# Offspring acquire genes from parents by inheriting chromosomes

- The transmission of traits from one generation to the next is called **heredity** or inheritance.
- However, offspring differ somewhat from parents and siblings, demonstrating **variation**.
- **Genetics** is the study of heredity and variation.
- Parents pass along to their offspring coded information in the form of genes.
    - Your ***genome*** is derived from the thousands of genes that you inherited from your mother and your father.
- Genes program specific traits that emerge as we develop from fertilized eggs into adults.
    - Your genome may include a gene for freckles, which you inherited from your mother.
- Genes are segments of DNA.
- Genetic information is transmitted as specific sequences of the four deoxyribonucleotides in DNA. *(WHAT ARE THEY??)*
    - This is analogous to the symbolic information of letters in which words and sentences are translated into mental images.
    - Cells translate genetic "sentences" into freckles and other features with no resemblance to genes.
- Most genes program cells to synthesize specific enzymes and other proteins that produce an organism's inherited traits.
- The transmission of hereditary traits has its molecular basis in the precise replication of DNA.
    - This produces copies of genes that can be passed from parents to offspring.
- In plants and animals, sperm and ova (unfertilized eggs) transmit genes from one generation to the next.
- After fertilization (fusion) of a sperm cell with an ovum, genes from both parents are present in the nucleus of the fertilized egg.
- Almost all of the DNA in a eukaryotic cells is subdivided into chromosomes in the nucleus.
    - Tiny amounts of DNA are found in mitochondria and chloroplasts.
- Every living species has a characteristic number of chromosomes.
    - Humans have 46 in almost all of their cells.
- Each chromosome consists of a single DNA molecule in association with various proteins.
- Each chromosome has hundreds or thousands of genes, each at a specific location, it's **locus**.

## Fertilization and meiosis alternate in sexual life cycles

- In humans, each **somatic cell** (all cells other than sperm or ovum) has 46 chromosomes.
    - Each chromosome can be distinguished by its size, position of the centromere, and by pattern of staining with certain dyes.
- A **karyotype** display of the 46 chromosomes shows 23 pairs of chromosomes, each pair with the same length, centromere position, and staining pattern.
- These **homologous chromosome** pairs carry genes that control the same inherited characteristics.
- An exception to the rule of homologous chromosomes is found in the **sex chromosomes**, the X and the Y.
- The pattern of inheritance of these chromosomes determine an individual's sex.
    - Human females have a homologous pair of X chromosomes (XX).
    - Human males have an X and a Y chromosome (XY).
- Because only small parts of these have the same genes, most of their genes have no counterpart on the other chromosome (non-homologous).
- The other 22 pairs are called **autosomes**.
- The occurrence of homologous pairs of chromosomes is a consequence of sexual reproduction.
- We inherit one chromosome of each homologous pair from each parent.
    - The 46 chromosomes in a somatic cell can be viewed as two sets of 23, a maternal set and a paternal set.
- Sperm cells or ova (**gametes**) have only <u>one set</u> of chromosomes - 22 autosomes and an X or a Y.
- A cell with a single chromosome set is **haploid**.
    - For humans, the haploid number of chromosomes is 23 (n = 23).
- When an egg and sperm cell unite, the cells fuse (**syngamy**) resulting in fertilization
- The fertilized egg (**zygote**) now has two haploid sets of chromosomes bearing genes from the maternal and paternal family lines.
- The zygote and all cells with two sets of chromosomes are **diploid cells**.
    - For humans, the diploid number of chromosomes is 46 (2n = 46).

- As an organism develops from a zygote to a sexually mature adult, the zygote's genes are passed on to all somatic cells by ***mitosis.***
- Gametes, which develop in the gonads (ovaries and testes), *are not produced by mitosis.*
    - If gametes were produced by mitosis, the fusion of gametes would produce offspring with four sets of chromosomes after one generation, eight after a second and so on.
- Instead, gametes undergo the process of **meiosis** in which the chromosome number is halved.
    - Human sperm or ova have a haploid set of 23 different chromosomes, **one from each homologous pair**.
- Fertilization restores the diploid condition by combining two haploid sets of chromosomes.
- Fertilization and meiosis alternate in sexual life cycles.
- The timing of meiosis and fertilization does vary among species.
- The life cycle of humans and other animals is typical of one major type.
    - Gametes, produced by meiosis, are the only haploid cells.
    - Gametes undergo no divisions themselves, but fuse to form a diploid zygote that divides by mitosis to produce a multicellular organism.