Chromosome Theory of Inheritance

Proposed by: Walter Sutton and Thoeodor Boveri. (1902)

What they did

- Studied chromosomes during the various phases of meiosis.

What they found

- Chromosomes occur in pairs
- Chromosome pairs separate (segregate) during anaphase 1 (This backs up Mendel’s claims of the Law of Segregation)
- Chromosomes align themselves independently along the equator of a cell. (This backs up Mendel’s ideas of independent assortment.

What the theory says

- Mendel’s factors or genes are carried on chromosomes.
- The segregation and independent assortment of chromosomes during meiosis is what accounts for inheritance.

Note: The work of Sutton and Boveri confirmed Mendel’s ideas about genes (Factors) and how they are inherited (segregation and independent assortment).

THOMAS MORGAN

- Studied Fruit flies (Drosophila melanogaster)
- Did crosses involving eye colour.

What he found

- Found that chromosomes in Fruit flies are the same except for one pair.
- He called the dissimilar pair Sex chromosomes because he believed they determined the sex of the fly.
- Found that certain traits such as eye colour in Fruit Flies are found on the X gene. This is what he called “sex-linkage”. Today, we call this “Sex-linked” genes or traits.
- Sex-Linked trait: A trait that is carried on one of the sex Chromosomes (X or Y)
- Morgan also found that certain genes on the same chromosome are called “Linked Genes”.
He said that Linked genes get \textit{inherited together} and not separately as Mendel had proposed (They do not obey Mendel’s Law of Independent assortment.)

This would account for some differences in ratios of crosses. Instead of getting a 9:3:3:1 expected ratio in a Dihybrid cross, the ratio may be different.

Morgan also found that genes on the same chromosome that are separated by a great distance will separate as a result of \textit{Crossing Over}.

Morgan Helped to restate Mendel’s Law of Independent Assortment

\textbf{Law of Independent Assortment in Modern terms}

\textit{If crossing over does not occur, genes that are located on the same chromosomes will be inherited together while those on separate chromosomes will assort independently.}
SEX-LINKED TRAITS

- Sex-Linked traits are traits that are carried on the sex Chromosomes (X, Y).
- Most often, the traits are carried on the X-Chromosome.
- Most of these traits are recessive and often lethal (deadly).
- Sex-linked traits affect males more often than females

Examples of Sex-Linked Traits

- Red-Green Colour blindness.
- Male Pattern Baldness
- Hemophilia
- Duchenne Muscular Dystrophy

To see how these traits are passed on, let’s do a sample cross.

Sample Sex-linked cross.

A woman who has normal vision marries a man that is colourblind. What are the possible ratios for their offspring?

Answer

Because this is a sex-linked trait we must use the X and Y chromosomes in our cross. Here is how it goes.

Parents: $X^N X^N \times X^n Y$ (the N is normal, the n is colour blind)

Gametes: $X^N, X^N, X^n, Y$

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The results will be as follows:

Females: All females (XX) will be carriers of the gene, but they will be Normal.

Males: All males will be Normal.
Let’s do another cross. This time we will cross one of the females with one of the males from above and see what happens.

Parents:  
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X^N & X^n & X^N Y & \\
\end{array}
\]

Gametes

\[
\begin{array}{ccc}
X^N & Y & \\
X^N & X^N & X^N Y \\
X^n & X^n & X^n Y \\
\end{array}
\]

In this case the results are these:

Females: All females will be normal; however, one of the females will be a carrier of the gene for colour blindness (X_NX_n).

Males: One male (50%) of the males will be normal and 50% will be colourblind.

**Things to keep in mind about Sex-linked traits:**

1. Sex-linked traits are recessive (Small letters).

2. Sex-linked traits are carried on the X chromosome, normally.

3. If a person has a big allele (N) and a small allele (n), they are a carrier of the trait.
POLYGENIC INHERITANCE

This is the idea that traits are affected by **more than one gene.**

**Result:** A range of phenotypes (i.e. not just short and tall, but some in the middle etc.). This is known as *continuous variation.*

**Continuous Variation:** Variations among individuals in a population where there is a gradient of phenotypes.

- Shortest → short → medium → long → longest

  Note: Either of these phenotypes may occur.

**Examples of Polygenic Inheritance**

- Length of Ear corn
- Human skin colour
- Human height

**Q. How does polygenic inheritance operate?**

**A.** Two genes work at the same time for the same trait. This leads to variations in the expression of the trait.

Example: In corn, the shortest length of corn occurs when the alleles for both genes are homozygous recessive.

In corn, the longest length of corn occurs when the alleles for both genes are homozygous dominant.

All other lengths of corn ears are caused when the alleles are something other than homozygous dominant and/or recessive.

**NOTE:** Polygenic Inheritance is the same as Multiple-gene inheritance.