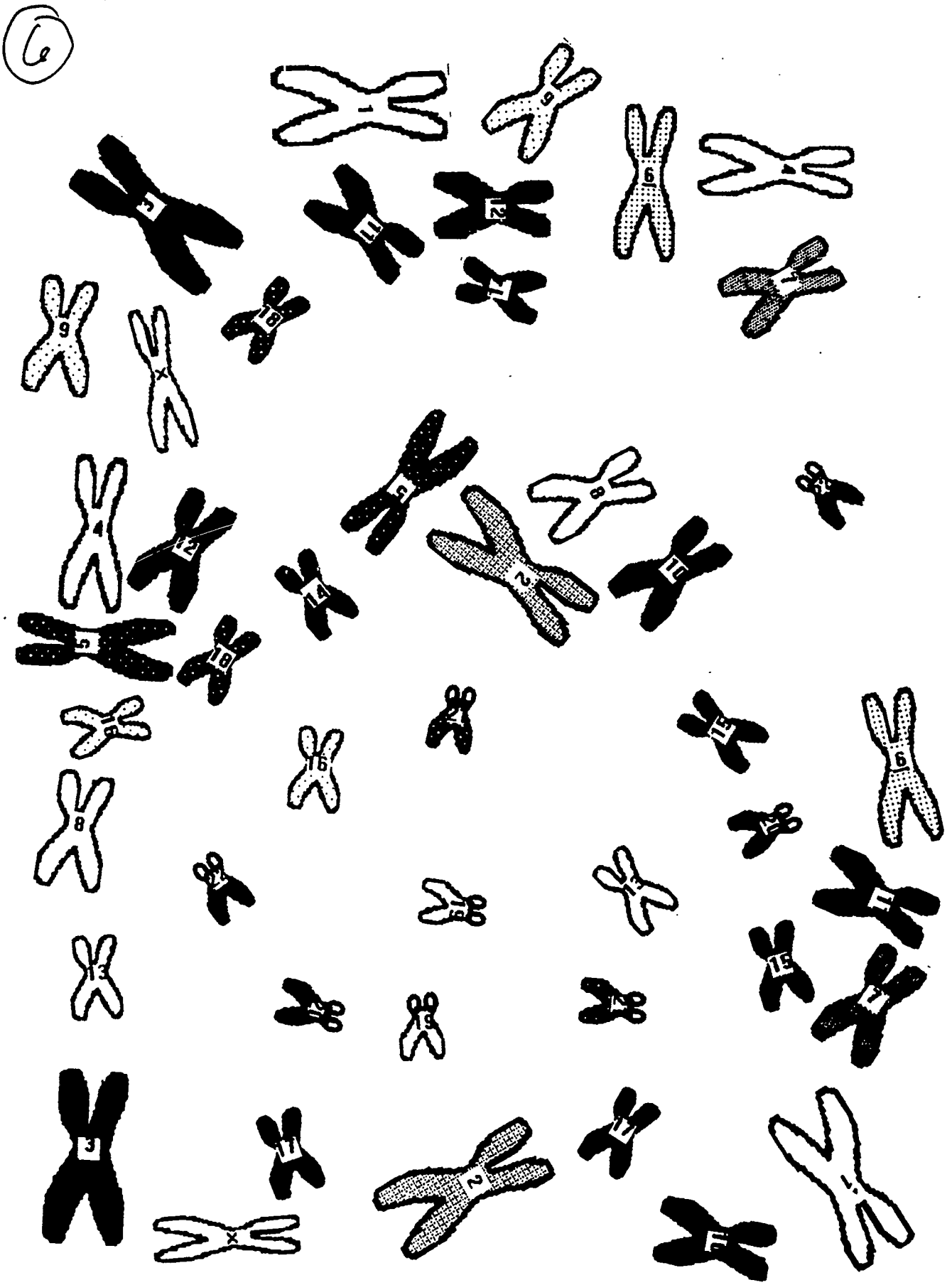

Biology With Junk: Cooperative Learning and Genetic Problems
Teacher Prep

Purpose: This exercise will allow students to teach other students how to do genetic problems.

Introduction: Sometimes students just don't understand genetics. No matter how much we try to teach them or how many problems we throw at them, they just don't get it. This exercise makes the students the teachers.

In this activity, students are split up into groups of 3 to 4. There will be 5 different genetic problems, each listed on a 4 X 6 index card. Each student group will pick up an index card and try to solve the genetic problem that is on the card. Every student will be required to hand in a paper with all five genetic problems solved. The students who don't understand the concepts studied will be helped by those who do understand. During the process, the teacher needs to walk around the room. Keeping students on task, answering questions and preventing students from copying each other's papers.

Materials:

50 4 X 6 index cards: this will be your source of genetic problems.

10 copies of the same 5 genetic problems: your source of problems.

Scissors, glue: used to put the cards together.

Procedure:

1) Split the class into groups of 3 to 4 students.

2) Have students select one problem.

3) Walk around the room as the students solve the problems.

4) When students are finished with one problem, have them bring back their card and select another problem.

5) Collect the answers.

Results:

When you collect the papers you can do a few things with them:

1) Correct every single one of them
2) Pick one paper from each group and correct it. Every member of the group will receive that grade.
3) Pick one paper from the entire class and correct it. Every member of the class will receive that grade.

Genetic Problems: you can do your own, here are 5 examples.

1) Color blindness is a sex linked trait, and curly hair (which is not a sex-linked trait) is dominant over straight hair. A man who is colorblind and is heterozygous for curly hair marries a woman who is a carrier for color blindness and has straight hair. List the phenotypic ratio of their children. You should have a) colorblind curly, b) colorblind straight, c) normal vision curly and d) normal vision straight.

2) A woman with type A blood marries a man with type B blood. She has a baby with type A blood. Is it possible? Show me the punnett square. Supposing the man's mother was B and his father was AB, is it still possible? Show me the punnett squares. O.K., If the man's mother's parents were both AB, is it still possible that the man is the father of the child? Show me the punnett squares.

3) In Snap Dragons (a flower) Red flowers are RR, Pink are Rr and white flowers are rr. If two pink flowers were crossed, what are the possible phenotypes (remember this is the F_1 generation). If the flowers of the F_1 generation were crossed randomly, what is the resulting phenotype? You will have 6 punnett squares.

4) Right handedness is dominant over left handedness, and having a straight thumb is dominant over a hitch-hikers thumb. A woman who is heterozygous for both traits marries a man who is also heterozygous for both traits. What is the expected phenotypic ratio and punnett square?

5) In rodents, T codes for a life-giving protein. If a rodent is recessive for this protein, then that rodent will be still born (dead). At the same time B codes for a dark mouse while b codes for a white mouse. These two mice were crossed TtBb X Ttbb. Give me the punnett square and the phenotypic ratio.

Biology With Junk: Polygenic Traits With Pennies
Teacher Prep

Purpose: This activity will allow students to understand how polygenic traits work.

Introduction: Polygenic traits or quantitative genetics is a topic that is often skipped by biology teachers. It seems that teachers have no real model or lab in which to demonstrate this complicated topic. We have found that if we used pennies to represent genes (heads are dominant and tails are recessive), we could show students how people fall into a bell curve type arrangement and how different heights are passed on to children.

Polygenic traits are traits that are controlled by more than one gene, ie. height, weight, hair color, skin color (basically, anything doing with size and color). This allows for a wide range of physical traits. For example, if height was controlled by one gene A and if AA= 6' and Aa= 5'7" and aa= 5', then people would either be 6', 5'7" or 5'. Since height is controlled by more than one gene, a wide of range of heights is possible.

Once the pennies have been handed out and the procedures reviewed, the teacher will put a table on the board, so that the class can collect the data. Each group will record the number of times the following situations occurred when the pennies were flipped.

0 tails	and	6 heads
1 tail	and	5 heads
2 tails	and	4 heads
3 tails	and	3 heads
4 tails	and	2 heads
5 tails	and	1 head
6 tails	and	0 heads

Materials:

Per group:

6 pennies: these will represent the genes for height.

Per student:

Table: to record data

Graph paper

Polygenic Trait Lab

Purpose: This activity will demonstrate how polygenic traits work and why certain traits in a population can be graphically represented by a bell curve.

Materials:

6 pennies
Graph paper

Procedure:

1) Each group will carefully flip all the coins on the table.

2) Record the number of heads and tails that result from the flip in table 1.

3) Continue to flip the coins and continue to record the number of heads and tails that result from the flip until the table is complete.

4) Complete table 2 by adding up the number of times the following situations occurred.

0 tails and 6 heads
1 tail and 5 heads
2 tails and 4 heads
3 tails and 3 heads
4 tails and 2 heads
5 tails and 1 head
6 tails and 0 heads

5) Record your results from table 2 on the board with the class results.

6) Record the class results in table 2.

7) Construct a bar graph from the class data. The number of heads and tails will go on the X axis while the number of times that the situation occurred will go on the Y axis.
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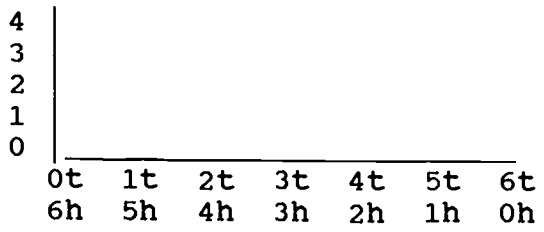


8) Answer questions.

Results:

Table 1: Group results

Flip (Group)	1	2	3	4	5
Number of tails					
Number of heads					

Table 1: continued

Flip (Group)	6	7	8	9	10
Number of tails					
Number of heads					

Table 2: Group and class results

Flip Situation	0 T 6 H	1 T 5 H	2 T 4 H	3 T 3 H	4 T 2 H	5 T 1 H	6 T 0 H
Your Group Total							
Class Total							

Construct a Bar Graph for both your results and the class results.

Conclusion: Use the following Height Table to answer the questions.

Penny Situation	Height
0 Tails and 6 Heads	6 feet 1 inch
1 Tail and 5 Heads	5 feet 11 inches
2 Tails and 4 Heads	5 feet 9 inches
3 Tails and 3 Heads	5 feet 7 inches
4 Tails and 2 Heads	5 feet 5 inches
5 Tails and 1 Head	5 feet 3 inches
6 Tails and 0 Heads	5 feet 1 inch

Remember: Heads are dominant genes. Tails are recessive genes.

Questions:
1) Do parents give (All or Half) of their genetic material to their children?

Example for the rest of the questions: A man is 5 feet 7 inches tall, has 3 heads (dominant genes) and 3 tails (recessive genes). He will give 3 genes to his child. These 3 genes can be given randomly.

He can give 3 dominant genes and no recessive genes
He can give 2 dominant genes and 1 recessive gene
He can give 1 dominant gene and 2 recessive genes
He can give 0 dominant genes and 3 recessive genes

These are all the possible combinations that he can give his child. The height of the mother will dictate the genes that she will give to the child. The combination of the mother's genes and the father's genes will decide the height of the child.

2) If a male is 5 feet 9 inches tall, it means that he has 4 dominant genes and 2 recessive. He will only give 3 genes to his child. What are the possible combinations of genes that he can give?

He can give _____ dominant and _____ recessive
He can give _____ dominant and _____ recessive
He can give _____ dominant and _____ recessive

3) The male is 5 feet 7 inches and the female is 5 feet 5 inches. Is it possible for them to give their child the necessary genes so the child can be 5 feet 11 inches tall? Explain your answer. Diagrams are often useful.

4) If 2 parents are 5 feet 7 inches, is it possible to have a child that is 6 feet tall? Explain how this is possible.

5) If the male is 5 feet 5 inches tall and the female is 5 feet 3 inches tall, what is the tallest height that their child could attain? Explain.

6) If the male is 5 feet 7 inches tall and the mother is 5 feet 3 inches tall, what is the shortest height their child could attain? Explain.

7) List 3 other polygenic traits.

8) How are polygenic traits different from traits that only require 2 genes?

9) Why do you think that some children are taller than their parents? Hint: it has to do with the number of dominant genes.

Biology With Junk: Pedigree Challenge
Teacher Prep

Purpose: This exercise will allow students to demonstrate their pedigree proficiency.

Introduction: After teaching students about pedigrees, give them a specific pedigree, some time and a piece of paper. This pedigree is challenging and educational. Have students map out the family including the genes for all the traits listed and answer the questions. Good luck and have fun.

Materials:

Pedigree: the story

Pen/Pencil/Paper: To record your pedigree.

Procedure:
1) Read the pedigree.
2) Construct the pedigree.
3) Insert the genes and traits.
4) Answer the questions.

Results:
Pedigree with genes and answers to the question.

From the Files of SKI² Genetic Counseling Service.

Welcome to the files of the SKI² genetic counseling service. The following is a case study along with background information that you, as a genetic counselor, need to know in order to chart the pedigree of the following family.

This is a story of Tanya and Tim Turkie, and their family. Tanya first made contact with our service a week after she successfully delivered Tom, their son. Tanya was concerned since they received notification that Tom tested positive for phenylketonuria. She wanted to know what it was and if there was a treatment for the disease.

PKU or phenylketonuria is a autosomal recessive disease that affects an enzyme, phenyl hydroxylase. In PKU, not enough of this enzyme is produced. The enzyme is necessary to convert phenylalanine (an amino acid) into tyrosine (another amino acid). In PKU people, phenylalanine starts to build up and prevents the normal brain and central nervous system development.

PKU happens in 1 out of 11,000 people in the U.S. If PKU is undetected, it can lead to severe mental retardation, which is not reversible. However, if PKU is detected within the first 30 days of life, then the child can be put on a phenylalanine free diet and can lead a normal healthy life.

Tim and Tanya were relieved that their other children had not come down with PKU.

Question 1: What are the odds that the other two normal children will be carriers.

Question 2: What are the odds that Tim and Tanya's next child will have the disease?

Six weeks after that incident, SKI² received another call from Tanya. Tony, their 8 year old son, had broken his hand at school. In treating Tony, the hospital discovered that he had hemophilia. As you know, hemophilia is a sex-linked trait that is recessive.

In all sex-linked traits, the gene that is associated with hemophilia is only found on the X chromosome. Since this is the case, then the gene is passed from the mother to the son and the incidence of the trait is much higher in males than females.

In hemophilia, the female is usually the carrier, and the males are the ones that show the symptoms. Hemophilia is a blood disorder in which the blood fails to clot due to a protein deficiency. A person with hemophilia will need medical attention for external and internal injuries. A simple bruise can prove fatal.

Tom was immediately tested for the disease but was negative. Tisha, their 4 year old daughter, also negative. Since Tim never showed any signs for the disease, SKI² showed concern toward Bitsy Blake, Tanya's sister. Bitsy had 2 children both females (Betty, and Betsy) and was pregnant with a third. The clinic wanted to contact Bitsy, but Tanya was still bitter over a broken dinner engagement and refused the clinic the needed permission.

Question 3: Why was SKI² concerned about the Blake's daughters?

While all this was taking place, Bitsy Blake made an appointment to see a counselor at SKI². Bitsy had an amniocentesis to confirm the sex of her child. It seemed that her husband, Bob, really wanted a boy and had threatened to walk out on her if she had a girl.

Question 4: Who's fault i it if the Blake's have another girl? Why?

Three months later, Tanya Turkie called again. Tim had died due to the fact that his aorta had exploded. It seems that Tim had Marfan Syndrome, and she was very concerned about the chance that her children would have it. You see, Tim's family had a history of Marfan Syndrome. Marfan Syndrome is an autosomal dominant disorder that strikes 1 out of 20,000 people each year. The defective gene is believed to form a weaker protein that makes connective tissue weaker than usual. Connective tissue is the material that holds the body tissues together. People with Marfan are usually tall, slender, and loose-jointed. They are prone to lung collapses. Their heart and heart valves are affected to the point that they have a heart murmur. The aorta, which is the largest blood vessel in the body, is also affected. A defective aorta can split and has caused instant death.

Tim's mother remarried after Tim's father ran out on her 10 years ago. As of now, there is no way to trace the genes of the father's family. Tim had a brother Dirk who shared Tim's father. Tim's mother, Francine, remarried a man named Mark Fields. Mark and Francine had four more children: Glen, Mary, April and Ted.

SKI² contacted the Fields family. Glen died at the age of 21 in a bizarre gardening accident. Mary entered the nunnery while Ted entered the monastery. Both had taken a vow of isolation and could not be tested. April and Francine both tested negative. Based on this information, it seems that Tim's father supplied the Marfan Syndrome gene to the family.

Question 5: What is the chance that Tony and Tisha may have Marfan Syndrome?

After Tim's death, Tanya had a major break down and made a confession. It seems that she had an affair before Tisha was born. She did not know if Tim was the father of the child. Tim had type A blood while Tanya had type B blood. Tim's father and mother were blood type AB. Tisha was tested and she had type B blood.

Question 6: Was Tisha Tim's child?

Biology With Junk: Murder and Genetics
Teacher Prep

Purpose: to have students apply the skills and information learned during a genetics unit to solve a make believe murder.

Introduction: In most classrooms, students only apply their genetic knowledge by solving simple word problems. Students rarely see how they can use their biology skills to solve real world problems.

In this activity a group of students will act together to solve a murder. Students will compile all the facts, fill out information sheets, complete the final answer sheet, and create their own motive for the crime that fits within the confines of the information provided.

The Murder and Genetics activity was designed specifically as a cooperative education activity. You can assign students to groups of 4 or have then assign themselves to the groups. Each group will be given a title in their group. To ensure accountability, students will complete the cooperative education sheet provided.

By the end of the activity, each student should do at least:

2 pedigrees
2 karyotypes
1 DNA sequence
some thinking.

As a teacher, have students collect all the data: construct karyotypes, pedigrees, and DNA sequences prior to handing out the lab report. You can set up a fake outline of a body to add atmosphere.

Prior to the activity, students should know how to construct pedigrees, complete karyotypes, and figure out DNA sequences.

The DNA sequences are imaginary sequences of the protein cytochrome C (a protein found in hemoglobin).

This activity may take 2-3 class periods.

Materials:

Murder Packet: provides information and worksheets.

Scissors/Tape: for the karyotypes.

Paper: for the pedigrees.

Answer Key:

			Yes or No		
Name of Person	Poss. Blood Type	DNA Sequence	Marf	H.C.	Chromosome Disorder
Theresa Thyme	A	GATTCC CAACGG	No	No	Down Syndrome
Fred Fleckstone	O	GATTCC CAACGG	Yes	No	Kleinfelters
Glen Glendora	A	GATTCC GAACGG	No	Yes	Normal
Sam Stubs	O	GATTCC GAACGG	No	Yes	XYY
Norma Nanny	A	GATTCC CAACGG	No	Yes	XXX
Capt. Relish	O	GATTCC GAACGG	No	No	XYY

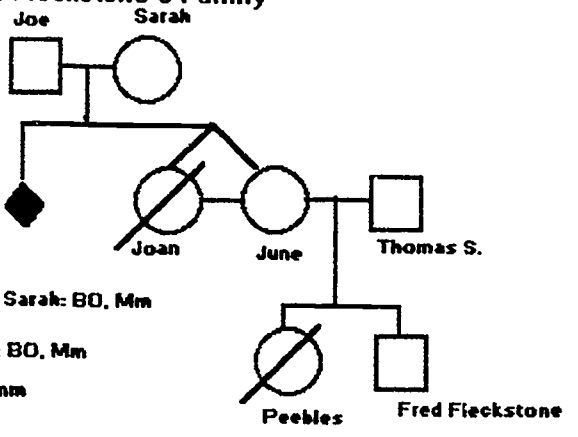
Marf = Marfan Syndrome
H.C. = Huntington's Chorea

Note: Captain Relish is actually Thomas Sandstone.

Killer: Norma Nanny.

Pedigree Answer Sheet

Fred Fleckstone's Family



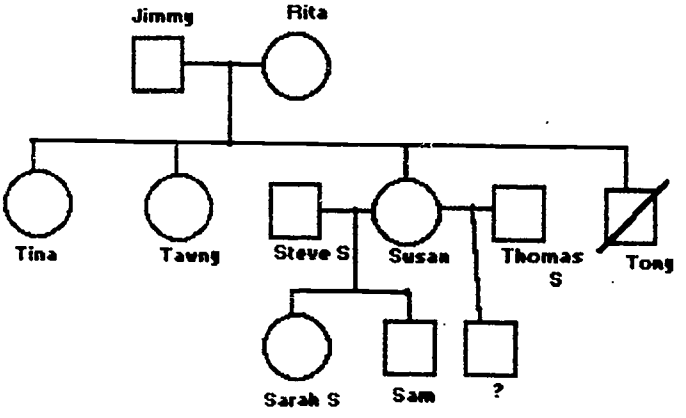
Joe: BB, mm Sarah: BO, Mm

Joan and June: BO, Mm

Thomas: OO, mm

Fred: OO, Mm

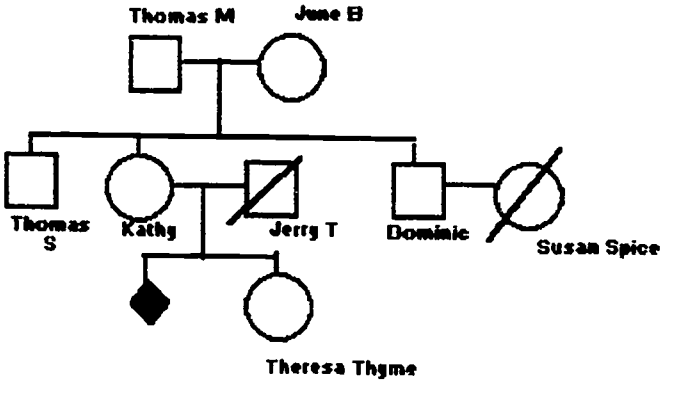
Sam Stubs' Family



Jimmy: AB, hh Rita: BO, hh Tina: B-, hh Tavng: AO, hh Steve: B-,Hh

Susan: AO, Hh Thomas: OO, mm, hh Tong: AB, Hh Sarah: A-, hh Sam: OO, Hh

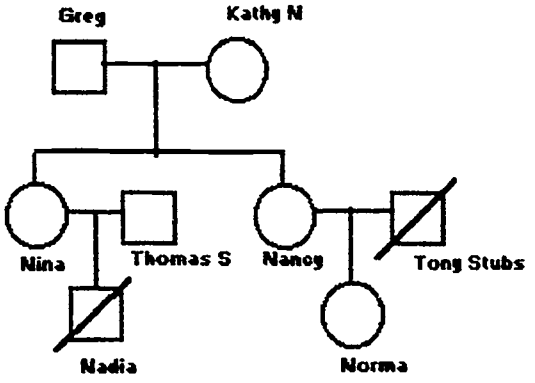
Theresa Thyme's Family



Thomas M.: OO June: OO Thomas S: OO Jerry: AO Dominic: OO Susan Spice: OO

Kathy: OO Theresa: AO

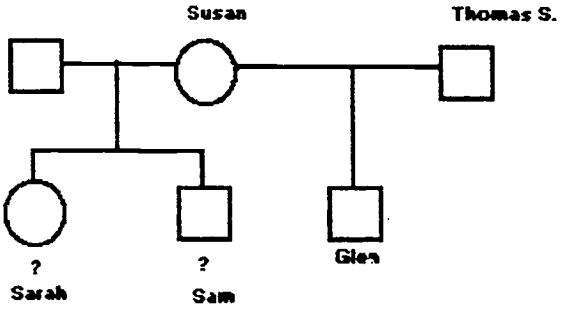
Norma Nanny's Family



Greg: AO Kathy N: BO Nina: AB Nancy: OO Tony Stubs: AB,hh

Nadia: A- or B- Norma: AO, Hh

Glen Glendora's Family:



Susan: AO, Hh Thomas S.: OO, mm, hh Glen: AO, Hh, Dd

Sam: OO, Hh Sarah: A-, hh

Key to pedigrees:

M= Marfan Sydrome, m= normal
H= Huntington Chorea, h= normal
D= Achondroplasia, d= normal
A,B,O = Blood types

Cooperative Education Assignments:

Assign each person in the group one of the following titles.

Title	Name of group member
Homicide Detective	
Pathologist	
Police Lieutenant	
Crime Lab Detective	

Below, fill in each persons completed assignments.

Karyotpes:

Title:	**Name of Karyotype:**
Homicide Detective	1)_____
	2)_____
Police Lieutenant	1)_____
	2)_____
Pathologist	1)_____
	2)_____
Crime Lab Detective	1)_____
	2)_____

Pedigrees:

Title	**Name of Family:**
Homicide Detective	1)_____
	2)_____
Police Lieutenant	1)_____
	2)_____
Pathologist	1)_____
	2)_____
Crime Lab Detective	1)_____
	2)_____

DNA Sequences:

Title	Name of Person:
Homicide Detective	1)_____
	2)_____
Police Lieutenant	1)_____
	2)_____
Pathologist	1)_____
	2)_____
Crime Lab Detective	1)_____
	2)_____

The Crime:

The rain fell violently on the night of April 1, 1993. A dinner party was being held at the house of an eccentric man, Captain Relish.

Captain Relish, a mysterious person was just released from prison and pocesses a new name. He decided to have a celebration party with the people he considered acquaintances.

7:00 pm:
Captain Relish escorted Norma Nanny, Theresa Thyme, Fred Fleckstone, Sam Stubs, and Glen Glendora to the dinner table. Although the guests didn't know it, each one's life was somehow affected by Captain Relish.

7:30 pm:
The host and guests sat down to a dinner of Tomato Soup, Fresh Garden Salad, Prime Rib, Baked Potato and small talk.

7:35 pm:
The lights of the house suddenly went out. Chairs rustled, people screamed, and Captain Relish loudly groaned.

7:36 pm: The light returned to show Captain Relish slumped forward, his face in his tomato soup and a large steak knife embedded in the back of his neck.

7:40 pm: The police are called.

7:55 pm: The police arrived.

8:00 pm: Captain Relish was officially pronounced dead at the scene. The knife was quickly sent to the police lab.

9:30 pm: The police lab determined that there were two types of blood on the knife: the killer's and the captain's.

The lab report is enclosed along with important information about all the Captain's dinner guests.

With the following information determine the Captain's killer and the killer's motive.

Theresa Thyme's Family Story:

Thomas Mustard returned from World War II and married his high school sweetheart, June Basil. The couple had three children: Thomas, Kathy, and Dominic. At the age of 18, Thomas changed his name to Thomas Sandstone and ran away from home. Thomas was never heard from again. Kathy married Jerry Thyme, and Dominic married Susan Spice. Kathy had a miscarriage after two years of trying to have a child. Undaunted, they tried again, and this time they were blessed with Theresa.

On a wild night, in a fit of anger Kathy Mustard killed her husband, and Dominic strangled Susan to collect on a life insurance policy.

All the Mustards had O blood while Jerry had A blood (both of Jerry's parents had AB blood). There has been no incidence of Huntington's Chorea or Marfans in the family.

Fred Fleckstone's Family Story:

Joe Granite, an infantry man from World War II, met Sarah Sand in the V.A. hospital after he returned from the war. Sarah, a very tall woman with B blood, and Joe married. Their first child died during labor due to an intoxicated doctor. After two years of severe depression, the couple tried again and this time they had identical twin girls: Joan and June (Joan had B blood). Sadly, Sarah died when her aorta burst during labor. Later it was determined that she had Marfan Syndrome.

June married a man named Thomas Sandstone. Thomas and June had two children: Peebles (a female) and Fred (a tall, slender man who was double jointed). In a bizarre love triangle, Thomas killed Joan and Peebles. Embarrassed about his father's actions, Fred changed his last name to Fleckstone. Fred was later engaged to Theresa Thyme.

Sam Stubs' Family Story:

Jimmy Butts (AB blood), an older tank driver from the second world war, rejoined his wife, Rita (B blood) and four children: Tina (B blood), Tawny (A blood), Susan (A blood) and Tony (AB blood). Tina and Tawny became nuns while Tony died in a bizarre gardening accident (after he married and had a children). Susan married Steve Stubs, an older man with B blood.

Steve and Susan had 2 children: Sarah and Sam. Unfortunately, Steve had Huntington's Chorea. While Steve was deteriorating, Susan had an affair with a man named Thomas Sandstone. A male child was the result of this affair, but Thomas took this child to an adoption agency immediately after his birth.

Ironically, Susan Stubs died from Huntington's Chorea 15 years after the death of her husband.

Sam was engaged to Peebles Sandstone and has been very despondent since her murder. Lately he has been seen with Norma Nanny.

Glen Glendora's Family Story:

Glen doesn't know much about his family history. You see, Glen was adopted by the Glendora family when he was 6 months old. This is what he says he knows.

Glen's father was Thomas Sandstone and his mother was Susan Stubs. He knows that his mother died from Huntington's Chorea (he thinks that he may have the disease) and he knows that he has a half-sister and half-brother, but he doesn't know their names.

Glen, an achondroplasic dwarf, has fallen deeply in love with Norma Nanny.

Norma Nanny's Family Story:

Greg Nanny couldn't fight in the "war to end all wars." It turns out that Greg had poor eyesight, flat feet, an A blood type, and had a low IQ. He and his wife, Kathy (B blood), had two children: Nina (AB blood) and Nancy (O blood).

Nina had an affair with Thomas Sandstone when she was 19 years old. Their child Nadia was kidnaped and murdered when she was 3 years old. After the news, Nina went off the deep end and lost her mind. She is now institutionalized with no hope for release.

Nancy married Tony Stubs and they raised Norma. Tony died in a bizarre gardening accident (one that the authorities said it was better left alone) when Norma was 3. Since Norma was raised by her mother, she took the last name of Nanny. Ironically, after Tony died, they did a blood test which showed that he may have had Huntington's Chorea.

Norma, a jealous woman, knows that Glen Glendora has a thing for her, but she feels that she can't love a dwarf who may have Huntington's Chorea. Fred Fleckstone is the one that she adores.

Captain Relish's Family Story:

Captain Relish is a very mysterious man. He says that he was recently released from prison and has changed his name. He claimed to have many children by different women. His blood type was O.

DNA Sequences of cytochrome C of the following people.

	Theresa Thyme				Fred Fleckstone				Glen Glendora			
	G	A	T	C	G	A	T	C	G	A	T	C
1	-				-				-			
2		-				-				-		
3			-				-				-	
4			-				-				-	
5				-				-				-
6				-				-				-
7				-				-	-			
8		-				-				-		
9		-				-				-		
10				-				-				-
11	-				-				-			
12	-				-				-			

	Sam Stubs				Norma Nanny				Captain Relish			
	G	A	T	C	G	A	T	C	G	A	T	C
1	-				-				-			
2		-				-				-		
3			-				-				-	
4			-				-				-	
5				-				-				-
6				-				-				-
7	-							-	-			
8		-				-				-		
9		-				-				-		
10				-				-				-
11	-				-				-			
12	-				-				-			

Lab Report:

DNA Sequences:

	G	A	T	C	G	A	T	C
1	–				–			
2		–				–		
3			–				–	
4			–				–	
5				–				–
6				–				–
7				–	–			
8		–				–		
9		–				–		
10				–				–
11	–				–			
12	–				–			

Blood Types:

A and O

Fingerprints: None

Enzymes Present:

No evidence of Marfan Syndrome.

Evidence of reduced level of neurotransmitters.

Karyotypes from White Blood Cells: Enclosed

Information Sheet:

			Yes or No		
Name of Person	Poss. Blood Type	DNA Sequence	Marf	H.C.	Chromosome Disorder

Marf = Marfan Syndrome
H.C. = Huntington's Chorea

Genetic Disorder	Description and Symptoms
Marfan Syndrome	
Huntington Chorea	
Achondroplasia	
Kleinfelters Syndrome	
XXX Syndrome	
XYY Syndrome	
Down Syndrome	

Final Answer Sheet:

1) Who was the murderer?

2) Explain why you chose this person. Include a detailed explanation of your evidence. On the back of this sheet staple your pedigrees, karyotypes, and information sheet.

3) What was the motive of this person to commit murder?

Karyotype Key: Name of Person:_____

1	1	2	2	3	3	4	4
5	5	6	6	7	7	8	8
9	9	10	10	11	11	12	12
13	13	14	14	15	15	16	16
17	17	18	18	19	19	20	20
21	21	22	22	X	X	Y	

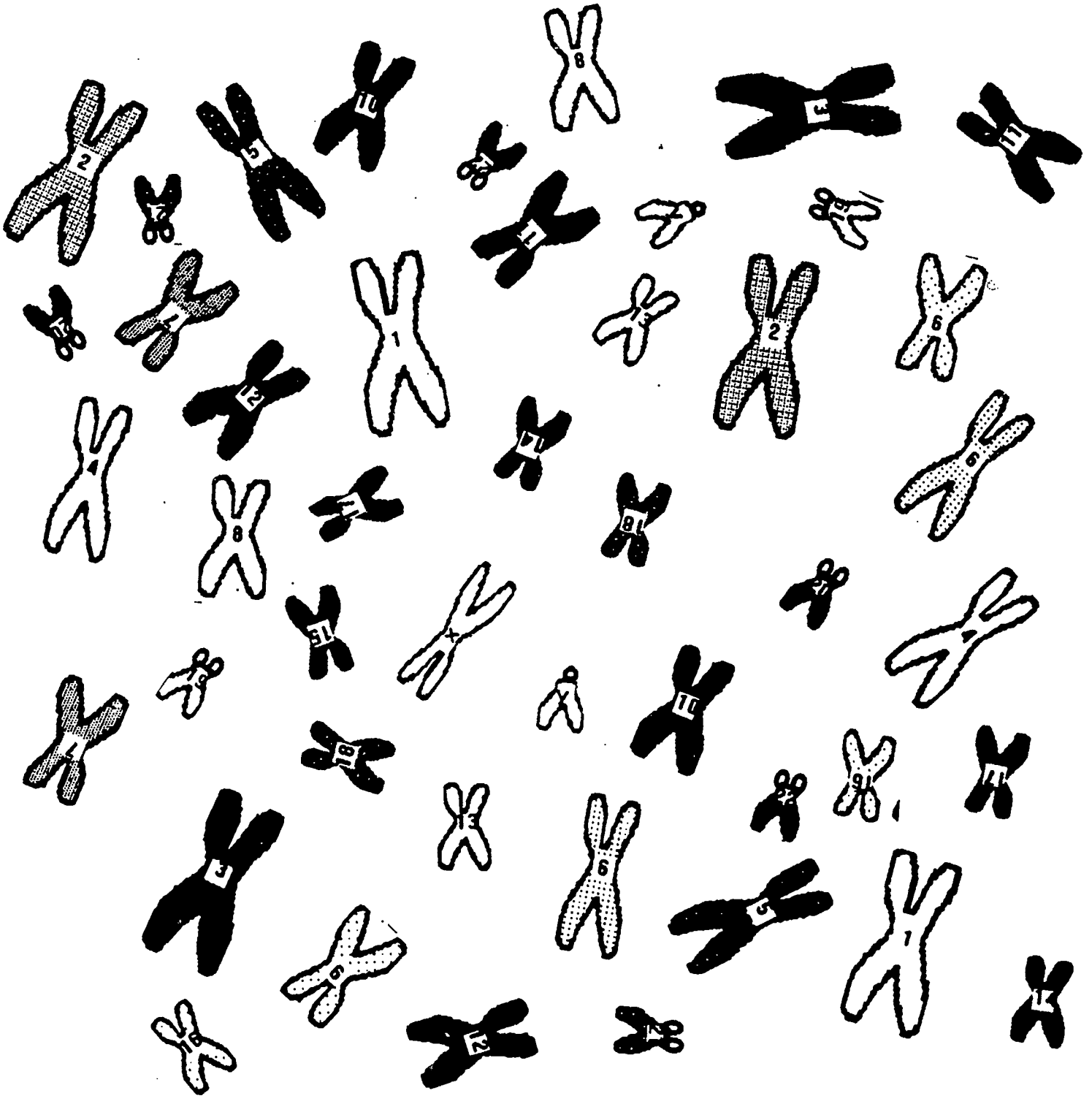
Gender of Person:

Chromosomal Abnormality? Yes or No:_____

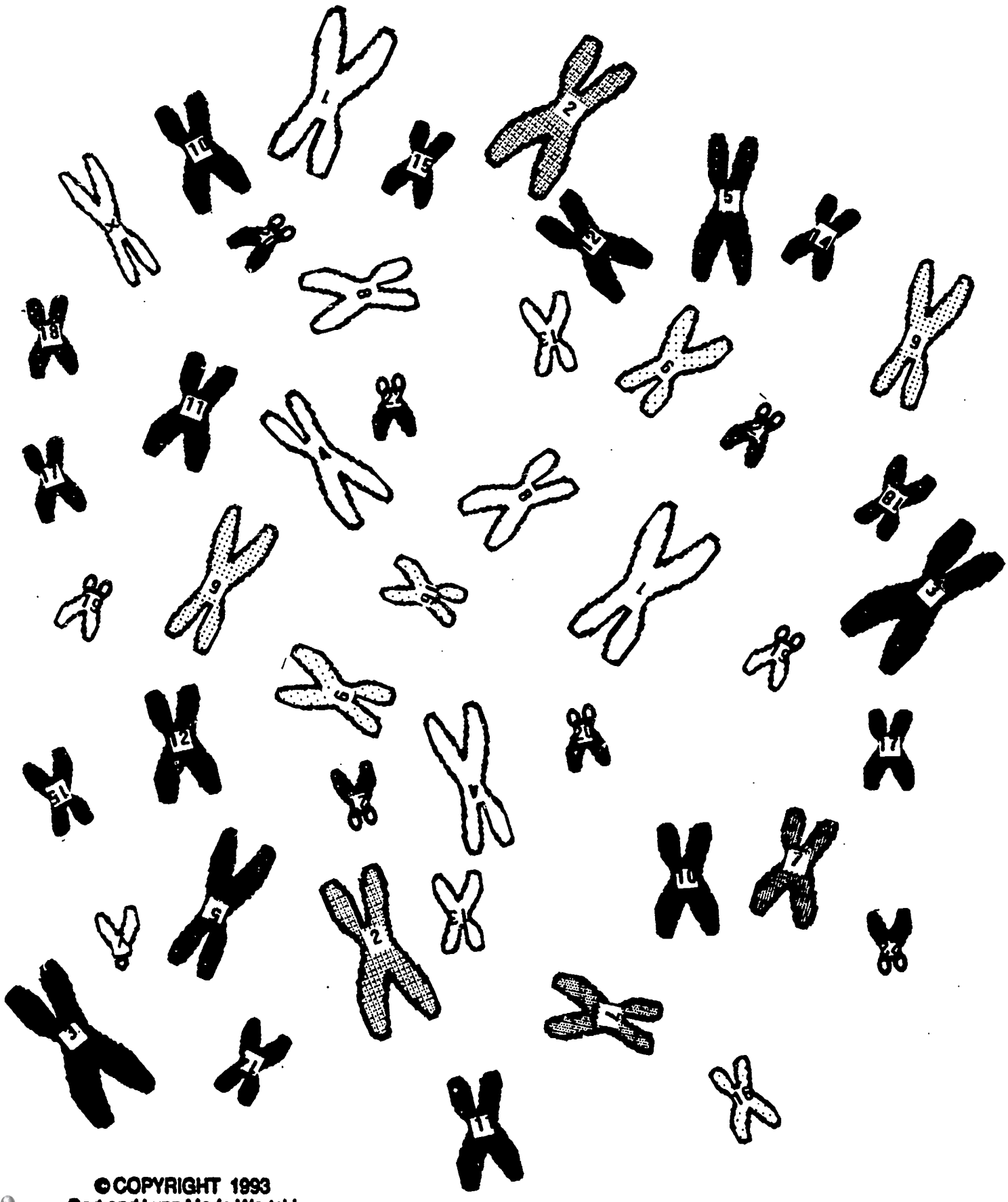
If there is a chromosomal abnormality, identify the disorder:

_____

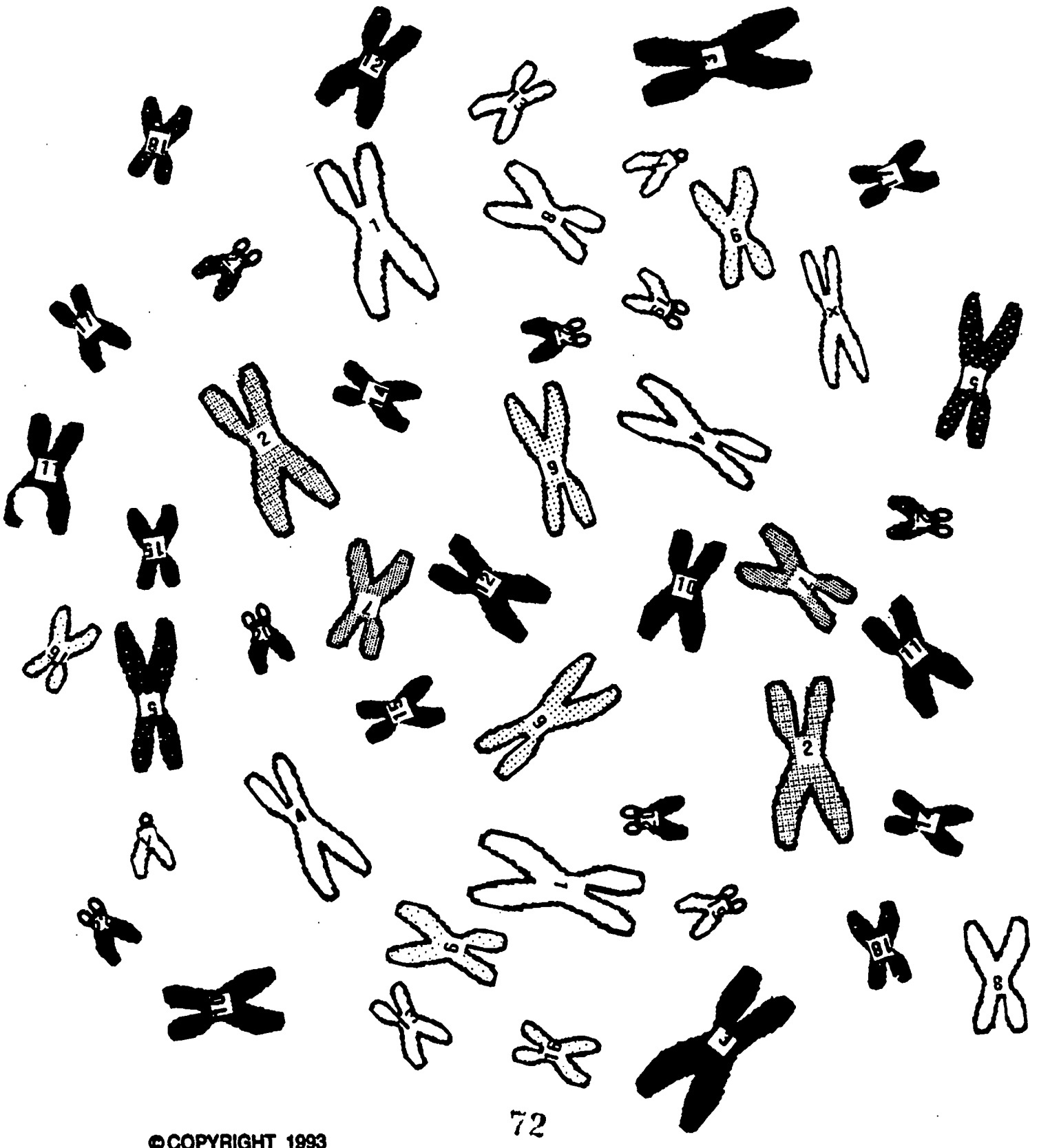
Sam Stubs' Karyotype



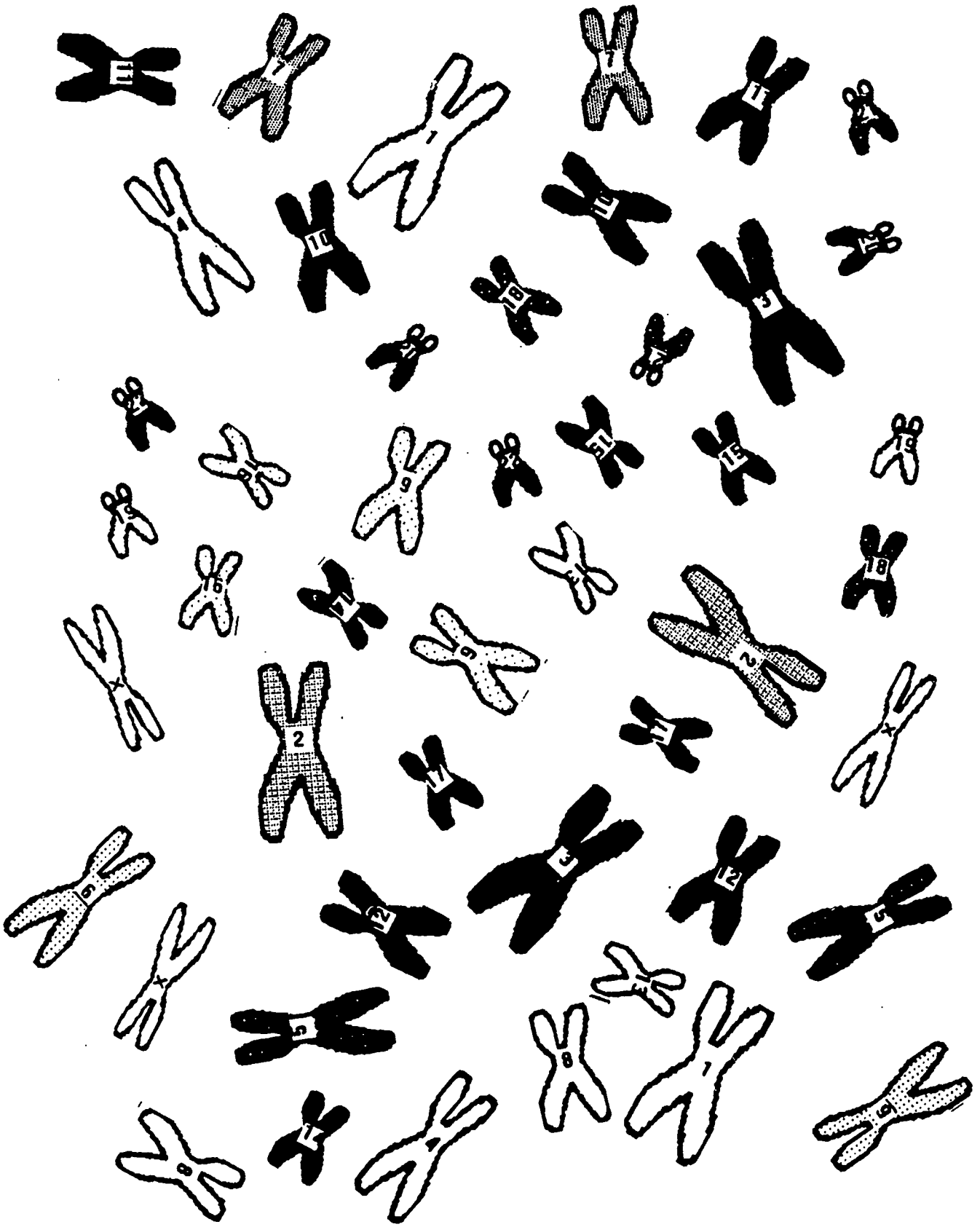
Glen Glendora's Karyotype



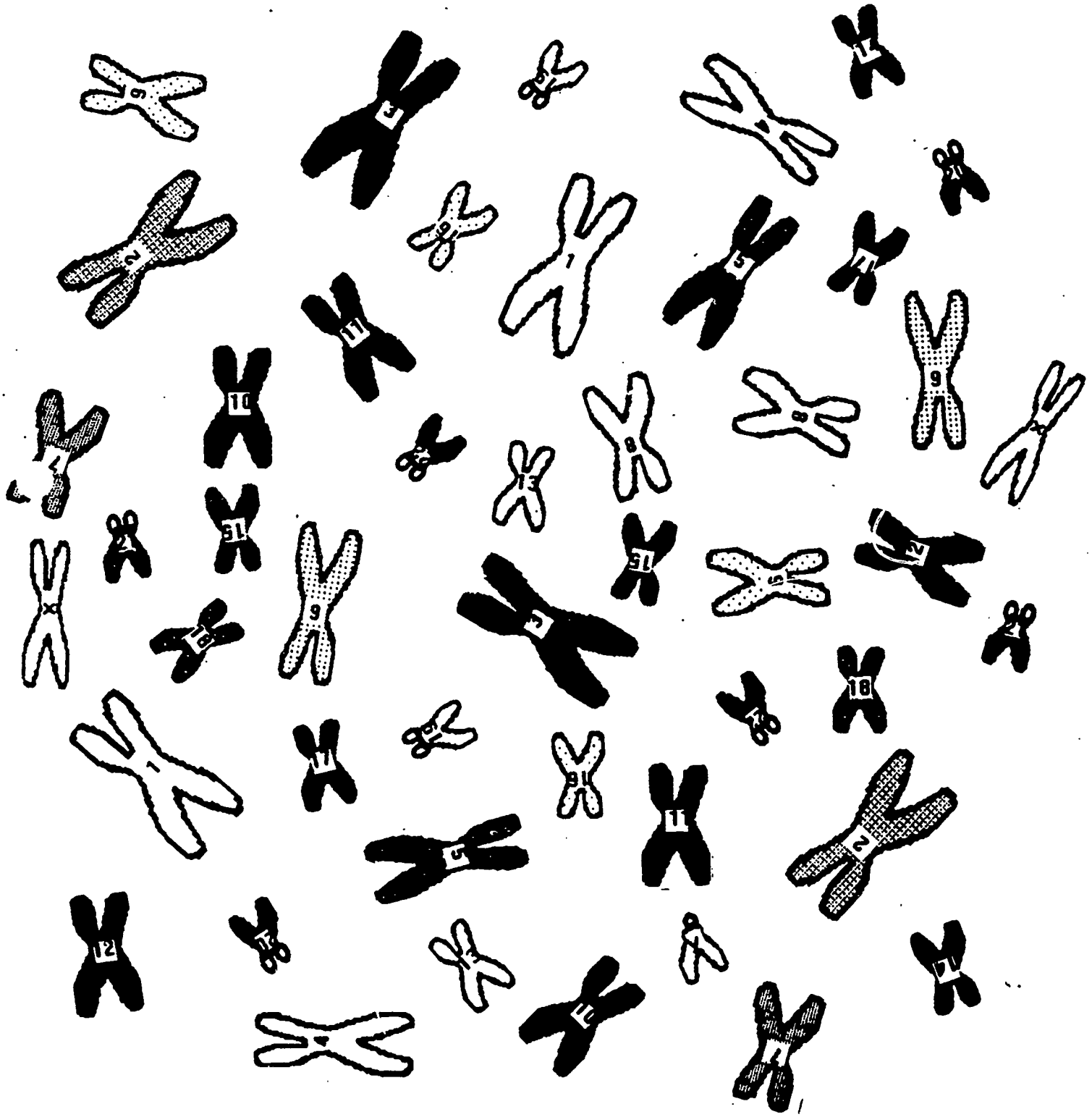
Captain Relish's Karyotype



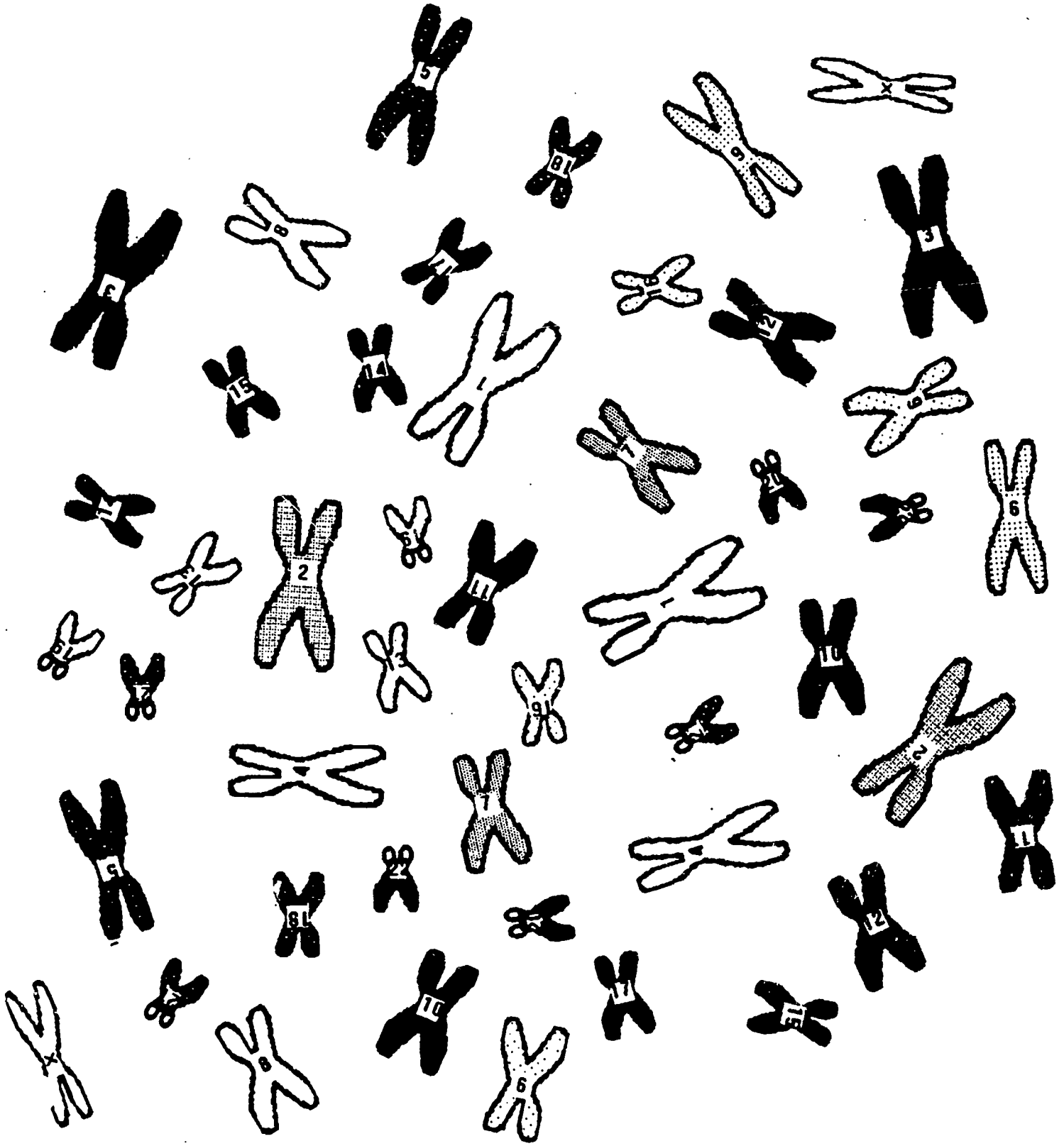
Norma Nanny's Karyotype



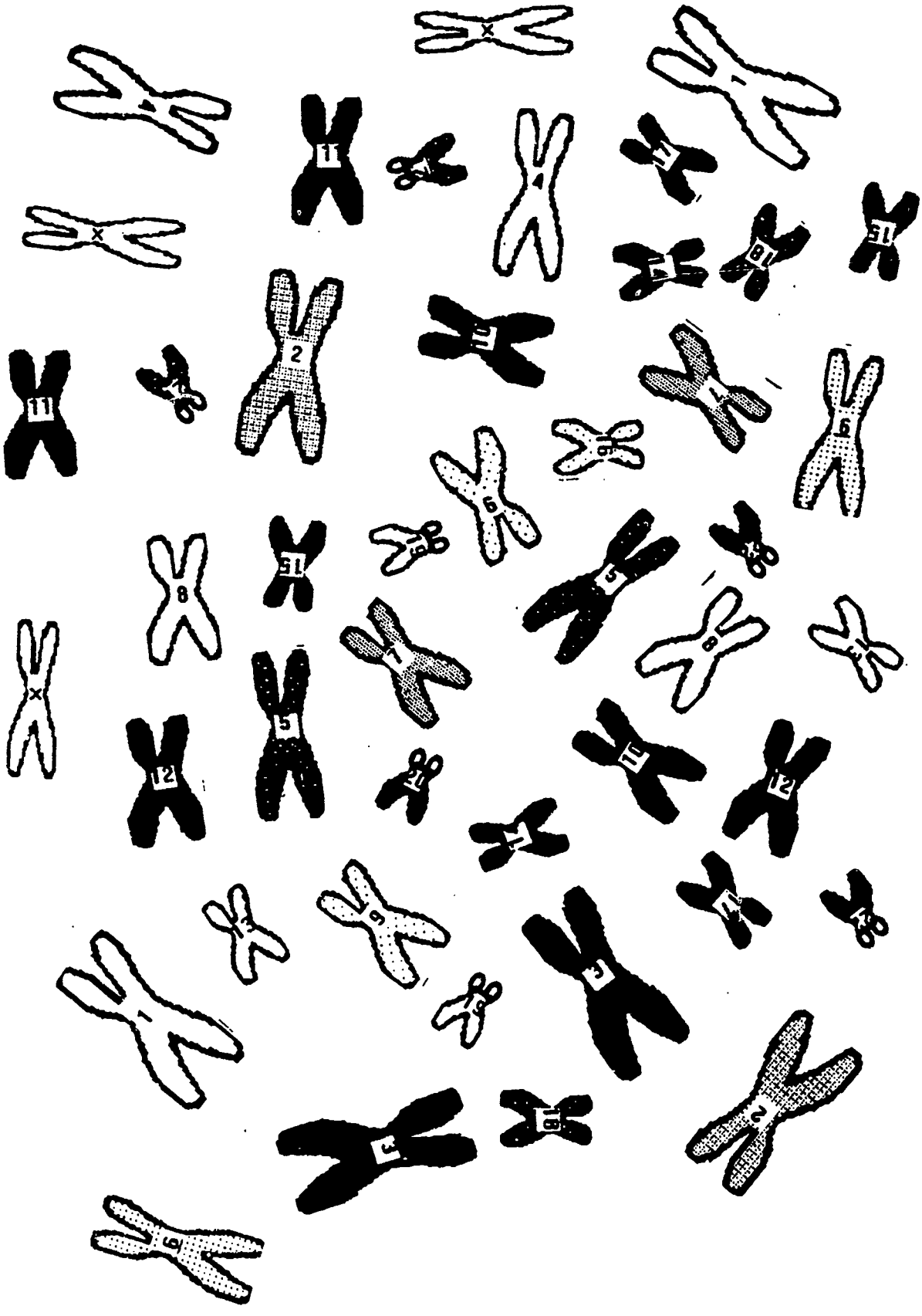
Fred Fleckstone's Karyotype



Theresa Thyme's Karyotype



Karyotype from Blood Sample 1



Karyotype from Blood Sample 2