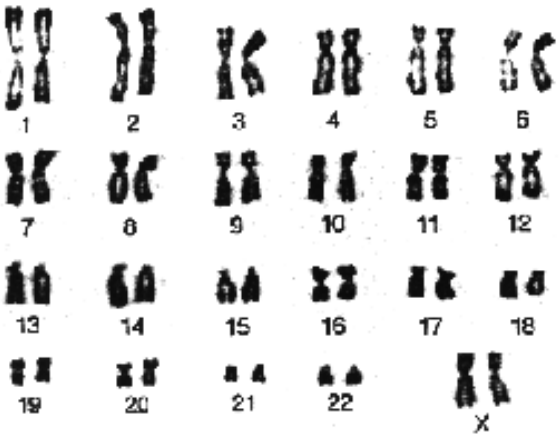
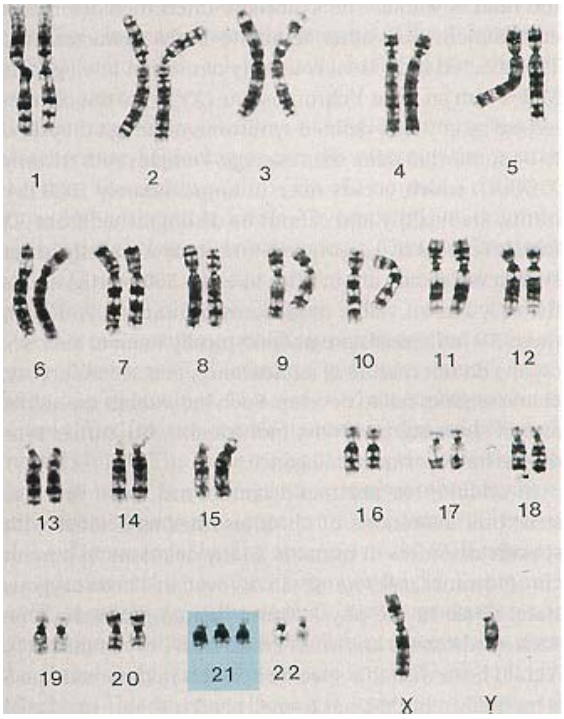
Remember, there are 23 pairs of chromosomes. Twenty-two of those pairs are not involved in sex determination. These 22 are called autosomes. Only one pair of chromosomes has anything to do with sex determination. They are called allosomes. In females, they are designated as XX chromosomes. In males, they are designated as XY. Actually, the Y chromosome is a very short, stubby chromosome. Shown below are two karyotypes: female and male



Female showing XX chromosomes.

A karyotype is a photography of chromosomes once they have been stimulated to divide by mitosis. They are stopped during the metaphase stage. The cells are then smashed on a slide, stained, and photographed. The biologist then cuts them out like paper dolls, arranges them, and photographs them again to produce the karyotype.



Male, showing XY chromosome and extra chromosome # 21 (Down's syndrome)

The production of a karyotype is very time consuming. Actually, one doesn't have to do a karyotype to determine whether the individual is male or female. An easier way to determine the sex of an individual is to look at a cell during interphase. In females, one X chromosome is inactive and can be seen attached to the nuclear membrane. This "body" is called a Barr body.

So what is the probability out of any mating, the first child will be a male. All you have to concern yourself with is the allosomes or sex chromosomes. In the male, 50% of the sperm will receive an X and 50% of the sperm will receive a Y. In the female, the eggs will all have X chromosomes in them. Separate the allosomes into sperm and egg. Then simply do a Punnett square.

	X	X
X	XX	XX
Y	XY	XY

Notice, the probability of producing a male child is 50:50 or ½. In genetics, we often describe the *probability* of an event taking place.

Probability

Probability is expressed as a number between 0 and 1. If an event takes place, the probability is said to be 1. If an event does not take place, the probability is said to be 0. If you flip a coin, the probability it will be heads is ½ (between 0 and 1).

What is the probability that out of two matings, both the children will be male? The answer is relatively simple. The probability the first child will be male is 50% or ½. The probability the second child is male is also 50% or ½ . The probability that the first two children will both be male is ½ x ½ = ¼ . This is called the product law of probability.

Sex Linked Genes

Sex linked genes are genes found on the X chromosome but not on the Y chromosome. The Y chromosome is too short to have a particular gene located on it.

The gene in question is located below a locus available on the Y chromosome. As a consequence, both XX chromosomes are involved in expression in the female, but only the single X chromosome in the male is involved in expression of the trait. An example is red-green color blindness. There are several types of color blindness and there are at least two types of red-green. People who are red-green colorblind cannot see those colors – instead, they appear as gray. Red-green colorblindness is a sex linked, recessive trait. There is only one way for a female to be colorblind. She must have a recessive gene and allele. For the male, whatever the X chromosome is, that's what he expressed.

Female	Male
X^CX^C = normal vision	X^CY = normal vision
X^CX^c = normal vision (carrier)	X^cY = colorblind male
X^cX^c = colorblind female	

Other examples of sex linked, recessive traits are hemophilia and eye color in fruit flies.

Sex Influenced Genes
Although the gene for this condition is not found on the X or Y chromosomes, it does make a difference if you are male or female. An example is male pattern baldness (although females can have this condition). Females never go completely bald, but they may have severe thinning of the hair.

Females	Males
BB = normal hair	BB = bald
Bb = normal hair	Bb = bald
bb = bald	bb = normal hair

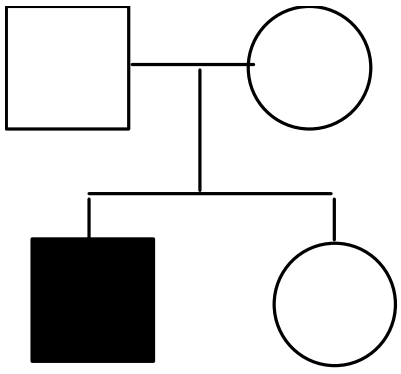
Notice the only way for a male to keep his hair is to be recessive for the trait while the only way for a female to be bald is to be recessive. Also key to males is to trace baldness through the mother's side of the family. If her father was bald, guys, kiss it goodbye!

Sex Limited Genes
In this case, expression of the trait is strictly limited to one sex. An example is cock feathering in roosters. Actually, the type of feathering you see on female chickens is called hen feathering. However, most people don't realize some of those hens are really roosters.

Genotype	Female	Male
HH	hen feathered	hen feathered
Hh	hen feathered	hen feathered
Hh	hen feathered	cock feathered

Holandric Traits
Holandric genes are found on the Y chromosome and not the X. An example is TDF or testis determining factor. This gene is responsible for triggering undifferentiated tissue into the formation of testes.

Pedigree Charts
An excellent way of tracing genes is the use of pedigree charts. Men are represented by squares and women are represented by circles. Matings and their results are indicated by lines. For example, the chart to the right represents a mating with two children, a boy and a girl with a boy expressing a particular trait – perhaps colorblindness.



CHROMOSOMAL BASIS FOR INHERITANCE

Some Common Genetic Facts and Fallacies
There are many misconceptions about heredity. Try your hand at these true-false questions. Questions are from Dr. Wilbrod St. Amand, retired Professor of Genetics, University of Mississippi. Once you know the answers, why no try the questions out on some of your friends or your parents?

STATEMENT	**TRUE**	**FALSE**
Certain thoughts or experiences of a mother may mark or alter the hereditary makeup of an unborn child.		
Color blindness is more common in males than females.		
A person may transmit characteristics to offspring which he/her does not show.		
Certain hereditary characteristics are influenced by the blood.		
Identical twins are more closely related than fraternal twins.		
Certain inherited traits may be altered by the stars, moon, or planets early in development.		
Males are biologically stronger than females.		
The tendency to produce twins runs in families.		
A craving for food, such as strawberries, may cause a birthmark on an unborn child. Many of a person's inherited traits are not apparent.		
The parent with the stronger will contributes more to a child's inheritance than the other parent.		
If a person loses a limb in an accident, it is likely he or she will have a child with a missing limb.		
The attitude of parents toward each other influences the emotional makeup of an unborn child.		
Children born to older parents usually lack the vitality of those born to younger parents.		
The total number of male births exceeds female births each year.		

Some Human Genetic Traits

Trait	Dominant	Recessive
Eye color	Brown	Blue
Hair pattern	Clockwise	Counterclockwise
Hair pattern (number)	One	Two
PTC paper	Taster	Non-taster
Red Blood Cells	Oval	Round
Middle Finger Hair	Present	Absent
Finger Length Male	Long	Short
Finger Length Female	Short	Long
Pattern Baldness	Male	Female
Finger nail	Curved	Square
Colorblindness	Sex linked male	Recessive
Hemophilia	Sex linked male	Recessive
Widow's Peak	Present	Absent
Ear Lobes	Free	Attached
Bent Little Finger	Bent	Straight
Dimples	Present	Absent
Hitchhiker's Thumb	Present	Absent
Big Toe length	Short	Long

Non-disjunction

Non-disjunction is the failure of chromosomes to separate properly during meiosis. This can occur in several ways:

1. deletion – when a portion of the chromosome breaks off and is not restored.
2. duplication – a segment of the chromosome is duplicated and kept with the original.
3. inversion – a portion of the chromosome breaks and reattaches at a different location.
4. reciprocal translocation – two different chromosomes break apart and reform with segments of each in each chromosome.

Examples of Non-disjunction

1. **Cri-du-chat**
    - **a.** Deletion of short arm of chromosome # 5
    - **b.** Microcephaly
    - **c.** Saddle nose
    - **d.** Retardation in mental skills, motor skills, and growth
    - **e.** IQ in 20-40's
    - **f.** Death in infancy or early childhood
    - **g.** Characterized by a meowing sound when the child cries.
2. **Down's Syndrome**
    - **a.** Extra chromosome # 21
    - **b.** Short hands
    - **c.** Simian palmar crease
    - **d.** Hyperflexibility of joints
    - **e.** Mental retardation
    - **f.** Open mouth with enlarged tongue
    - **g.** Epicanthal folds
3. **Patau Syndrome**
    - **a.** Extra chromosome # 13
    - **b.** Mental deficiency and deafness
    - **c.** Cleft lip or palate
    - **d.** Polydactyly
    - **e.** Cardiac anomalies
4. **Edward's Syndrome**
    - **a.** Extra chromosome # 18
    - **b.** Multiple congenital malformation of many organs
    - **c.** Malformed ears with elfin-like appearance
    - **d.** Mental deficiency
    - **e.** 90% die within the first 6 months
5. **Turner's Syndrome**
    - **a.** Only one X chromosome
    - **b.** Female with retarded sexual development
    - **c.** Usually sterile
    - **d.** Short stature
    - **e.** Webbing of skin in neck region
    - **f.** Cardiac abnormalities
    - **g.** Hearing impairment
6. **Kleinfelter's Syndrome**
    - **a.** Extra X or extra Y chromosome
    - **b.** Male, sub-fertile, small testes
    - **c.** Developed feminine breasts and feminine voice
    - **d.** Long limbs, rambling talkativeness
    - e. Frequent early death

7. **Triple X**
    - **a.** Female with under developed genitalia and limited fertility
    - **b.** Frequent mental retardation
8. **XYY**
    - **a.** Males approximately 7 cm taller with this trait
    - **b.** Suggested delayed tendency towards maturity
    - **c.** More physically active
    - **d.** high incidence of XYY in prison population of Starke, Florida