1. Giant Molecules Of Life

There are four groups and three of these correspond to the three food groups: **carbohydrates**, **fats** and **proteins**, while the fourth to the genetic material **DNA**.

The carbohydrate group contains two subgroups, **sugars** and **fibres**.
Ordinary sugars are built from two possible basic molecules, **glucose** and **fructose**, both of which have the same formula, $C_6H_{12}O_6$, but the atoms are arranged differently.
Each food like carrot, malt, milk have different compounds from these.
Manufactured kitchen sugar is a compound of one glucose and one fructose molecule.
Inside the cells, there is an other energy transforming sugar, the **ribose** $C_5H_{10}O_5$.
A variant of this by taking away one oxygen is the **deoxy-ribose** $C_5H_{10}O_4$, which will be vital for other reasons than energy source.
The fibres are also built from glucose, though they don't taste sweet.
Here, there are again two subgroups, because the glucose can be combined repeatedly or alternatively. In the first case the chain is bending into spiral shape and this is what we call **starch**, while in the second case, the chain is straight and the molecule is called **cellulose**. The first is contained in wheat, potato, rice and so on, while the second in stem of plants, grass, wood and even paper.
Humans can only break down starch while cows eat mostly cellulose from grass.

The fats or **lipids** are mainly built as chains of carbon and hydrogen atoms, so we might wonder why they are not in the carbohydrates. But "hydrates" refer to HO water roots not to hydrogen alone. Here, at fats the oxygens are all located at one end of the chain. These ends can face each other and thus fats form bubbles or films that repel water and thus, won't be dissolved by it, unlike sugars. So these are important as the materials for cell walls. Also, as energy source, they are twice as efficient as carbohydrates but slower to obtain. That's why for fast energy we eat sugar, but if its always available in our blood then the fat will not be used, so we'll get overweight.

Proteins are the most important of the three groups, because our body itself is mainly made of this. But a second type of proteins, the **enzymes** are agents that help to build other proteins. These of course, are built by other enzymes so we have a whole sequence of buildups. Amazingly, in spite of this complicated system, all proteins in our bodies are made of twenty fundamental **amino acids**. Since a protein can have a hundred of these combined, the variation is still $20 \times 20 \times \ldots \times 20 = 20^{100}$ thus, enormously big.
The food we eat is broken down and then rebuilt. At carbohydrates and fats, it meant simply breaking down the long chains. Here it is more exact, because we reduce all consumed proteins to the twenty amino acids. This also means that if we don't get one of those , we won't be able to rebuild our own proteins. Meat contains all of them, but if we are vegetarians, we have to be careful to get all amino acids from plants.

The abbreviation DNA, means deoxy-ribo-nucleic acid. The word "nucleic" refers to the nucleus of the cells because that's where DNA can be found. The deoxy-ribo refers to the above mentioned deoxy-ribose sugar molecule. Similar molecules as the DNA are built with ribose molecules and these are called ribo-nucleic acid or RNA. These are just as important as the DNA. The deoxy-ribose or ribose sugar molecules are attached to a phosphate group, containing one phosphorus and four oxygen atoms. The alternating phosphate and sugar groups can form extremely long chains. Yet the crucial part is a third group that connects to each sugar and sticks out of the chain. This so called **base** group can be five different kinds. Three of them are common in both DNA and RNA. Namely:
A = **adenine** , C = **cytosine** , G = **guanine**
The fourth T = **thymine** is only in DNA, while the fifth U = **uracil** is only in RNA.
The fundamental law of the five bases is the following:

C and G can connect to each other, while A can connect to U or T.

Such connections will not happen between different bases of a single chain, rather only with an other chain. Two DNA chains for example, can now appear like two spirals with the C – G and A – T connections inward, like steps on a ladder staircase. This further strengthens the whole double molecule. This double spiral has been also dubbed as the double helix.

The inward connections can easily open up like a zipper. This has two purposes:

One is duplication, the other is information.

If a DNA zipper opens up, then gradually both chains will pick up the missing other half of the sugar-phosphate-base groups and those combine into a new chain, a perfect copy of the lost one. Thus, one double helix becomes two.

On the other hand, the DNA helix can open up in the middle too like a faulty zipper. Then this is only temporary and C – G , G – C , T – A , A – U connections will be formed. Thus, instead of a new DNA, an RNA is formed. This leaves and the DNA can close back. The leaving RNA is called messenger RNA, because it carries the exact sequence of the DNA. Of course, C is carried as G and vice versa, while T is carried as A and A as U.

Both the duplication and information reveal the vital role that DNA plays in life. It is the genetic material given to the offspring and then in each cell, it organizes the rebuilding of materials. It was known that most of these materials of living things are the proteins and they are all combined form the twenty amino acids, thus it seemed logical that the information blocks of the DNA and RNA, that is the bases must relate to the amino acids. A single base of course, can not identify an amino acid, in fact, even two were insufficient because $4 \times 4 = 16$ only. On the other hand, three is plenty because $4 \times 4 \times 4 = 64$.

Indeed, every triplet of A , C , G , T or A , C , G , U will correspond to an amino acid. But many different triplets will be coding the same amino acids and this redundancy is probably a safe guard for exact translation. This actual triplet coding for the twenty amino acids was completely solved soon after the discovery of DNA by Watson and Crick. The absolutely amazing and most fundamental fact is that this coding of the twenty amino acids is the same for every single living organism on the earth, from the simplest bacteria to humans! In other words, all living things use the same code for inheritance and buildup. This doesn't mean that all species have the same sequences of codes. The short sequences are obviously similar because they merely list all the amino acids that are needed for one particular protein. The longer sequences of such are the order in which the proteins should be built up and these are different for each specie. To know the order for a particular specie, can help to find the individual differences and eventually to cure genetic, that is inherited illnesses. The complete mapping of the sequences for the human race only finished in the last decade of the 20^{th} century.

2.) Genetics

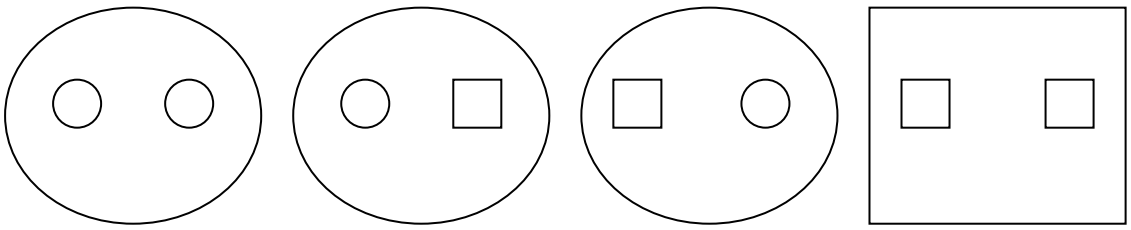
From breeding to evolution

It was obvious from the breeding of dogs, that we can obtain sub-species by simply selecting individuals with certain features. The offspring usually inherit the same feature in some degree and then, we can again select among them, and thus, accumulate or increase the wanted feature. The idea that such selection is happening by nature on its own, only came very late by Darwin. The reason for this ignorance is the same as the mistakes in physics by ancient thinkers that were officialized by Aristotle. People relied on their senses and didn't use their fantasy to imagine what our senses ignore. Best example is the falling of bodies. Our eyes can not see the exact speeds, so we think the simplest scenario, namely that the bodies fall with a fix speed. Amazingly, a simple logic show that this must be wrong. Indeed, a stone falling from higher will make a bigger impact in the sand, than from lower. If the speed were fix, then the travel before the lower height wouldn't change the rest of the fall. It was only Galileo who first actually measured the increasing speeds of the falling bodies. Today, special cameras can actually show this. The same way the continuing generations of animals seem unchanging but under millions of years, they do change. If the sharper toothed tigers have only a tiny advantage in their survival, and breeding opportunities, then through the millions of years, this explains

the perfectly sharp teeth. Similarly, the accidentally longer necked giraffes became the better survivors and thus, gradually lengthening the neck of all giraffes.
The big mistake before Darwin, was to make connection between the useful features and the actions of the animals. For example, it seemed "logical" that the giraffe's reaching up to the trees somehow increases the neck of the offspring. On the other hand, everybody knew that an injury on a body doesn't get inherited. So the half correct idea emerged that body changes can be inherited only in the long run. Even long after Darwin, some scientists were raising generations of rats, cut off their tails and tried to show that the tail lengths will decrease. The soviet "biologist" Michurin also failed when tried to freeze the seeds to be more adapted to Siberia.
By the way, Darwin never claimed that the natural selection is the only way a specie can change. He merely wanted to show that this explains many of the changes. The body features like the tooth of tigers, and the neck of giraffes are obvious results from natural selection. Complex behaviors like the nest building or using a stone to break an egg, are hard to imagine to be selected by nature. After all, what could have been the original behavior that turned into these? A nest is only useful if it is perfect. So a bad nest building or random gathering of twigs couldn't be bettered because it didn't give an advantage in survival. Similarly, throwing stones unsuccessfully couldn't become the persistent effort to break an egg. Even some body appearance are ambiguous. Some animals became colored melting into the forest which is logical for survival, but some became colorful to draw attention from the other sex. So which tendency is selected in the end? And of course about the biggest mystery, the human intelligence, just to say that it evolved by natural selection is an empty formalism. If other phony elements are mixed in like walking on foot, hunting in groups, or communication, that's an even worse metaphysics. To solve something, one first has to describe that something beyond its naïve appearance. With human intelligence, we couldn't even do that yet. So Darwinism, or evolution in general, is the most abused concept in new science, which doesn't decrease its truth.
The seemingly final seal of proof for Darwinism came through the discovery of DNA, that we mentioned before. Indeed, if DNA regulates the building of proteins and only DNA is inherited, then the old pre-Darwinian idea of inheriting body changes or learnt abilities is completely impossible. On the other hand, the DNA coding system raised a strange new question about evolution itself, namely how did such coding system evolve at all. We have no idea about this! Even more importantly even if we accept that it evolved somehow, then the identity of this coding for all living things on earth means that they all evolved on a single line. If we had different species with different DNAs, it would support their evolution.
The single coding system leaves some doubts about evolution. Most amazingly though, it raises a new twist for space exploration! Indeed, if we'll find any living organism in the solar system (or maybe somewhere else later) and it has the same DNA coding as we, then this system couldn't have evolved on earth, so life was either brought here or is determined by non evolutionary causes.

Naïve Genetics

Mendel, a priest experimented with plants and discovered some strange laws.
The first thing he separated were the features that are mixable from the ones that remain fixed. For example, the colors of certain flowers, can become pink from red and white parents, thus it is a mixable property. On the other hand, the color (green or yellow) or shape (round or squared) of peas will never mix. The first fact was that two squared pea always breeds to squared ones, while round ones can produce squared ones too. Thus, it seems logical that the roundness is caused by some material that can come from each parent. If none of the parents had it, then of course, it must be missing in the offspring too. In short, we have roundness and squaredness as so called **genotypes** hidden as the information from the parents, but also as **phenotypes**, that is as appearance itself. Then we have only four possible combinations:



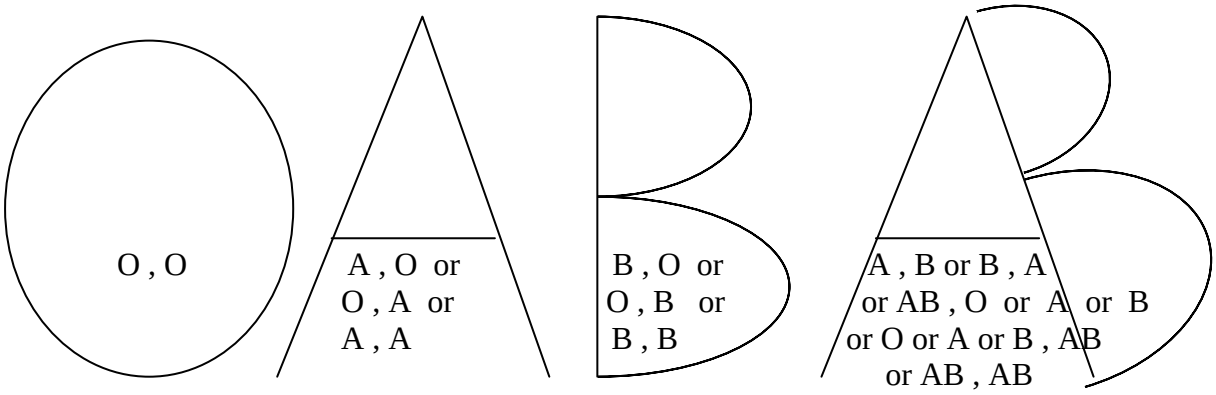
round pea with hidden inherited round features

round pea with hidden inherited round feature from the father, square from the mother

round pea with hidden inherited square feature from the father, round from the mother

square pea with hidden inherited square features only

The mathematically possible combinations of square outside appearance with any round inherited feature inside are not possible, biologically. This can be expressed by saying that the roundness is **dominating** the squaredness, so one parent's round inheritance is enough to cause round appearance. An other way is to say, that the round peas can carry the hidden squaredness from one parent.
A best example of how dominant and mixing features can work at the same time is the human blood type. A and B are certain materials in the blood. So 0 means the non existence of either, A means the appearance of only A in the blood, B only B, and AB means both. Thus, the possible appearance and inheritance combinations are:



The human eye being brown or colored inherits exactly as the peas being round or squared.
The brown dominates the color. Thus colored eye people don't carry the browning agent. So two parents with colored eyes can only have colored eye children. but brown eyed parents can have colored eye children.
A pure bred is a population that not only appears with the same features, but carries only those inner features too. To achieve this is hard and yet the Asian population today can be regarded as a pure bred for the brown eye color.

3. Chromosomes

With the use of microscopes, the nucleus of cells was examined and showed strings that could be colored by ink and thus, became called chromosomes (chromo = color). It turned out that these carry the genes. Different species have different number of chromosomes. Most amazingly, the different sexes have also different shaped chromosomes. At humans, the females have two similar X X pairs, while males have X Y. As from the shapes of X and Y follows, the X chromosome is actually containing parts that the Y is missing. So females contain

twice the necessary genes on those X parts, while males only once. Just Y Y combination is not viable, but rarely X Y Y can occur and was linked to aggression and criminality. There are actually known features which are carried on the X sex chromosome and such are the color vision and the blood clotting agent. Thus, hemophilia, which is an illness of not having this blood clotting agent, is a special sex related illness. In short, if X denotes a healthy, while X* a faulty, then the following combinations can occur:

X X = healthy girl
X* X = healthy girl but carrying the illness hidden
X* X* = hemophiliac girl who dies still in the womb
X Y = healthy boy
X* Y = hemophiliac boy, survives birth but in constant danger for life

This also shows that in spite of only X carrying the necessary agent, X* Y is still better than X* X*, so a certain mixing still exists.

The duplication and division of chromosomes are obviously caused by the earlier explained DNA molecules. Under microscope we only see the big blocks of chromosomes, not the actual DNA, and indeed we see that the chromosomes after duplication are pulled aside towards two new centers and then the whole cell divides. Of course, every cell contains two of each chromosome, one from the father and one from the mother. This makes it clear that the parental chromosomes must be halved, otherwise after every generation, the total of chromosomes would be doubled. This halving of the chromosome number only happens to the sexually important cells, that is the male sperms and the female eggs. They go through a special form of cell division called **meiosis** different from the normal **mitosis**. The most obvious difference is that after the normal duplication of the chromosomes, not only one division, but two after each other will happen. A more hidden feature is that even before the first such division, the parental chromosomes cross into each other and mix up, which is called **crossing over**. The purpose of this is quite obvious, namely to mix up the parental genes and thus bring about new combinations. This special halving of the sex cells happens quite differently for females and males. In females, all the eggs go through meiosis at puberty and then all the halved egg cells sit and wait for all life long. At males the meiosis of the sperm cells starts at puberty and keeps on going for all lifetime. Amazingly, fungi go through a reverse life as all other living things, because they live their whole lives in half chromosome existence and it’s not the sex cells, rather the fertilized egg cells that go through the meiosis.