

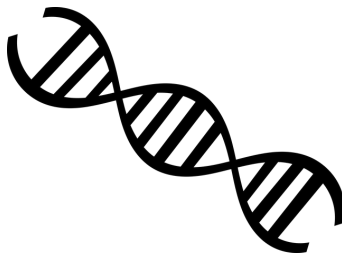
A3. Describe, in general terms, the role of genetic materials in the continuity and variation of species characteristics; and investigate and interpret related technologies

A 3.1 describe, in general terms, the role and relationship of chromosomes, genes and DNA

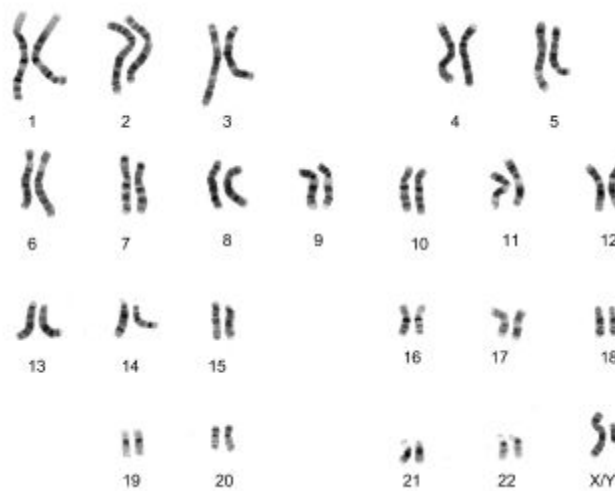
Chromosomes, Genes and DNA

Deoxyribonucleic acid (DNA) is found in the nucleus of cells. Watson and Crick revealed the structure of DNA and explained that it is the chemical building blocks that carries a wide range of instructions responsible for the diversity of traits.

DNA is a spiral-shaped, double-helix molecule made of **nucleotides**. Each nucleotide contains deoxyribose sugar, phosphate, and four types of nitrogen bases called guanine, cytosine, adenine, and thiamine. The arrangement of these bases forms a code that cells can be read. Millions of combinations are possible.



Chromosomes are packages of DNA. In plant and animal cells, the chromosomes are present inside the nucleus. Every organism has a specific number of chromosomes, and they usually come in pairs. Each human cell contains 46 chromosomes. All the cells of the human body, except the gametes, have a complete set of 23 pairs of chromosomes. Dogs have 78 chromosomes on each cell. Cats have 38 chromosomes in each cell.



The 23 chromosomes of a male human

Genes are the portions of an organism's DNA that carry genetic information and are responsible for the inheritance of an organism's traits. Genes and the traits that they produce are passed from the parent to the offspring.

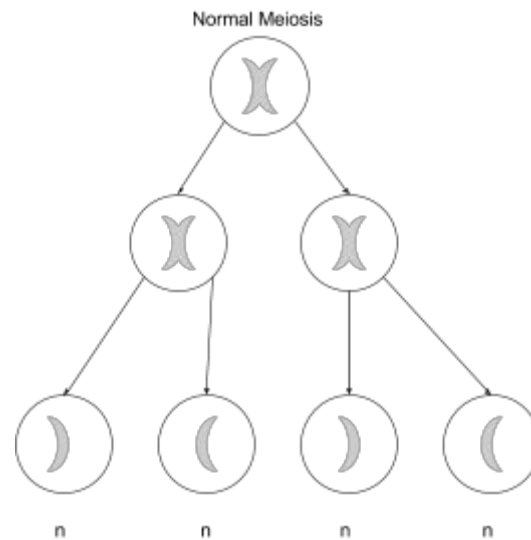
Genes are located on Chromosomes. Like chromosomes, genes also exist in pairs called alleles. **Alleles** are responsible for expressing variations or characteristics. Alleles that are dominant are able to express themselves. Alleles that are recessive are unable to express themselves, and the characteristic trait does not appear.

A.3.2 distinguish between cell division that leads to identical daughter cells, as in binary fission and mitosis, and cell division that leads to formation of sex cells, as in meiosis; and describe, in general terms, the synthesis of genetic materials that takes place during fertilization [Note: At this level, students should understand that the formation of sex cells involves the halving of the parent cell's genetic materials and that this process leads to zygote formation. Opportunity for further study of the specific stages of cell division will be provided in senior high school courses (e.g., prophase, metaphase, anaphase, telophase).]

Cell Division

The multiplication of the somatic (body) cells takes place by cell division called **mitosis**. Mitosis begins with a cell duplicating all its contents (including the Chromosomes). Then, half the content are pulled to each side of the cell. Mitosis is complete when a membrane forms in the middle and results in the production of two new cells with the same number of chromosomes. Mitosis is responsible for growth and repair in multicellular organisms.

Meiosis is the type of cell division that takes place in the formation of gametes (egg and sperm). Just as with mitosis, the cell duplicates its chromosomes.. However, in meiosis, the cell divides twice. This results in cells (gametes) that have half the chromosome number of the original cell.



When a male sperm cell and female egg cell unite to form a zygote, the chromosome number is restored.

A3.3 compare sexual and asexual reproduction, in terms of the advantages and disadvantages (e.g., recognize that asexual reproduction provides an efficient means of transmitting characteristics and that sexual reproduction provides an opportunity for recombination of characteristics)

Comparing Asexual and Sexual Reproduction

Asexual reproduction results in the formation of a large number of cells very quickly. A single bacterial cell can reproduce asexually every 20 minutes. At this rate of division, it is possible to have over 1 million bacteria produced in a seven-hour period. This is an advantage of asexual reproduction: in a short span of time, innumerable new cells are produced. However, asexual reproduction can be disadvantageous. Entire populations of a species may be destroyed if the conditions are not suitable for survival. For example millions of bacteria can be destroyed by administering antibiotics.

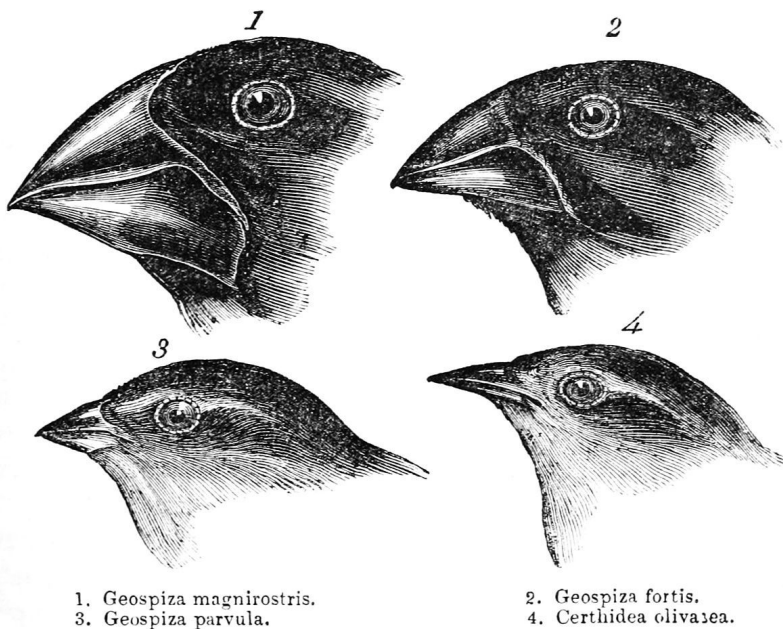
Sexual reproduction involves two parents. The offspring receive characteristics from each parent. A lot of variation can exist as a result of the recombination of genes, and these variations are useful for survival during unfavourable conditions. The major disadvantage of sexual reproduction is that it takes a lot of time and consumes a lot of energy. When humans reproduce, the fertilization process must occur, and then the embryo needs nine months to grow and develop inside the mother. The amount of time and energy this takes limits the number of offspring that are produced.

A3.4 distinguish between, and identify examples of, natural and artificial selection (e.g., evolution of beak shapes in birds, development of high milk production in dairy cows)

Natural and Artificial Selection

If a species lives in a changing environment, the individuals often exhibit a great deal of variation among themselves in order to adapt to the changes. Survival of a species is affected by certain changes like the spread of disease, the presence of predators, or the scarcity of food resources. The species that exhibits some variation will be more likely to adapt to the new environment and will have a better chance of surviving.

Natural selection is a process in which the environment helps the species to survive. It is a process in nature that results in the fittest organism producing offspring. The species that is able to adapt by showing variability in traits becomes the fittest. Nature selects this individual to produce new offspring. Other individuals either perish or migrate. The Galapagos Island finches represent one of the most well-known examples of natural selection. There is an extremely diverse range of 13 different finch species on the island. The primary difference observed among the different finch species of variation in their beak shape. Each species has a beak shape that is uniquely adapted to the particular food resource it eats. After studying the finch population on the island Charles Darwin concluded that the beak structure changed over time by natural selection as each finch species adapted to its environment .



Artificial selection is the process in which the individuals with the most suitable traits are selected artificially (by humans not by nature) and are allowed to produce offspring. For example certain cows produce only small amounts of milk, whereas others produce large amounts of milk. A farmer who wants cows that produce a lot of milk would only allow those cows that produce large amounts of milk to breed. The result is offspring that are good milk producers.

In artificial selection, the intervention of humans ensures that only individuals with more desirable traits produce offspring.

A3.5 describe, in simple terms, some genetic technologies (e.g., cloning and genetic engineering); and identify questions and issues related to their application

A4.4 investigate and describe the use of biotechnology in environmental, agricultural or forest management; and identify potential impacts and issues (e.g., investigate issues related to the development of patented crop varieties and varieties that require extensive chemical treatments; identify issues related to selective breeding in game farming and in the rearing of fish stocks)

Genetic Technologies

Artificial selection in plants and animals has led to some new technologies. Some of these technologies include cloning, artificial reproductive technology and genetic engineering.

A **clone** is an exact copy of something. It can be a copy of a single gene, a cell, or an entire organism. Scientists often create plant clones. To do this, the cells from a plant with a particular trait are removed and are placed in the nutrients and hormones required by those cells for growth. These cells will develop into seedlings and are transplanted in soil. New plants develop in a short span of time.

Artificial reproductive technology refers to artificial methods of fusing male and female gametes. In artificial insemination, the sperm of a male animal with a desired trait are inserted into many female animals of the same species. The female gives birth to the offspring with the desirable traits. The advantage of this is that the desirable traits from the male are passed down to many offspring.

Genetic engineering is the technology of altering the DNA of an organism. For example, bacteria can be genetically engineered to produce life-saving insulin to control diabetes. Through genetic engineering, pest resistant crops can be created, thereby reducing the use of pesticides. This could be beneficial to the environment by preventing the excessive use of pesticides.

Development of these technologies allows desirable traits to be passed on to future generations of offspring. However, these technologies reduce genetic variation. This makes the population more susceptible to being wiped out by a disease or changes in the environment.