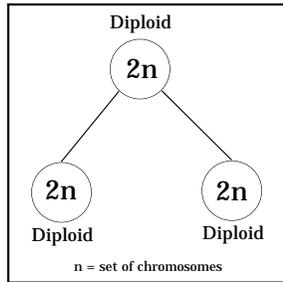

Senior 1

**Appendices:
Cluster 1
Reproduction**

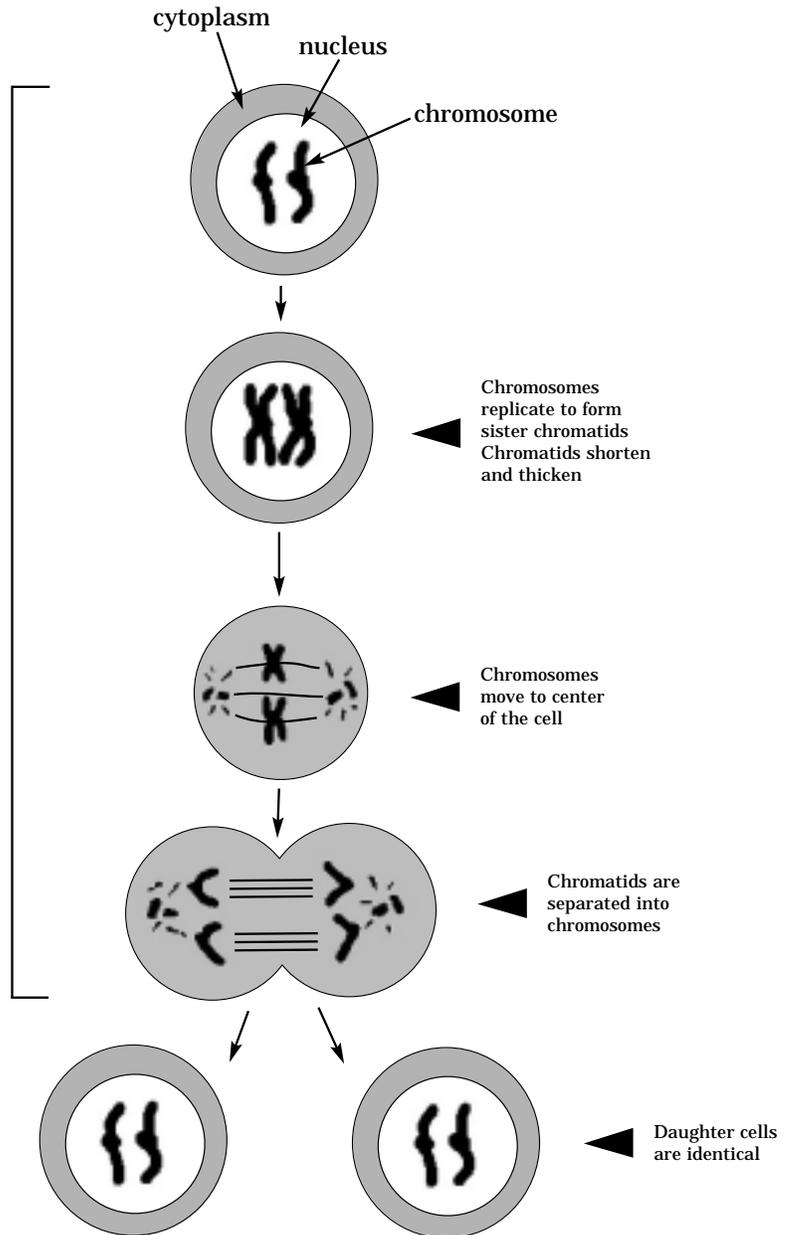


Mitotic Cell Division



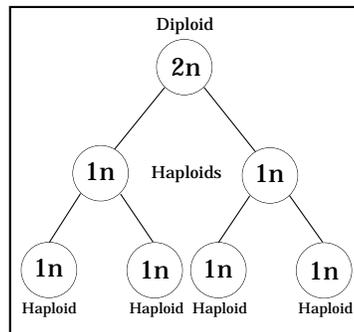
Mitosis
(division of the nucleus)

Cytokinesis
(cytoplasmic division)

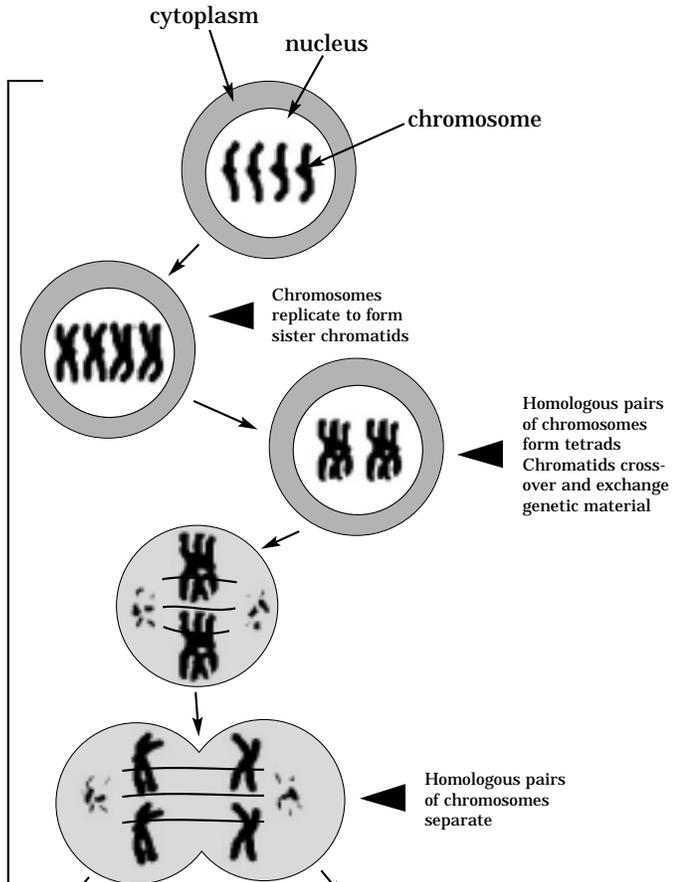




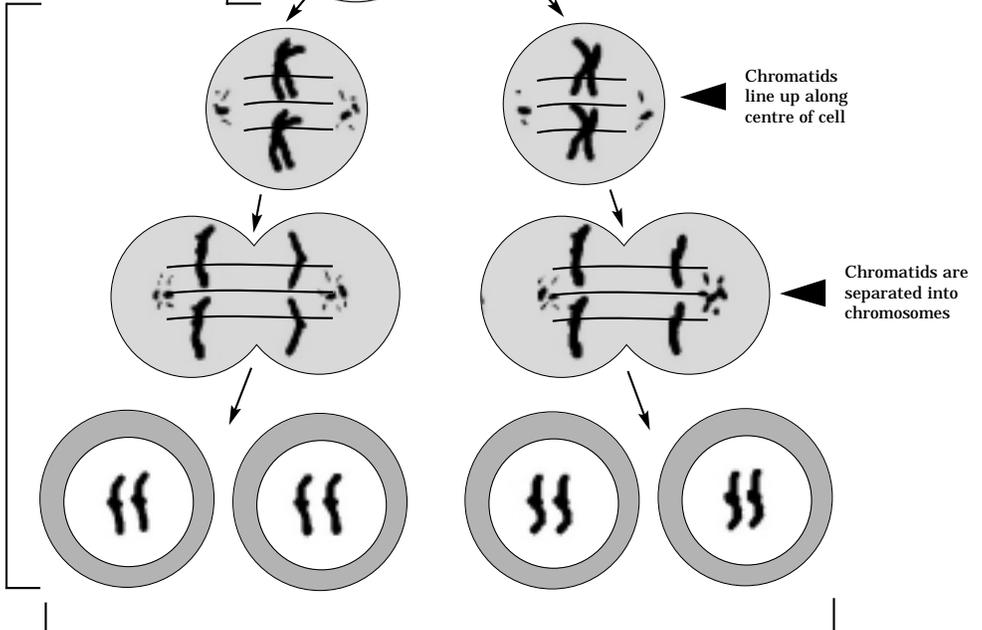
Meiotic Cell Division



Meiosis 1



Meiosis 2

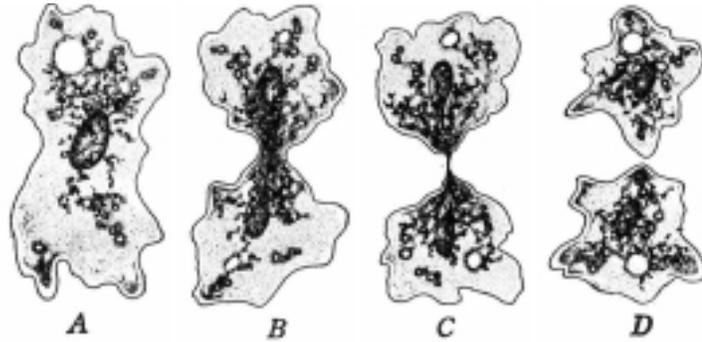


Four different gametes (sex cells) are formed

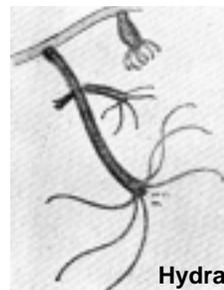


Types of Asexual Reproduction

1. **Binary fission:** This is the process by which a unicellular organism divides by mitosis into two equal halves. A parent cell becomes two genetically identical offspring cells (e.g., bacteria, algae, and protists).



2. **Budding:** In unicellular organisms, this process is similar to binary fission, but the parent cell keeps most of the cytoplasm (yeast). In multicellular organisms, a miniature version of the organism (e.g., the bud) grows directly on the body of the adult. When it is big enough, it can detach from the parent to become an independent organism (e.g., Hydra).



3. **Sporulation:** This is the process by which an organism produces reproductive cells (spores) by mitosis. The organism stores these cells in sporangia, which burst open to release spores that are capable of producing adult organisms (e.g., bread mould, Penicillium). Sporulation can also be a sexual type of reproduction (e.g., gametophytes).



4. **Vegetative propagation:** This is the process by which a new organism is created from the roots, stems, or leaves of plants (e.g., rhizoids in moulds, willow branches can develop roots and grow into a new tree, runners in strawberry plants can sprout roots and develop into a new plant).



5. **Regeneration:** This is the process by which a multicellular organism is divided into fragments. Each fragment becomes a new organism by regenerating the parts that are missing (e.g., flatworms, sea stars, sponges).





Advantages and Disadvantages of Sexual and Asexual Reproduction

	Advantages	Disadvantages
Asexual Reproduction	<ul style="list-style-type: none"> • produces a new organism that is genetically identical to its parent • it is not necessary to find a partner • energy can be used to produce offspring • offspring is usually well adapted to its environment because of the success of its parent • an area favourable to the parent can quickly be colonized due to the high number of offspring the parent can generate in little time • offspring are often already multicellular and more viable 	<ul style="list-style-type: none"> • does not give rise to genetic variability in organisms of a same species • the species does not adapt at all or adapts very slowly when circumstances change • there is only one parent to take care of offspring • the parent sometimes disappears because its body no longer exists (fission) • an asexual species runs the risk of suddenly disappearing because of a catastrophe that affects all organisms of the species that are genetically identical
Sexual Reproduction	<ul style="list-style-type: none"> • produces a new organism that results from a combination of traits of two parents • increases the genetic variability in organisms of the same species and even within the offspring of one couple • in the long run, allows the best adaptations to be widespread within a species, especially in changing circumstances • the variability of organisms within a species guarantees that a higher proportion will survive in perilous circumstances • two parents can watch over offspring 	<ul style="list-style-type: none"> • finding a reproductive partner and producing gametes demands the output of a lot of energy • mechanisms for the transportation of gametes for fertilization, for the attraction of the opposite sex, and for competition within a species must be put in place • not only do you need two gametes for fertilization, one has to be male, the other female • the genetic results of meiosis, and often of fertilization, are unpredictable • genetic "errors" happen more frequently because meiosis is more complex than mitosis and diploid organisms have more chromosomes to double • offspring are not necessarily as well adapted to their environment as the parents • many organisms never become parents because they can't find a partner; many gametes are lost, because they aren't fertilized



Human Development

Name: _____ Date: _____

Predict the month in which the following developments will occur in a human fetus by writing the letter preceding each statement in the appropriate box. Then consult various sources to verify your predictions.

- | | |
|--|---|
| A. Weighs 500 grams | J. A spermatozoon fertilizes an ovum to form a zygote |
| B. Measures 7 mm in length | K. Comprises 64 cells |
| C. Teeth are formed | L. The cartilage of the skeleton is transformed into bone |
| D. Nervous system is formed | M. Heart is developed |
| E. Heart is beating | N. Can hiccup |
| F. Genitals are formed | O. Covered in fine hairs |
| G. All organs are well formed but are not completely developed | P. Arms and legs move; has developed a sucking reflex |
| H. Can open eyes | Q. Now growing quickly, and organs are rapidly starting to function |
| I. Viable if born prematurely | R. Full-term and the mother is now in labour |

	I predict	I checked it out	Sources of Information
1 st month			
2 nd month			
3 rd month			
4 th month			
5 th month			
6 th month			
7 th month			
8 th month			
9 th month			



Human Traits — Punnett Squares

DOMINANT	RECESSIVE
brown eye colour	blue eye colour
free earlobes	attached earlobes
cleft chin	smooth chin
tongue roller	non-roller
dimples	no dimples
freckles	no freckles
dark hair	light hair
widow's peak hairline	straight hairline
curly hair	straight hair
PTC taster	non-taster
long eyelashes	short eyelashes
non-red hair	cystic fibrosis
normal vision	red hair
normal pigmentation	nearsightedness
green or hazel eye colour	albino
bushy eyebrows	blue eye colour
round face	fine eyebrows
normal blood clotting	square face
almond-shaped eyes	hemophilia (sex-linked)
large ears	round-shaped eyes
large nose	small ears
large eyes	small nose
normal vision	small eyes
Huntington disease	red-green colour blindness (sex-linked)
Rh+ blood	Rh- blood



Single Trait Inheritance Problems

Complete the following problems using Punnett squares. Give the genotype, phenotype, percentage, and ratio (if applicable) of the offspring from each cross.

- In pea plants, yellow seeds are dominant over green seeds. If a purebred yellow seed plant and a green seed plant are crossed, predict what the offspring will be like. (Practice Question — see Process Notes for sample solution.)
- Cross two hybrid yellow seed plants.
- Cross a hybrid yellow seed plant with a green seed plant.
- In pea plants, smooth seeds are dominant over wrinkled seeds. Predict the offspring resulting from the cross of a hybrid smooth seed plant with a purebred smooth seed plant.
- Cross a wrinkled seed plant with a hybrid smooth seed plant.
- Cross two wrinkled seed plants.

Process Notes for Punnett Squares

Sample solution for practice question 1:

Questions	Solutions									
a) Which trait is dominant?	a) yellow = dominant b) green = recessive									
b) Assign letters to traits.	b) yellow = Y green = y									
c) Decide on letter combinations, (e.g., pure/hybrid).	c) YY and yy									
d) Write parental genotype around square.	d) <table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>Y</td> <td>Y</td> </tr> <tr> <td>y</td> <td></td> <td></td> </tr> <tr> <td>y</td> <td></td> <td></td> </tr> </table>		Y	Y	y			y		
	Y	Y								
y										
y										
e) Determine possible offspring (complete square).	e) <table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>Y</td> <td>Y</td> </tr> <tr> <td>y</td> <td>Yy</td> <td>Yy</td> </tr> <tr> <td>y</td> <td>Yy</td> <td>Yy</td> </tr> </table>		Y	Y	y	Yy	Yy	y	Yy	Yy
	Y	Y								
y	Yy	Yy								
y	Yy	Yy								
f) Determine offspring genotypes (letters).	f) geno = Yy (100%)									
g) Determine offspring phenotypes (looks).	g) pheno = yellow (100%)									
h) Record percentage of phenotypes in offspring (yellow versus green).	h) see f & g above									

*Upper and lower case letters must look different.



Genetics — Punnett Squares

Solve problems using the dominant and recessive human traits listed in Appendix 1.6.

Procedure:

1. Create a word problem using the word problem frame below as a guide.
2. Provide a written answer key on a separate sheet of paper. The key must include the genotype, phenotype, percentages, and ratio (if applicable).
3. Include the following crosses:
 - purebred dominant x purebred dominant
 - purebred dominant x recessive
 - recessive x recessive
 - recessive x hybrid
 - purebred dominant x hybrid
 - hybrid x hybrid
4. Have your work checked and signed by another student.
5. Write one of your problems on an overhead and present it to the class.

Word Problem Frame:

In humans, *brown eyes* are dominant over *blue/grey eyes*. What offspring would result from a cross between a *pure dominant* individual and a *pure recessive* individual?

Note: The words in italics will vary with the trait selected. Replace the information in italics to suit the trait being studied.



Vocabulary Review on Genes

Name: _____ Date: _____

In the following statements, G represents the dominant gene for curly hair and g represents the recessive gene for straight hair.

Part A

Check the answer that correctly completes each statement. Make sure you can explain your answer.

If an ovule G and a sperm cell G unite:

- the genotype of the resulting zygote will be:
 GG gg Gg
- the zygote will be:
 heterozygous homozygous
- the resulting human will have the following phenotype:
 curly hair straight hair part curly, part straight hair
- the resulting human will be able to produce the following gametes:
 G g G or g

If an ovule g and a sperm cell g unite:

- the genotype of the resulting zygote will be:
 GG gg Gg
- the zygote will be:
 heterozygous homozygous
- the resulting human will have the following phenotype:
 curly hair straight hair part curly, part straight hair
- the resulting human will be able to produce the following gametes:
 G g G or g

If an ovule G and a sperm cell g unite:

- the genotype of the resulting zygote will be:
 GG gg Gg
- the zygote will be:
 heterozygous homozygous

11. the resulting human will have the following phenotype:
 curly hair straight hair part curly, part straight hair
12. the resulting human will be able to produce the following gametes:
 G g G or g

If an ovule g and a sperm cell G unite:

13. the genotype of the resulting zygote will be:
 GG gg Gg
14. the zygote will be:
 heterozygous homozygous
15. the resulting human will have the following phenotype:
 curly hair straight hair part curly, part straight hair
16. the resulting human will be able to produce the following gametes:
 G g G or g

Part B

State your answer to the following questions in the form of a fraction or as a percentage.

17. If a father (GG) and a mother (gg) have children, what will be the expected proportions of the following genotypes?
 GG _____ gg _____ Gg _____
18. If a father (gg) and a mother (Gg) have children, what will be the expected proportions of the following genotypes?
 GG _____ gg _____ Gg _____
19. If a father (Gg) and a mother (GG) have children, what will be the expected proportions of the following genotypes?
 GG _____ gg _____ Gg _____
20. If a father (Gg) and a mother (Gg) have children, what will be the expected proportions of the following genotypes?
 GG _____ gg _____ Gg _____



It Runs in the Family

Introduction:

Many human traits are controlled by a single pair of genes, which may have contrasting forms — dominant and recessive. Dominant genes are identified with a capital letter, while the contrasting recessive form uses the lower case version of the same letter. Examples of single inheritance traits include the ability to roll one’s tongue, the shape of the hairline, and earlobe attachment.

The term phenotype refers to an individual’s physical appearance, while genotype refers to his or her genetic makeup. It is not always possible to determine a person’s genotype from observing his or her phenotype. A pedigree is a diagram that shows how the phenotype of a genetic trait appears in a family from one generation to the next.

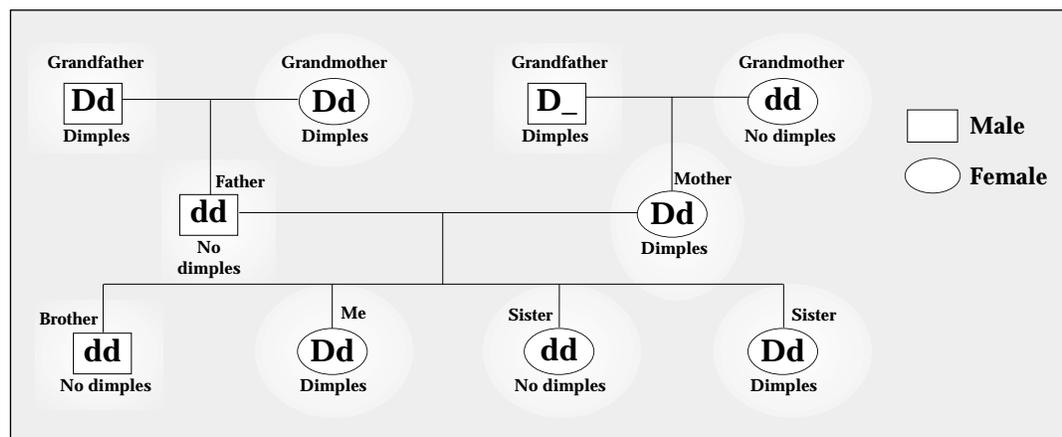
Purpose:

To collect family data of single inheritance traits and to construct a pedigree.

Procedure:

- Examine the sample data table on the following page, and construct a similar table that will accommodate the members of your family.
Note: “Family” in this instance, means any of the people living in your home or with whom you are in close contact, regardless of whether this includes your biological parents. The titles at the top of the Data Table can be changed to reflect your home situation.
- Record your family’s characteristics in your data table.
- Construct a pedigree to represent one of the traits studied. Use different phenotypes and genotypes (e.g., dimples/no dimples, DD, Dd, dd) for each trait. The pedigree must be neat and must contain a legend of the trait studied and a title (your family name). Pedigrees can be adapted to reflect the makeup of your family situation if desired.

Sample Pedigree: The Simpsons



Data Table: The “Sample” Family

	Trait	Description			You	Mother	Father	Brother	Sister	Maternal Grandparents		Paternal Grandparents	
										GF	GM	GF	GM
1	Dimples	Yes		No									
2	Freckles	Yes		No									
3	Allergies	Yes		No									
4	Hair Whorl	Clockwise		Counter CW									
5	P.T.C.	Taste		No taste									
6	Earlobes	Attached		Free									
7	Sight	Near sighted		Normal									
8	Thumb	Not bent		Bent									
9	Tongue	Roller		Non-roller									
10	Eye colour	Blue		Not blue									



Making Sense of Sex-Linked Traits

Background Information:

Sex-linked traits are carried on the X-chromosome. A sex-linked trait is a recessive trait that shows up more often in men than in women.

Hemophilia is an inherited disease of the blood. Affected persons do not have the ability to form blood clots. The letter H represents the dominant, normal gene. The recessive gene is represented by the letter h. Is hemophilia sex-linked or not sex-linked?

How do we know if a disease is sex-linked or not?

If a trait is sex-linked, the gene is located on the X-chromosome. If the trait is NOT sex-linked, the gene is located on a chromosomal pair other than the sex chromosomes.

Purpose:

To determine the probability that an inherited disease is sex-linked or NOT sex-linked.

Materials:

- masking tape
- two pennies
- two nickels
- pen

Part 1: Trait is sex-linked

Genes for sex-linked traits are located on the X-chromosome. A heterozygous female ($X^H X^h$) has a 50/50 chance that her egg cells will receive either an X^H or an X^h during meiosis. Normal males have the genotype $X^H Y$. The chances that their sperm cells will receive either X^H or Y during meiosis are 50/50. You can determine the offspring of the cross between a heterozygous female and a normal male by coin tossing.

- put tape on both sides of two pennies
- mark one penny as the heterozygous female (i.e., mark one side of the penny X^H and the other side of the penny X^h)
- mark the second penny as the normal male (i.e., mark one side of the penny X^H and the other side of the penny Y)
- toss both pennies together 50 times. Record the combination that results after each toss in the chart below
- total the results of each genotype and record the totals in the table

Results if the Trait is Sex-Linked

Offspring Phenotype	Offspring Genotype	Result of Each Toss	Totals
Normal female	$X^H X^H$ or $X^H X^h$		
Female with hemophilia	$X^h X^h$		
Normal male	$X^H Y$		
Male with hemophilia	$X^h Y$		

Part 2: Trait is not sex-linked

If the trait is not sex-linked, the genes for hemophilia are not located on the sex chromosomes. This means that there are two sets of chromosomes involved — one set for determining the sex of the offspring and another set that determines if the offspring will have hemophilia or not.

Four coins are needed to represent the two pairs of chromosomes.

The following cross will be made $XXHh \times XYHh$.

Results if the Trait is Not Sex-Linked

Offspring Phenotype	Offspring Genotype	Result of Each Toss	Totals Observed
Normal female	$X^H X^H$ or $X^H X^h$		
Female with hemophilia	$X^h X^h$		
Normal male	$X^H Y^H$ or $X^H Y^h$		
Male with hemophilia	$X^h Y^h$		

Questions for Understanding:

(Use the information from your tosses to answer the questions below.)

- If a trait is sex-linked, how many genes must a male have to inherit the trait? _____,
How many genes must a female have? _____
- If a trait is not sex-linked, how many genes must a male have to inherit the trait? _____,
How many genes must a female have? _____
- If the father is normal and the mother is heterozygous, how many normal female children were observed when the trait was considered to be sex-linked? _____
- If both parents were heterozygous, how many normal female children were observed if the trait was not considered to be sex-linked? _____



Mutations

Name: _____ Date: _____

Included below are various imaginary scenarios about accidental mutations. Think about the possible consequences of each situation.

Scenario 1

Manon regularly visits tanning salons. She does not realize that an ultraviolet ray has caused a mutation in one of the cells of her big toe. The modified gene produces green skin with big white polka-dots.

- Is Manon in danger?
- Will she have problems?
- If she gives birth to a baby in a few months, will her child have a green toe? Explain.

Scenario 2

Patrick liked to sunbathe at his cottage. Unfortunately, he was unaware of the fact that the Sun's rays irradiated one of the chromosomes in the germinal cells of his testicles (the cells that produce sperm). This resulted in a mutation that caused his son to have a nose with three nostrils. Also, the water in which he liked to swim contained a mutagenic pesticide that changed the cells in his lungs, causing Patrick to develop asthma. Five years later, Patrick wonders if his children will also be sick.

- Will Patrick's children also be asthmatic?
- What kind of problems do his children risk having? Why? Why won't all his children develop problems?
- Can Patrick prevent having children with three nostrils? How could this mutation be an advantage to his children?

Scenario 3

Rebecca has been pregnant for three months. Her fetus's cells have begun to differentiate and its brain is in full development. Rebecca eats too much meat that contains preservatives. These preservatives circulate in her bloodstream, causing a mutation of nervous cells that provide both with an extraordinary musical talent. Thirty years later, Rebecca's child, Peter, is internationally renowned, is married, and has many children.

- Will Peter's children become musically talented as well? Explain.
- Will his children necessarily have little musical talent? Explain.
- Is there a way to produce offspring who would have Peter's musical mutation?

Scenario 4

Freddy the frog is lazy and always hungry. His diet has many deficiencies, so much so that he is lacking ingredients for the proper mitosis of his germinal cells. Freddy does not realize that one of his sperm cells contains a gene that produces wings, and that he has fertilized an ovule that also contains a bizarre mutation that produces antennas.

- Will the flying frog with antennas also be lazy?
- Will the frog be able to feed more easily than Freddy?
- Will Freddy produce more flying frogs with antennas?

Scenario 5

Yok and Yik come from the same zygote. They are twins who are experiencing the effects of a drug taken by their mother during an emergency operation while she was pregnant. In Yok's body, the drug caused a mutation in her gland cells, which provoked an overproduction of growth hormones. In Yik's body, the same gene is subjected to this mutation, but only in the ovules she already has.

- Are Yik and Yok identical twins?
- At birth, Yok is twice as heavy as Yik. Why?
- Will Yok's children be bigger than Yik's? Explain.



Biotechnology Organizer

Name: _____

Date: _____

Complete the following table, based on your own knowledge. You will be able to fill in a second one later, after the class has shared answers and you have done some research on biotechnology.

Genetic Fingerprinting			
Cloning			
Genetic Screening			
Genetic Engineering			
	What is it?	In which circumstances is this type of biotechnology used?	What are actual or eventual repercussions of this type of biotechnology?