BIO 1305 – Modern Concepts in Bioscience I – Campbell Textbook
Week of March 21st: Chapters 14 & 15

Hey everybody! This week we’re continuing our discussion of chromosomes, but we’ll be focusing on the basis of inheritance as a biological principle. This will be important to get a hold of now because you will see this again when you take genetics as a sophomore! I’m so proud of all of you guys’ hard work- let’s dive into this week’s resource!! Reminder: I hold weekly group tutoring sessions on Mondays from 6:30-7:30 pm in room 74 in the basement of Sid Rich! Sign up to join the session here: https://baylor.edu/tutoring. I would love to see you there!

Keywords: Chromosomal Inheritance, Linked Genes, Abnormal Chromosomes

**Topic of the Week: Chromosomal Basis of Inheritance**

After Gregor Mendel presented his “gene idea,” many other scientists began investigating his work further. A few scientists developed the **chromosome theory of inheritance**, which states that genes have loci on chromosomes, and the chromosomes separate and independently assort.

**Sex-Linked Genes**

The sex of a species is determined by the presence of **sex chromosomes**. There are two types of sex chromosomes: **X** and **Y**. The **X chromosome** is found in **females** while the **Y chromosome** is found in **males**. These chromosomes exist as a **homologous pair** and separate during meiosis. Therefore, after fertilization, the zygote has a 50% chance of having the X chromosome and a 50% chance of having the Y chromosome.

A **sex-linked gene** is a gene found on either the **X** or **Y** sex chromosome. If a gene is on the **X chromosome**, it is called an **X-linked gene**. Similarly, a gene found on the **Y chromosome** is a **Y-linked gene**.

**Inheritance of X-Linked Genes**

Genes found on the X chromosome exhibit interesting **inheritance patterns**. Here are some significant patterns:

- Fathers pass the trait to all daughters but no sons
- Mothers pass the trait to sons and daughters
- If the trait is recessive, a female will only express the trait if she is homozygous
- Heterozygous and homozygous are terms that do not apply to males since they only have 1 X chromosome

**HIGHLIGHT #1: Linked Genes**

Two genes are “linked” when they are found close together on the same chromosome. Because of their close proximity, they are usually passed to individuals together.

Another concept that is important to understand is the idea of **genetic recombination**. Genetic recombination is how offspring tend to differ from their parents genetically. In the picture below,
you can see how some of the offspring do not inherit the same phenotypes as their parents. These offspring are called the **recombinants**.

Another extremely important source of genetic variation is **crossing over**. This occurs during **prophase in meiosis I**. When the homologous chromosomes are paired, parts of the chromatids break and switch places.

When linked genes were discovered and more was known about recombination, **genetic maps** became a popular way to understand the location of particular genes of chromosomes. A **linkage map** is a type of genetic map that depends on recombination frequencies of certain alleles. The photo on the right is an example of a linkage map.

**HIGHLIGHT #2: Errors in Chromosomes**

**Abnormal Chromosome Number**
Sometimes, the spindle in meiosis makes an **error** and does not properly distribute the chromosomes between the daughter cells. This is called **nondisjunction** and can result in severe consequences. Here are some of the results of nondisjunction that are possible:

- **Aneuploidy**: abnormal number of chromosomes
  - Monosomic: missing chromosome
  - Trisomic: extra chromosome
- **Polyploidy**: abnormal number of sets of chromosomes
  - Triploidy: three sets

All diagrams, tables, and external information is property of Pearson Campbell Biology 11th edition, unless otherwise specified.
Tetraploidy: four sets

Alterations of Chromosome Structure
Sometimes, *damage* can occur to chromosomes. There are four types of damage that can occur:
- **Deletion**: part of the chromosome is lost
- **Duplication**: broken piece becomes attached to a separate chromosome
- **Inversion**: part of the chromosome breaks but reattaches in the opposite orientation
- **Translocation**: a broken fragment attaches to a nonhomologous chromosome

HIGHLIGHT #3: Pedigrees, Genomic Imprinting, and Organelle Genes

Pedigrees
The genetics aspect of biology comes to life in something called a pedigree! A pedigree organizes information about family genetic history in order to show how certain traits or diseases are transmitted. The photo on the right shows how to read pedigrees and understand the symbols.

It is important to understand pedigrees because they provide a lot of insight to how genetic diseases and disorders behave within a family line.

Genomic Imprinting
There are few more important topics to hit in this genetics portion of bio 1. One of these is genomic imprinting. The idea behind genomic imprinting is that when an allele is transmitted to offspring, whether or not the offspring will express the trait depends on if they received the allele from the mom or the dad.

Inheritance of Organelle Genes
One last important topic must be taken into consideration before wrapping this chapter up! We have talked a lot about chromosomes and alleles passed through cell division, but what about the genes that are found in the cytoplasm or in organelles such as chloroplasts or mitochondria? How are these passed to the offspring? The simple answer is: through the cytoplasm of the egg! Because an egg is significantly larger than a sperm, most of the cytoplasm in the zygote comes from the egg, so most of the cytoplasmic genes in a zygote would resultingly be from the egg as well.

CHECK YOUR LEARNING
1. True or false: two X chromosomes pair with each other in a homologous pair.
2. In what phase does crossing over occur?

THINGS YOU MAY STRUGGLE WITH
1. Sex-linked genes are not called “linked” genes because they are close in proximity. The term “sex-linked genes” just refers to the fact that you can find them on the sex chromosomes.
2. A male cannot be heterozygous or homozygous for a gene that is found on the Y chromosome. This is because they also have one X chromosome!

Answers:
1. False; one X and one Y chromosome pair together in a homologous pair.
2. Prophase I (of meiosis I)