Cells and Heredity

Chapter 5: Human Genetics and Genetic Technology

8th Grade

Lesson 1 (Human Inheritance)

Human Inheritance:

1. Many human traits are controlled by a **single gene with two alleles**. (one dominant and one recessive allele)
   - – This results in two different phenotypes (appearances).
   - ***Examples:*** widow's peak, dimpled chin
2. Some human traits are controlled by a **single gene that has several alleles**. (multiple alleles)
   - **multiple alleles –** three or more forms of a gene that code for a trait
   - – A person can carry only two of the alleles because chromosomes are in pairs and each chromosome carries only one allele for each gene.
   - ***Example:*** blood type (there are more than 2 blood types)

3. Some human traits are controlled by **multiple genes** (more than one gene works together to determine the trait).
   - ***Examples:*** height, skin color
4. Some human traits are controlled on the **sex chromosomes**.

Sex chromosomes – a pair of chromosomes that carry genes that determine male or female
- – They also carry other genes for other traits.
- – They are the only chromosome pair that do not always match. (in females they do)

females – have two X chromosomes

males – have an X chromosome and a Y chromosome (Y is much smaller than an X chromosome.)

Sex-linked gene – a gene that is carried on the X or Y chromosome
- – The resulting traits are called **sex-linked traits**.

Example: Colorblindness

Colorblindness – a recessive trait controlled by a gene on the X chromosome
- – Affects males more than females.

Carrier – a person who has one recessive allele for a trait, but does not have the trait
- – The recessive allele can still be passed on to the child.

Lesson 2 (Human Genetic Disorders)

Genetic disorder – an abnormal condition that a person inherits through genes on chromosomes
- – Some disorders are caused by mutations in the DNA.
- – Some are caused by changes in the overall number of chromosomes in the cells. (mistakes made during sex cell production)

Cystic Fibrosis – genetic disorder in which the body produces unusually thick mucus in the lungs and intestines
- – Affected people have difficulties breathing.
- – Caused by a recessive disorder on one chromosome with a mutation in which 3 bases are removed from the DNA of that chromosome.

Sickle-cell anemia – a genetic disorder in which a person's red blood cells are odd-shaped
- – Sickle cells can't carry as much oxygen as normal red blood cells and can get stuck in the capillaries.
- – The allele for this trait is codominant. (neither dominant nor recessive)
- – A person with two sickle-cell alleles will have all abnormal red blood cells and has the disease.
- – A person with one sickle-cell allele will produce both normal and abnormal red blood cells and is usually fine. (He/she has what is called **sickle-cell trait**.)

Hemophilia – a genetic disorder in which a person's blood clots very slowly or not at all when they are cut

- A protein needed for clotting of the blood is not being produced.
- Caused by a recessive allele on the X chromosome.

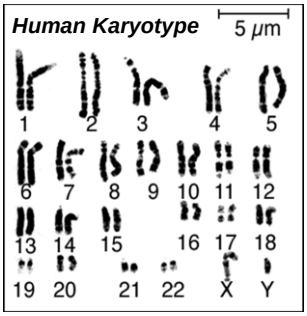
(a sex-linked trait that affect males more than females)

Down syndrome – a genetic disorder caused by an extra chromosome on the 21st pair of chromosomes

- Caused by a mistake during meiosis when the chromosomes separate.
- Results in various degrees of mental disabilities.
- Heart defects (problems) are also common.

Karyotype – a picture of all the chromosomes in a cell, arranged in pairs

- Doctors can use karyotypes to help find a problem.



Pedigree – a chart that shows the history of a trait from one generation to the next

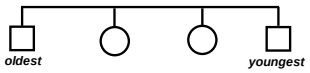
males = ☐ **females =** ○

members with the trait are shaded ■ **or** ●

members that carry (have) the allele, but don't show the trait

◧ **or** ◐

Children are shown in order from oldest to youngest.



Genetic counselor – a professional that helps couples with family histories of genetic disorders determine the chances of their child having the disorder

- They use karyotypes, pedigrees, and Punnett squares to help make predictions.

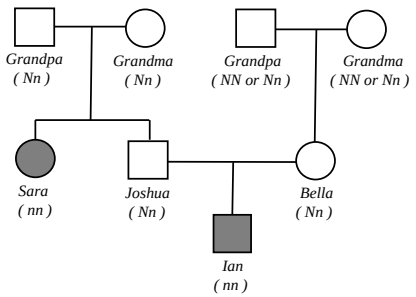
Joshua and Bella want to know the probability that any future children they have might inherit cystic fibrosis like their son Ian. Cystic fibrosis is inherited through a recessive allele.

- Ian has been diagnosed with cystic fibrosis.
- Joshua and Bella are both healthy.
- Bella's parents are both healthy.
- Joshua's parents are both healthy.
- Joshua's sister, Sara, has cystic fibrosis.

Draw a pedigree that shows all the family members.

Write each person's name on your pedigree.

Write each person's genotype below their name.



If Bella's father's genotype is ***NN***, does that allow you to determine her mother's genotype?

What is the probability that Joshua and Bella will have another child with cystic fibrosis?

What is the probability that they will have a healthy child?

Lesson 3 (Advances in Genetics)

Selective breeding – selecting organisms with desired traits to be parents of the next generation

Types of Selective Breeding:

1. **Inbreeding** – selective breeding in which 2 individuals with identical or similar sets of alleles are crossed (Inbred organisms are genetically very similar.)
2. **Hybridization** – selective breeding where 2 genetically different organisms are crossed (common in seed corn producers)
   - Hybridization is done to get the best traits from both parents.

Clone – an organism that has exactly the same genes as the organism it cam from.

Genetic engineering – genes from one organism are transferred into the DNA of another organism

- Often used to produce medicines (such as insulin)
- Often used to improve food crops (to resist insects or produce better)
- Human genes have been inserted into cows to produce blood-clotting proteins for hemophiliacs. (passed on in the cows milk)

Gene therapy – inserting "good" genes into a person with a genetic disorder to try to correct their problem

Lesson 4 (Using Genetic Information)

Genome – all the DNA in one cell of an organism

The Human Genome Project – scientists worked to identify the entire DNA sequence of every gene in the human cell

What they have found so far:

- There are at least 30,000 genes in the DNA of the human cell.
- The average gene has about 3,000 base pairs.
- We now know what gene(s) control traits in humans and what chromosome those genes are on.

DNA fingerprinting – a technique used to identify people or show if two people are related

- The DNA from a person is broken into fragments.
- A fragment is selected and the pattern of genes is noted.
- Just like your fingerprint is like no other, that fragment will be like no other person's.