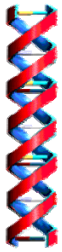


Topic 5 - When Plans Change

DNA: The Secret of Life <http://www.dnai.org/index.htm>

The blueprint that is passed on from the parents to the offspring is found in a molecule of the cell nuclei. This molecule, *deoxyribonucleic acid*, (DNA) is the inherited material responsible for variation. All living organisms contain DNA in their cells. DNA was discovered prior to 1944, by Swedish chemist Johann Miescher (1886). This simple substance is able to carry out all of the functions of genetic material, reproducing itself, moving from parent to offspring and controlling structures and functions of cells. DNA contains all the instructions, which create the organism's characteristics. The multitude of characteristics for each organism means that there is a lot of DNA in any one cell. This DNA is arranged in the cell in compact packages, called **chromosomes**.

The Structure of DNA <http://www.dnafb.org/dnafb/15/concept/>



All DNA molecules contain exactly the same chemicals, but the way the chemicals combine determines the characteristics of the organism. **James Watson and Francis Crick** unraveled the structure of DNA in 1953, revealing the key to the multitude combinations of variation that are possible.

The DNA molecule is like a ladder twisted into a spiral (see image). The sides of the ladder are the same in all DNA molecules, but the rungs are what make the variations.

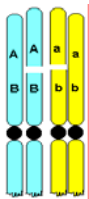
Each rung pairs up two of the following chemicals: **guanine (G)**, **cystosine (C)**, **adenine (A)** and **thiamine (T)**. The arrangement of these four chemicals creates the code that the cells are able to interpret. This is the **genetic code** of the organism.

The Genetic Code

Characteristics are passed on from one generation to another within a species through the **genetic code** of the parents. This genetic code is a unique sequence in each individual that provides the **blueprint** for each individual organism. Protein molecules make up much of the structure of cells and tissues in plants and animals. A section of the DNA molecule for a specific protein is called a **gene**.

The Dance of the Chromosomes







All human cells contain 46 chromosomes. In order to have a complete human organism, all 46 of the chromosomes must be present. Not all organisms have the same number of chromosomes (Dogs have 78, cats have 38). Every cell of a human contains 23 pairs of chromosomes (dogs 39, cats 19). Not all of the chromosomes from species to species are the same, which accounts for the different characteristics between the species. A single gene is an uninterrupted segment of DNA, which contains the coded instructions for the organism.



Genes are located in the **chromosomes** and come in pairs. Each chromosome has numerous gene locations. Both genes in a pair carry DNA instructions for the same thing. Specific characteristic genes occupy matching locations on the two chromosomes. DNA code may not be exactly the same in both locations. Offspring inherit genes from both parents. The genes exist in an array of possible forms that differ as to their exact DNA sequence. These variations in forms are called **alleles**. The ultimate combination of the chromosome pair is what makes the variation possible - combining the different variations of different characteristics to create a unique variation.

Normal Cell Replacement

Different human cells (somatic cells) have different life spans.

	Brain cells	30-50 years
	Red blood cells	120 days
	Stomach lining cells	2 days
	Liver cells	200 days
	Intestine lining cells	3 days
	Skin cells	20 days

Replication of the contents of each cell occurs and then. When the cell divides, the process of Mitosis ensures each cell ends up with a complete set of chromosomes, identical to each other and identical to the original cell.

Sex Cells and Genetic Variation

The sex cells are called **gametes**. Male gametes are **sperm cells** and female gametes are **egg cells**. **Meiosis**, the process of forming gametes occurs in the same way as somatic cells. Meiosis is a type of cell division that produces cells with only half the DNA of a normal cell. This process involves two cell divisions, not one. Each sperm cell and egg cell contains 23 chromosomes.

Tutorial: http://www.biology.arizona.edu/cell_bio/tutorials/meiosis/page3.html



When an egg cell is fertilized by a sperm cell a **zygote** is formed, which has a complete set of 46 chromosomes – 23 from the sperm cell and 23 from the egg cell. When the zygote grows and develops it becomes an **embryo** and then becomes a human at birth. This type of sexual reproduction increases variation within a species. In multi-cellular organisms the process that produces two new cells with the same number of chromosomes is called **Mitosis**. http://www.sci.sdsu.edu/multimedia/mitosis/mitosis_gif1.html

The Benefits of Variation

Life is relatively short and to ensure that a species will survive, reproduction must occur. Asexual reproduction produce identical members of the same species, so there is good chance that some will survive to reproduce and continue the cycle of life. Sexual reproduction produces variation

Technology and Variation

Moving pieces of one strand of DNA to other cells is a relatively new technique that has emerged. In the science of genetics, genetic engineering has enabled scientists to create individuals within a species with desirable traits. Biotechnologies are beginning to become controversial, now that the genetic code for many species has been unraveled. The question remains – Are we 'tampering too much with nature'? The debate rages on!

Biotechnology in Medicine

One of the first uses of modern biotechnology was to move the human gene for **insulin** into bacteria. By doing this, bacteria were able to produce large quantities of insulin in a relatively short time, as a waste product, which then was collected and used by diabetes patients. Bacteria are not the answer to everything, but they have motivated scientists to think about other more complex possibilities. Genetically modified, or transgenic, mammals are produced by adding human genes to the fertilized eggs of the mammal. Offspring that develop grow up with the human gene that can produce complex proteins, collected in the milk produced, purified and then used in the treatment of many human conditions, including iron deficiency, emphysema, hemophilia and blood clotting.

Biotechnology in Food Production

Genetic engineering has become an important technique for producing food, such as fish. **Aquaculture** is becoming an increasingly important method of fish farming mass production. Disease resistance genes, growth hormones and even antifreeze genes enable fish farmers to increase their yield with less chance of disease, in a shorter amount of time, and at all times of the year. But what happens if these 'special' fish make it out into the natural fish population? Will the natural populations of fish be able to compete with them?

A Cost-Effective Crop

Most genetically engineered crops in Canada are altered for specific reasons – to lower costs, decrease pest problems, and to improve yields. The monoculture that is produced as a result has its own problems. A single event or pest can wipe out an entire crop. And, what about genetically engineered food you see in the supermarket – would you buy it?

Purebred VS Hybrid

To produce purebred organisms, a breeder would choose pure bred parents, those parents whose ancestors have produced only the desired characteristic they want (**true-breeding**). If a breeder chooses two different 'true-breeds' then a **hybrid** would be produced.

Dominant Traits

Crossbreeding two different true-breeds will result in all of the offspring having the same characteristic, that is, the **dominant trait**. Only the DNA instructions for the dominant trait will be carried out.

Recessive Traits

When crossbreeding hybrids, the average results will produce 75% of the offspring with the dominant trait and 25% of the offspring with the recessive trait, because there are only 4 possible combinations. One trait is recessive and therefore the allele is recessive. A recessive trait only appears in the offspring if two recessive alleles are inherited.



Punnett Squares

<http://www.mansfieldct.org/schools/mms/staff/hand/genpunnettsquares.htm>

<http://library.thinkquest.org/20830/Textbook/Genetics.htm#Punnett%20Squares>

Incomplete dominance occurs because the dominant-recessive pattern does not always prevail. When the alleles are neither dominant, nor recessive, an intermediate trait will occur (combining the two traits).

Offspring Unlike Either Parent.

More than one gene location and more than one allele may be responsible for specific traits. As a result, the complex mixing of the possible combinations for that particular trait may account for the variation of traits an offspring has.

Bonus Material: **Biological Diversity Classification**

The two-name Latin naming system for all living things was developed by Carolus Linnaeus in the 18th century, enabling scientists, around the world, to refer to the same species, by the same name. This classification system was much more reliable than previous systems, because he used structure, rather than habitat. Two words identify each organism. The 1st represents the organism's **genus** and the 2nd represents the organism's particular **species**.

Scientists earlier had developed a system, which classifies all organisms, based on their structural differences, into 5 kingdoms.

- **Animalia** (animals)
- **Plantae** (plants)
- **Fungi** (yeasts, moulds and mushrooms)
- **Protista** (mostly single-celled organisms)
- **Monera** (*bacteria*)

The 5 kingdom classification system can be further subdivided, with each sub-division having its own name.

Kingdom phylum class order family genus species

Specialists refer to other sub-divisions as well, such as; subfamilies, super-orders, and sub-species or varieties.

<http://www.ruf.rice.edu/~bioslabs/studies/invertebrates/kingdoms.html>