The grand bazaar of evolution

REGARDER NOTRE TERRE

Contributors:

Conservatory and Botanical Gardens of Geneva: Yamama Naciri, curator; Romain Dewaele, science educator; Philippe Clerc, curator

Natural History Museum of Geneva: Nadir Alvarez, head curator

RTS Découverte: Tania Chytil, journalist

Scientific Committee: Guillaume Lecointre, professor, Paris National Museum of Natural History, France; Alicia Sanchez-Mazas, professor, University of Geneva, Switzerland; Kostas Kampourakis, lecturer, University of Geneva, Switzerland; Patrick Charlier, instructor, Department of Public Instruction, Geneva, Switzerland

Translation: Daniel Hoffman

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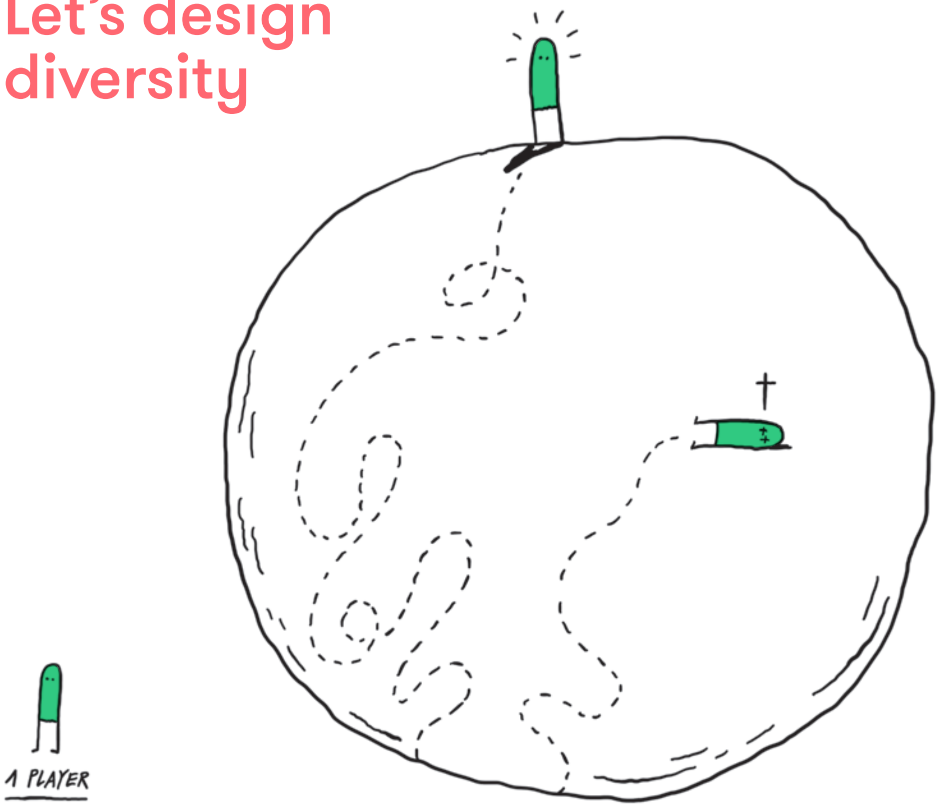
Do you know what drives evolution? That chance plays a significant role and that there is no endpoint or destiny? That diversity is the result not only of competition, but also of cooperation, mutual benefit, and entanglements? That living things often give each other a boost? That there aren't "inferior" or "superior" organisms? That a seemingly hopeless creature today may become the most advantaged tomorrow, if the environment changes in its favor?

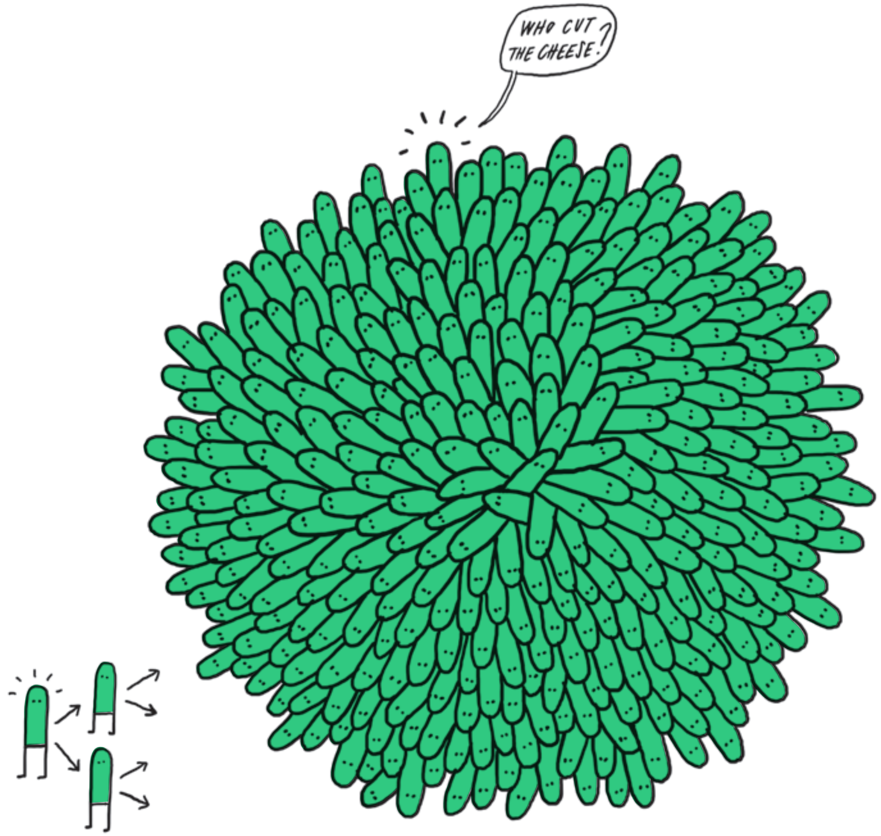
This booklet approaches evolution in light of recent scientific discoveries, especially in genetics. You will see that the mechanisms of evolution are rather simple, yet they give rise to highly diverse, complex and at times surprising forms of life.

Understanding evolution is to appreciate all that surrounds us, to respect and protect the extraordinary biodiversity of our planet.

Are you curious about nature? Already convinced? Skeptical? Whichever it is, jump in, and let's begin with a game.

Let’s design diversity





Let’s simulate the evolution of life on an imaginary exoplanet, and we’ll call it Glurb. Our aim is to create life similar to that on Earth, with a great variety of species. You’ll see that just a few simple mechanisms are sufficient to bring forth impressive diversity.

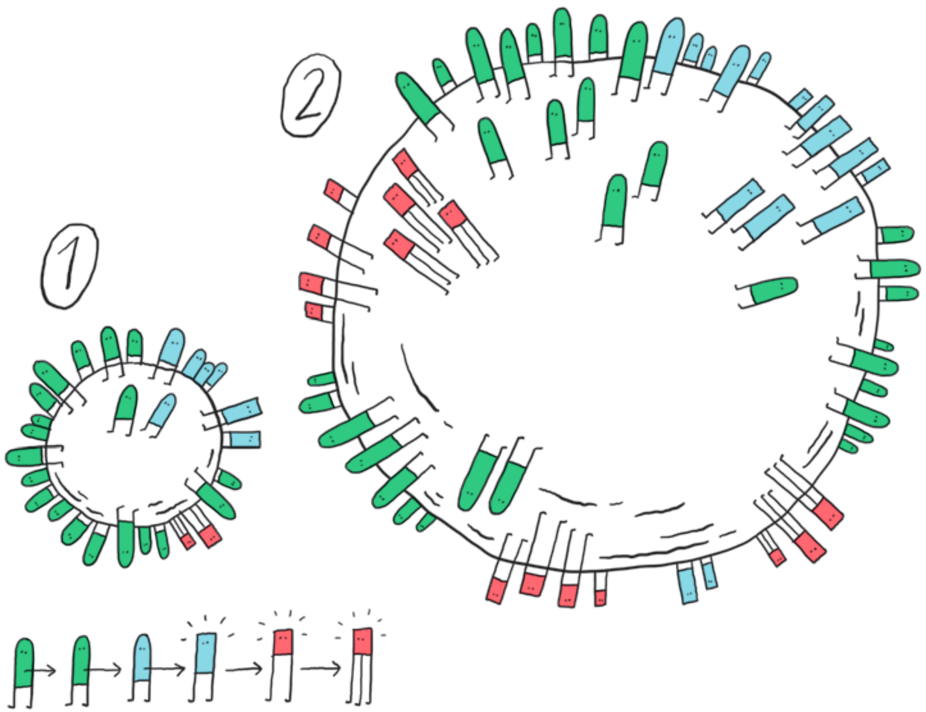
❶
Life and death
Let's begin by imagining a single living thing on Glurb. It’s all alone, but it can move and eat.

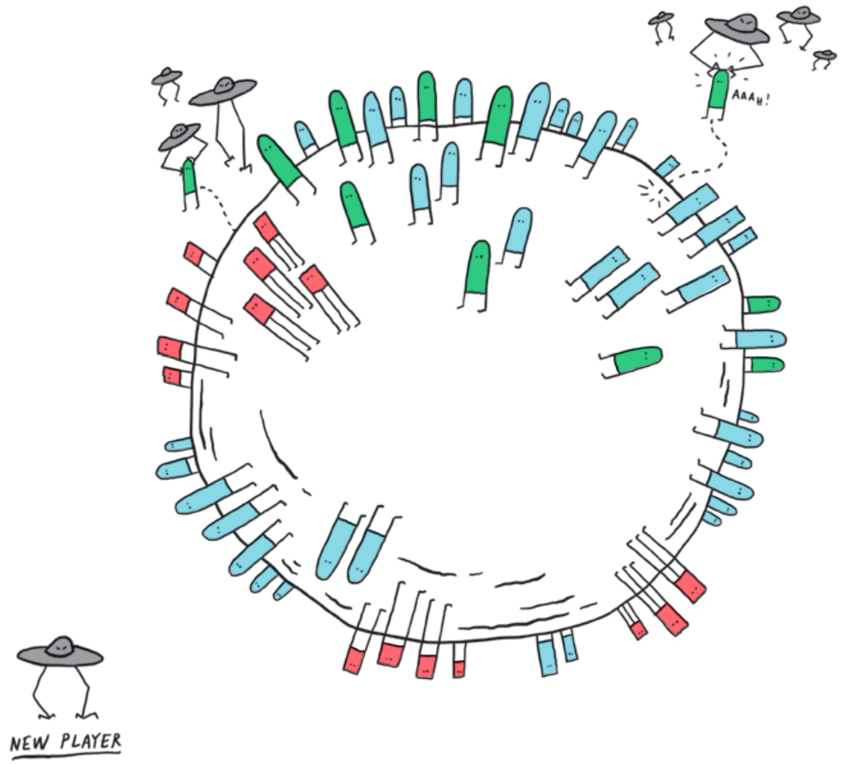
It moves, it eats; it moves, it eats. Little by little, the environment wears out our friend, it grows old, and a year later, it dies.

This first attempt didn’t go very far. An organism indeed lived on Glurb, but only briefly. We’ll have to come up with a better arrangement.

❷
Reproduction and transmission
Let's restart our game, this time giving our friend a new ability: that of reproducing and passing its traits on to the next generation. Let's say that every evening—if it has survived—**it duplicates, producing a perfect, younger copy of itself**. For this new simulation of evolution on Glurb, we start again with an organism with a life expectancy of one year, but this time it has a reproductive rate of 2x per day. On day two, therefore, there are 2; the next day, 4; then 8, 16, 32, 64, 128... In a month, there are already over a billion on Glurb!

We know that, on Earth, no population behaves this way. For one, food is limited. Population growth is constrained as well by **competition between individuals**. We can introduce these new factors into our game to control population size. Yet, we will still not see diversity: every individual is identical. Our scenario has to be modified once more.





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Variation, chance and genetic drift
We need to add another rule to our simulation: when individuals reproduce, let's give them a small chance of **producing slightly different offspring** which are not perfect clones of their parent. In this way we introduce a little variation from one generation to the next.

We start our simulation once again. After a few generations of identical clones, an individual appears with a new trait: a different color. Later, an individual appears with a novel shape. Variants thus arise, each having a set of traits making it unique. They arise by chance, but they can disappear rather quickly. We now have variation on Glurb, but it isn't much. Glurb in fact isn't very large, and resources are limited: the population on Glurb continues to be small.

Let's then imagine a larger planet: Glurb 2. It has greater resources and more space, so we see a larger population form. It is also more varied, overall, and each variant has a greater likelihood of persisting, due to chance alone.

There is no way to predict which colors and shapes will be the most common on either Glurb or Glurb 2, since these forms arise and change randomly. We know, however, that the population on Glurb 2 will be more varied and more stable than on Glurb, simply due to its greater size.

This phenomenon, where the traits of a population change randomly over time, is called genetic drift.

4

Natural selection: favoring certain variants that arose by chance.
On Glurb 2, we obtained a high diversity of lifeforms, like on Earth. However, we haven't yet explained why some populations seem so well adapted to their environment. Is it simply due to chance?

In our model so far, being red or green, square or triangular had no influence on an individual's chance of surviving and reproducing. This is why the numbers of these variants evolved randomly across time. Let's now introduce alien predators which regularly visit our planet. They really like the color green, but they won't balk at eating red or blue if there is nothing else to be found.

The green variants are at greater risk of being eaten by the predators.
Their life expectancy is therefore lower. Red and blue individuals, on the other hand, aren't eaten as much by the aliens, and they have a greater chance of surviving. They thus will leave more descendants than green individuals.

A sorting out takes place. Though we began with a population with an abundant mix of colors, the impact of predation could put the color green at high risk of disappearing after a few generations. The majority or remaining individuals will be either red or blue. **This is the effect of natural selection.**

The ingredients of evolution

The preceding scenarios showed that just a few rules are sufficient to see the evolution of new lifeforms on our hypothetical planet and arrive at considerable diversity, just as we observe on Earth. Here are the necessary elements:

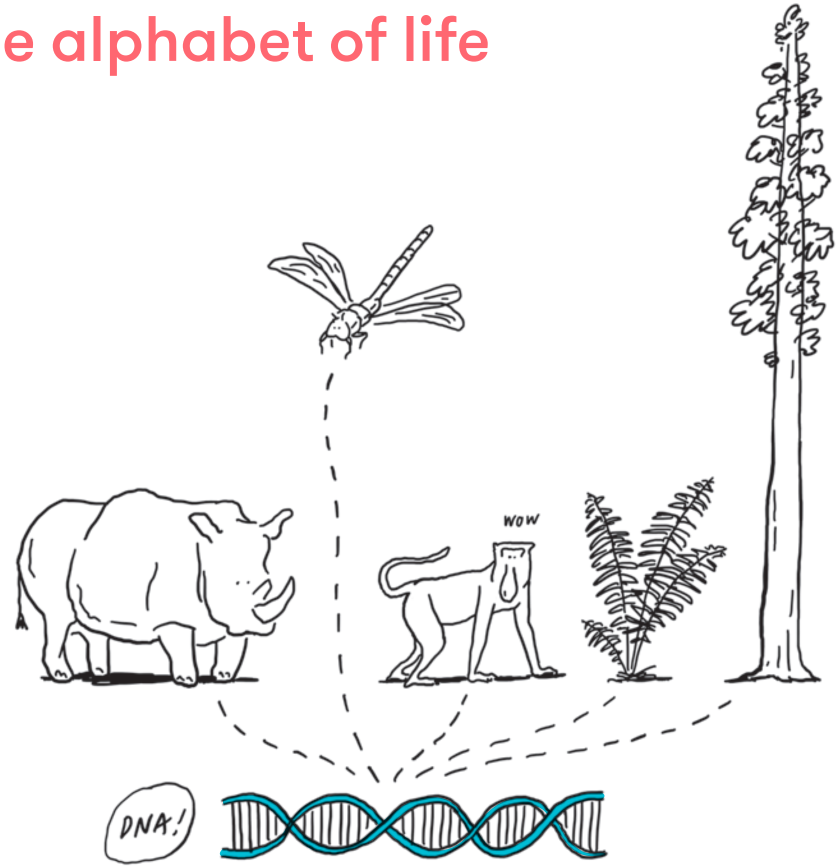
– mechanisms creating **variation**, and we will see that there are several,

– the **transmission** of new traits from one generation to the next,

– diverse **interactions** (between individuals of the same species, between individuals of different species, and between individuals and their environments), which will shape this variation. These interactions and processes include natural selection, genetic drift, migration, competition, cooperation, predation, symbiosis, etc.

Life on Earth appeared at least 3.5 billion years ago. It has gone through many upheavals. We now understand that all living things populating our planet are to varying degrees related. We thus share ancestors with bacteria, plants, insects and mushrooms. Amazing, isn't it?

The alphabet of life



WHAT IS A GENOME?

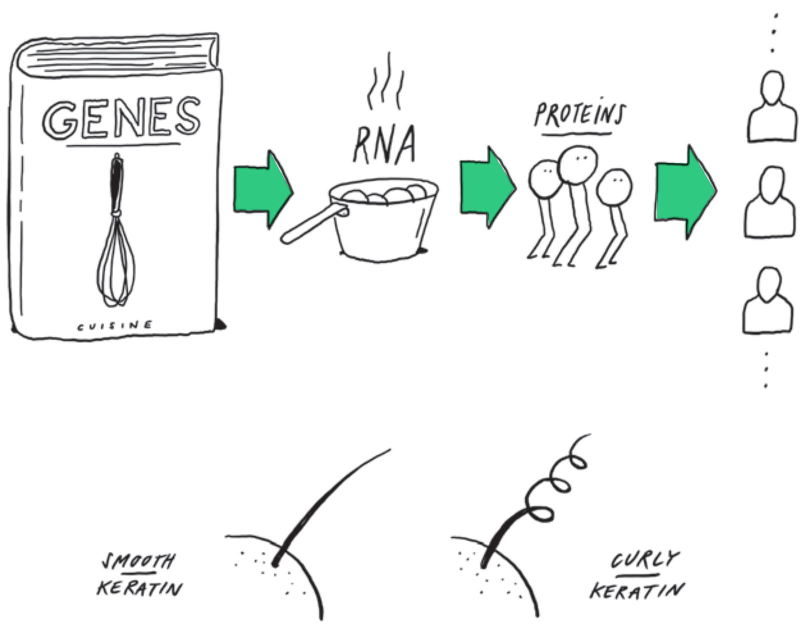
It is held in every cell of organisms, in the form of **DNA** (**D**eoxyribo**N**ucleic **A**cid) which is organized in long molecules, usually as chromosomes. All living things have a genome: rhinoceros, redwoods, ferns, dragonflies, bacteria, fungi, ... and us!

These molecules of DNA are comprised of chains of varying lengths, called sequences, whose elements are made up of **4 chemical bases**:

A = Adenine
T = Thymine
G = Guanine
C = Cytosine

Even though the **alphabet of life** consists of only 4 letters, their possible combinations are infinite. These provide the equivalent of "recipes" (genes) for manufacturing proteins and assembling the cells of organisms. These proteins are integral to the machinery enabling cells to live and reproduce.

From genes to organism



Genes are the "recipes" for making the main lines of what organisms are.

This all requires a complex machinery, entailing in particular a **molecule related to DNA, called RNA**, which participates in the manufacture of proteins.
The expression of genes as proteins and interactions between cells guide the growth and development of organisms.

Proteins provide diverse functions. For example:

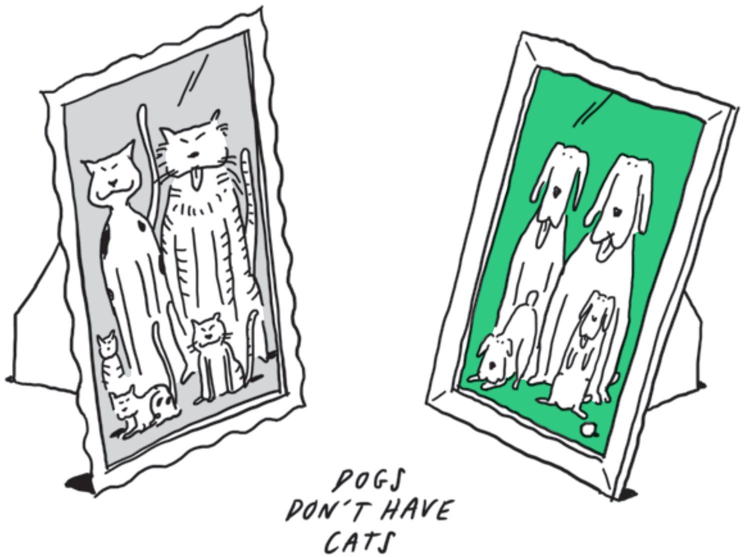
- ***keratin*** *is a structural protein. Hair is 95% keratin, which gives it its strength.*
- ***hemoglobin*** *is a transport protein. It binds oxygen in red blood cells, allowing its transport throughout the body.*
- ***Vin3*** *is a protein that regulates flowering and is sensitive to outdoor temperature. In certain plants, it triggers flowering when winter is over.*

A difference of just 2%

The genomes of chimpanzees and humans are about 98% identical.
The differences between chimpanzees and people are explained of course by the remaining 2%, but also in relation to when the shared genes are called upon to manufacture their proteins.
The differences thus arise also from the way genes are controlled and regulated within cells. But let's revisit the three principal ingredients of evolution.

1. Variation

The different levels of variation



The variation of characteristics and their different combinations explain why individuals are all distinct. Variation appears constantly at all levels, by chance. Across time and generations, certain traits arise, are transmitted, and are either retained or lost. This is true for molecules and populations, cells and organisms.

Each and every one of us is thus a unique variant among others. Our DNA, our microbiota, our interactions with others and our surroundings, our culture, our behaviors are all elements that make us unique and can be transmitted from one generation to the next.

Generally, at our time scale, most changes are imperceptible, which explains why we often feel that nothing is changing. The challenge is to explain how an apparent outward stability coexists with constant change.

Genetic variation

But what is the basis for this genetic variation? It can take several forms, including mutation, gene duplication, recombination, and transposition.

Mutations create **variations in the DNA** of individuals. However, only mutations appearing in reproductive cells—such as ovules, sperm, spores or pollen grains—can be transmitted to successive generations.

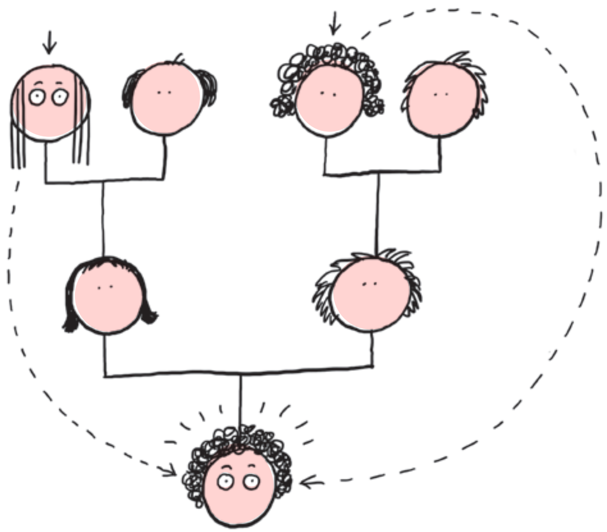
Mutations are **copy errors** that occur during cell replication, and they alter the order of the letters (chemical bases) in DNA.

Mutations happen **very rarely**, and **by chance**. Out of 100 million bases, about one mutation occurs for each generation. In humans, with a genome including 6.4 billion bases, this can add up to several dozen mutations per generation.

Depending on the site of the mutations in the DNA, they can have a positive, negative or neutral effect on the organism. Most often, mutations are neutral, particularly when they occur outside the zones which code for proteins. These mutations are called "silent", that is, they don't have measurable effects on the survival of the organism.

Recombination and rearrangement: shuffle the deck!

Variation / Transmission / Interactions



Genetic **recombination** also creates variation. This event occurs during the formation of sexual cells, such as eggs, sperm, spores, and pollen.

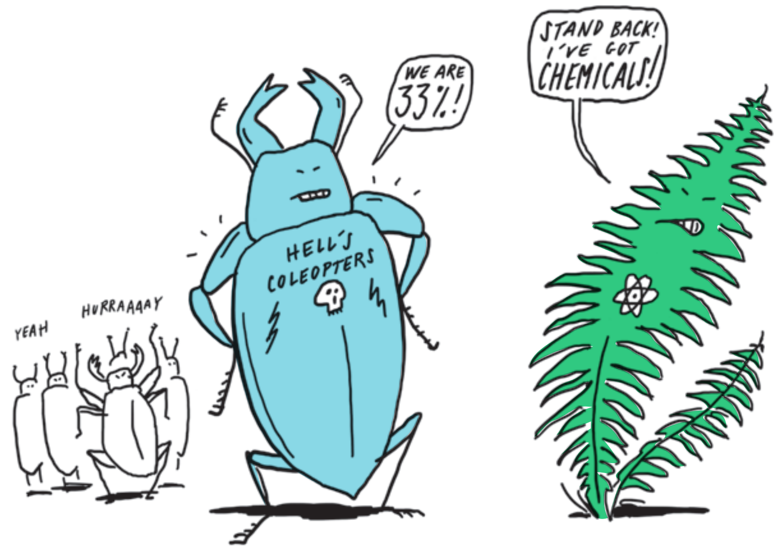
During recombination, **the chromosomes from the two parents exchange portions of DNA**, creating new combinations of characters which are unique to each sexual cell.

Sometimes entire fragments of DNA move to another chromosome. This is called **chromosomal rearrangement**.

Such an event occurred, for example, *between the genome of humans and that of chimpanzees. These two genomes are 98% alike. The human number 2 chromosome, however, corresponds to two chromosomes found in chimpanzees. The two chromosomes apparently fused sometime after the human lineage diverged from the chimpanzee lineage.*

Gene duplication and new functions

Variation / Transmission / Interactions



Gene duplication is a random genetic mechanism that occurs when cells are replicating and DNA divides. Gene duplication is a **recombination error**: a piece of DNA is found to be doubled in the new cells.

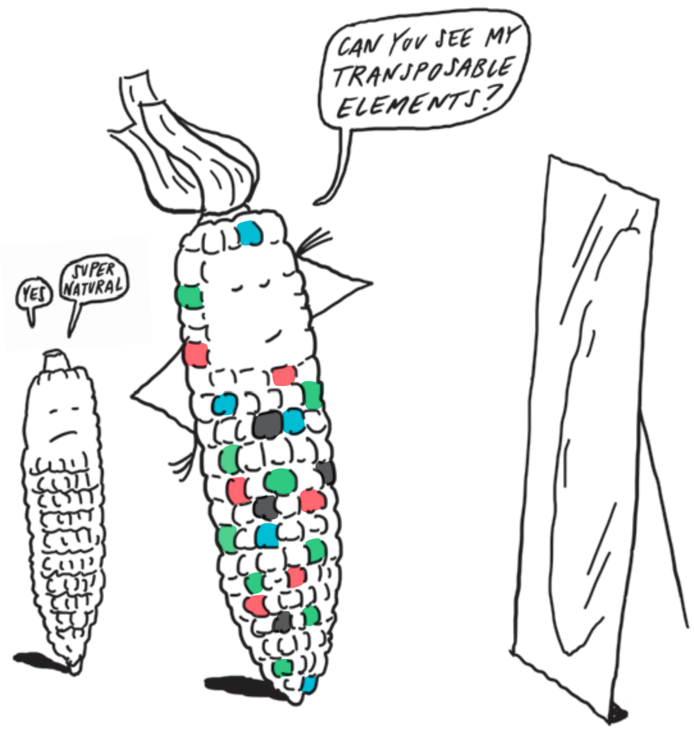
When such duplication affects a gene, the copied gene may, subject to chance mutations and natural selection, acquire a new function.

This genetic mechanism probably allowed the *Polyphaga* subgroup of beetles, mostly herbivorous, to become the most diversified insect group, with some 350,000 species, representing about a third of all known living species of insects. Specifically, the duplication of certain genes involved in digestion and detoxification allowed *Polyphaga* beetles to adapt to the extraordinary diversity of plant chemical compounds found in their diets.

It is noteworthy that gene duplication can also affect the **entire genome**. This is known as **polyploidization**.

Transposition

Variation / Transmission / Interactions



The genome is fluid. Not only does it change constantly from one generation to the next, but also within the lifespan of an organism. And this change occurs through different processes, such as transposition and the insertion of foreign DNA.

Transposable elements are small DNA sequences that are like **squatters**. They can potentially multiply and move randomly around the genome, and this may take place at any time in the life of an organism.

Most often, these transposable elements have no discernable effects. They can nonetheless influence the way genes are expressed, that is, their efficacy at producing proteins. Today we know that 45% of the human genome, and 70% of the corn genome, is made up of transposable elements.

For example, the variation in the color *of kernels on a given ear of corn is due to transposable elements. Their movements within the genome changes the color of kernels.*

Insertion of foreign DNA

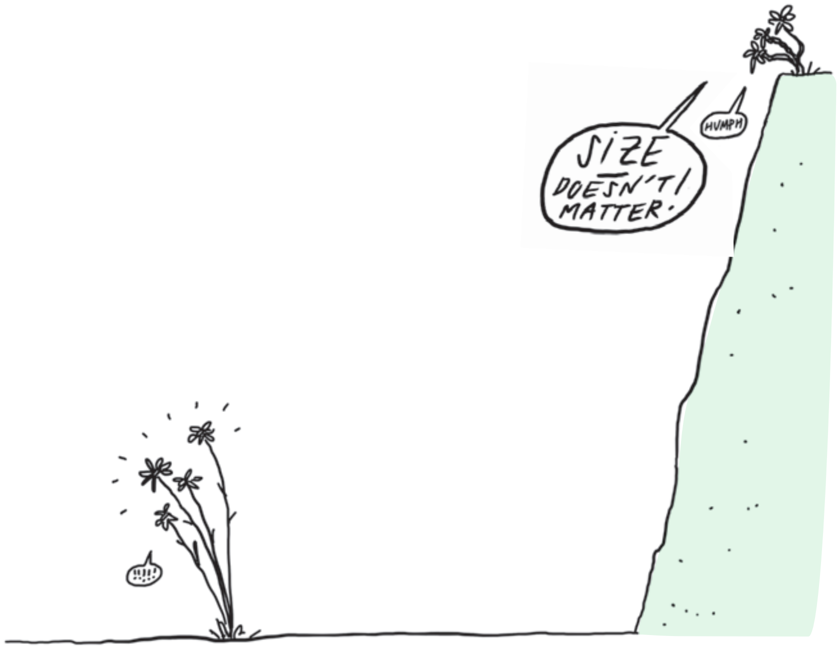
Variation / Transmission / Interactions

Organisms sometimes incorporate pieces of **DNA from other species**. This is quite common among bacteria, but also occurs among plants and animals.

Thanks to new DNA sequencing techniques, we know that **this insertion phenomenon is much more common than previously thought**. In this manner, in the genomes of humans and the other organisms there are traces of many viruses that were introduced in the past. A small part of our genome is thus composed of DNA of viral origin.

Parasitism can also facilitate such transfers, as is the case of *Rafflesia*, a plant parasite of a tropical tree. *Rafflesia* has acquired about 2% of its genes from its host.

Epigenetic regulation: experiences that last!



Variation between individuals cannot be explained entirely by genetic differences. Some changes, called **epigenetic**, are influenced by the **environment**.

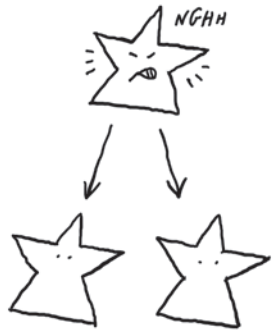
These changes result from **molecules that attach to DNA but do not alter the sequence of genes**. Rather, they regulate the expression of a gene. These molecules can reposition themselves along the genome in response to the environment.

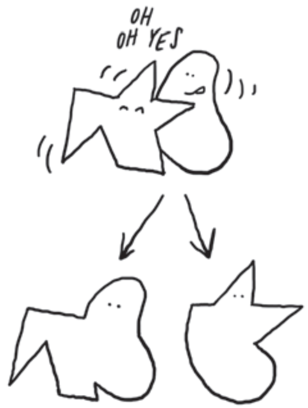
Epigenetic variation allows individuals to make exceptionally fast adjustments to their environment. What's noteworthy, however, is that epigenetic variation is **transmissible**, at least for several generations.

Proteins are not produced continuously by genes—much to the contrary. Even though the genome is present in every cell of an organism, each gene is expressed only in certain cells, or at certain times during development, or again in response to the environment. This activation is regulated in part by epigenetics.

2. Transmission

To transmit is, among other things, to reproduce.





There are several ways to produce a new generation.

CLONING

Some organisms reproduce by cloning, rather than sexually. Each individual reproduces by simply producing one or many **copies** of itself, apart from a few mutations, as we saw on Glurb. This asexual reproduction was the only form of reproduction for living things on Earth for several billion years after life first arose.

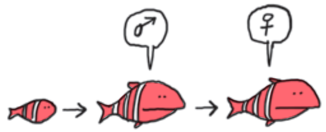
SEX

Sexual reproduction first appeared around a billion years ago. Two organisms then became necessary to produce a new individual. In this case, however, the new individual is different from its parents: sexual reproduction mixes the genes of the two parental lineages, creating **unique new combinations**. This is the power of sexual reproduction compared to cloning: it brings novelty.

Among some species of animals and plants, the evolution of sex was accompanied with the appearance of sex chromosomes, which predetermine the male or female character of individuals. On the other hand, with some animals such as tortoises and some plants such as horsetails, environmental factors determine the sex: temperature for tortoises, and light for horsetails.

Sex: an infinite variety

Variation / **Transmission** / Interactions



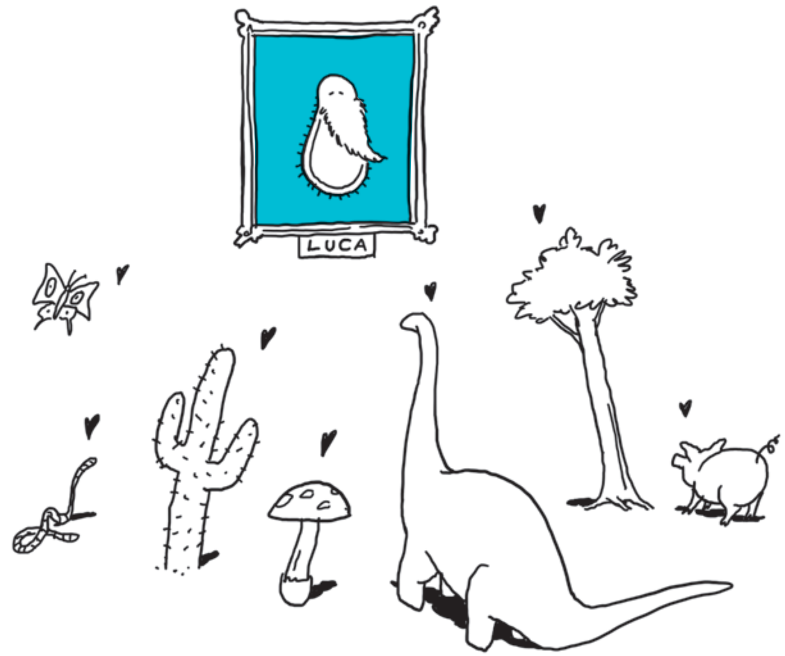
Asexual reproduction is associated with the origin of life, and today many organisms still reproduce this way. And it isn't just for simple organisms. Many plants and animals reproduce asexually from unfertilized ovules. With plants, this is called **apomixis**: it occurs in bananas and dandelions. Among animals, it is called **parthenogenesis**: this is the way male honeybees are produced. Parthenogenesis is also found in certain vertebrates, including some fish, amphibians, and reptiles.

Among organisms with sexual reproduction, sex is inventive. For example:

- *clownfish are initially male but become female over their life course, as with oysters.*
- *snails are both male and female simultaneously, and are thus termed "hermaphrodite". Nonetheless, they need another individual to reproduce.*
- *wheat is also hermaphrodite, but wheat can fertilize itself.*
- *individual willows are either male or female.*

The origin of life

Variation / **Transmission** / Interactions



We don't know how many times life arose on earth. We do know, however, that all living things existing today on our planet arose from **the same common ancestor**, which has been given the name "**LUCA**", for **L**ast **U**niversal **C**ommon **A**ncestor.

Today we think that **LUCA** was composed of RNA, a molecule closely related to DNA, or of some similar molecule that has since disappeared. This RNA was enveloped by a sphere of small molecules of fat, which made it possible to separate the internal environment from the external environment.

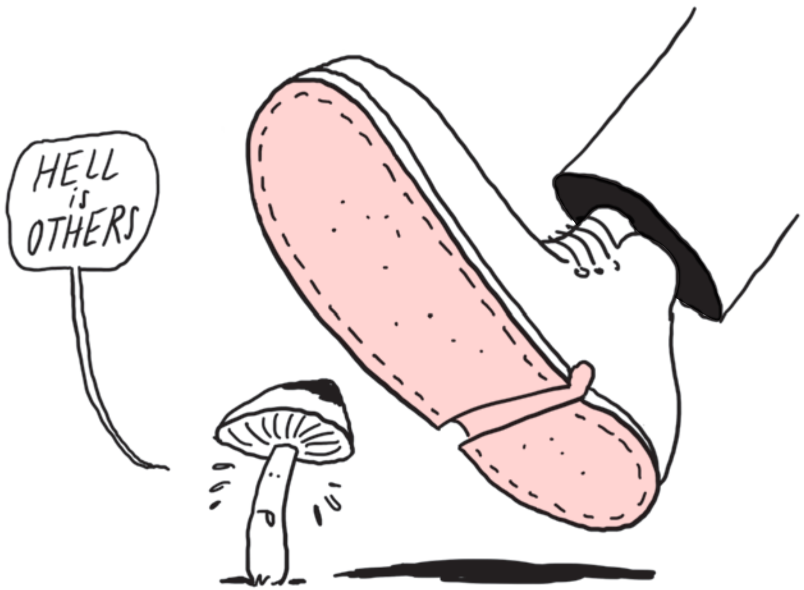
By studying the relationships between known organisms today, scientists have concluded that **LUCA probably resembled a primitive bacterium**, or a population of such bacteria. **LUCA** probably originated in thermal vents at the bottom of oceans, and would have relied on hydrogen, carbon dioxide, and iron as sources of energy and nutrition. Sunlight doesn't reach such environments; life was thus able to develop without it.

It is said that Enceladus, a satellite of Saturn, has an ocean of liquid water beneath an icy crust. And recently planetary scientists have concluded that there are thermal vents there!

And exoplanets? Those planets, circling other stars, could also hold surprises.

3. Interactions

We've come to understand that variation is everywhere, from molecules to organisms. This variation, if it is transmitted, is subject to different interactions that influence its organization, continuation, or disappearance.



Natural selection, **genetic drift**, and **migration** follow from all the **interactions** that exist between different organisms, and between organisms and their environment.

Natural Selection: not necessarily survival of the strongest

Variation / Transmission / **Interactions**

The message of **Charles Darwin** regarding natural selection has often been misunderstood. Many people assume that natural selection inevitably favors the strongest. But this is incorrect. There are many other ways to leave more descendants to the next generation than being the strongest. For example, through cooperation.

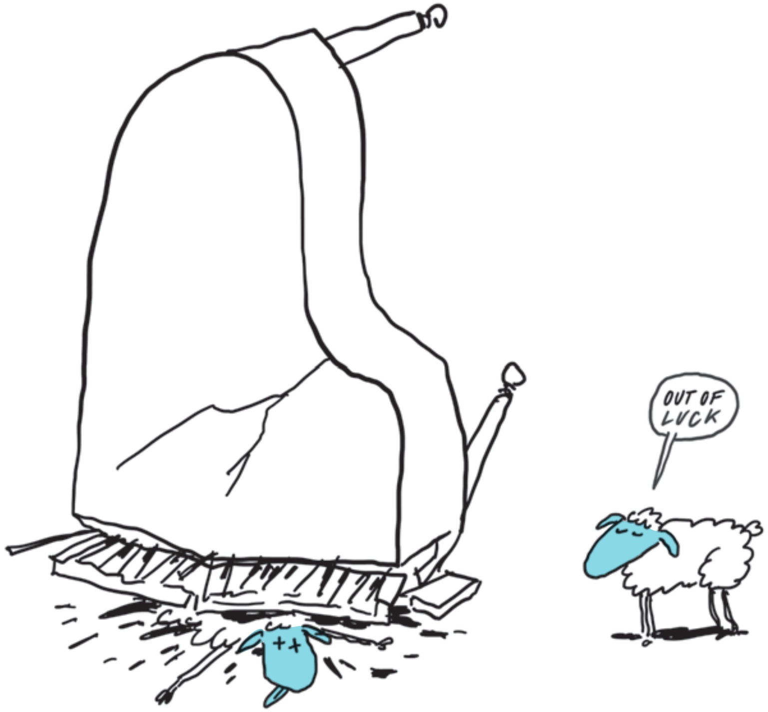
The organisms having greater chances of surviving and reproducing will be those that transmit their traits to the next generation. An organism however may be well adapted in one environment at a given moment, but completely maladapted elsewhere, or at another time.

Natural selection doesn't modify genes themselves, but rather the frequency of their many variants in populations. Over generations, selection tends to reduce the proportion of genetic variants that are disadvantageous to their carriers, while increasing the frequency of other variants, simply because the former will have less chance of being retained than the latter. **Artificial selection**, practiced by humans to develop useful races of animals or varieties of plants, follows the same principle.

The Lizard *Podarcis sicula* on an Adriatic Sea island. *In 1971, researchers introduced five pairs of lizards to an island in the Adriatic Sea. After some 30 generations over 33 years, significant changes were noted in the descendants of the five pairs: a shift to a herbivorous diet; the development of a symbiosis with microorganisms permitting the digestion of cellulose; shorter limbs and a more robust, upright head.*

Genetic Drift: The influence of chance

Variation / Transmission / **Interactions**



Genetic drift is the effect of **chance** alone on the composition of populations, that is, on the frequency of their variants.

The smaller the population, the greater the speed and significance of genetic drift. For example, if one individual out of a population of only ten dies by accident, prior to reproducing, a tenth of the total genetic variation of the population is lost. If, on the other hand it belonged to a population of 1000 individuals, then only a thousandth of the variation would be lost. Genetic drift can run counter to the effects of natural selection, allowing certain gene variants to persist in a population despite being deleterious. Similarly, favorable variants can disappear.

Is everything really perfectly adapted?

Variation / Transmission / **Interactions**

If an individual is adapted at a given moment, it doesn't mean that its descendants will necessarily be so if the environment changes. **The individuals least adapted to their environment will be eliminated by natural selection, but that doesn't imply that the that those which remain are perfectly adapted.**

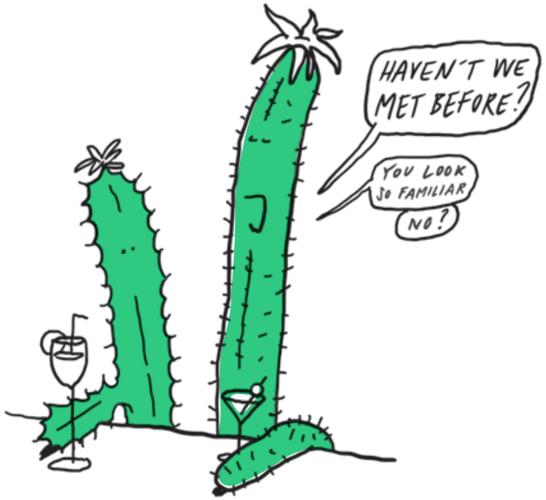
Take the example of the absorption of sugar by humans. For thousands of years, it was rare to come across sugar. It was advantageous therefore for our metabolism to assimilate it quickly. Today, in contrast, sugar is everywhere. This ease of assimilating sugar has become a disadvantage, contributing to both obesity and diabetes.

Also, as we have seen, natural selection is sometimes countered by genetic drift. This occurs especially when populations are small. Less adapted individuals can survive simply due to chance.

Changing environments and the effects of chance therefore explain in part why all organisms are less than perfectly adapted to their environments. Not to mention that perfect solutions may never have existed!

Similar, but unrelated: convergent evolution

Variation / Transmission / **Interactions**



At times natural selection leads to similar life forms in very different organisms, such that species **may resemble one another without being closely related**. This is called convergence, and occurs when similar environmental constraints influence the evolution of unrelated species.

For example, **cacti** and **euphorbias** are two groups with distinct evolutionary histories, yet they can appear very similar morphologically.

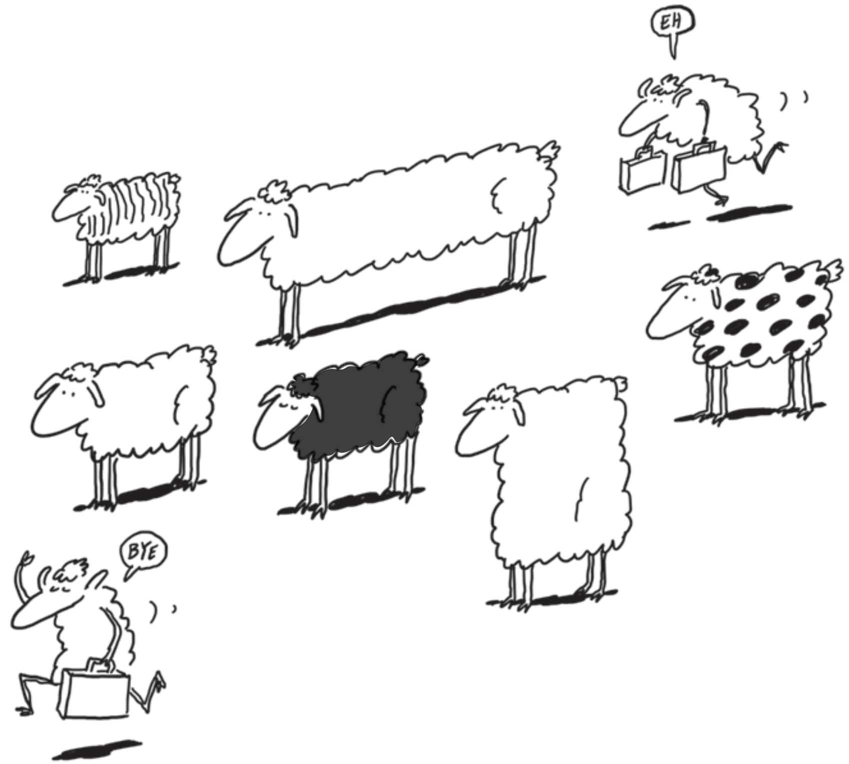
Both groups include columnar or candelabra-shaped species armed with spines. Their geographical distributions however are quite different: cacti diversified almost exclusively in the Americas, whereas columnar euphorbias are found mainly in Africa.

These similar appearing plants actually diverged more than 100 million years ago, well before the disappearance of dinosaurs!

There are many examples of convergent evolution. *Among birds, the condors of the Andes and Old World griffon vultures diverged 80 million years ago. Among mammals, marsupial moles and the Soricidae (a group composed mostly of shrews) diverged 160 million years ago. Thylacinidae (the extinct family of the Tasmanian wolf) and Canidae (the family of wolves, foxes, and fennecs) diverged during the same period. Among insects, the Styrian praying lacewing and praying mantises diverged 360 million years ago.*

Dispersal, or how do alter populations

Variation / Transmission / **Interactions**



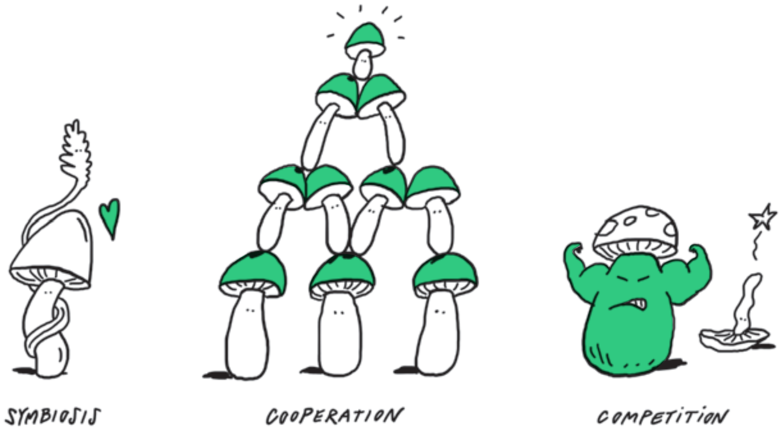
Dispersal is the phenomenon of **individuals, seeds, or pollen moving to new sites**. In plants, seed and pollen are dispersed by wind, water, and animals. But there are limits to dispersal: individuals must be able to survive in their new environments. Temperature, humidity, and competition with other species are examples of limiting factors.

Dispersal facilitates the movement of variants between sites, usually resulting in changes in their frequency in populations.

Another consequence of such movement is to **reduce differences among populations**, making them in effect larger and more varied, and therefore potentially more resistant to disruption.

Symbiosis / Cooperation

Variation / Transmission / **Interactions**



Often, we are left with the impression that evolution is the same as survival of the “strongest”. However—even though competition between individuals of the same or different species has an important role—mutual assistance, cooperation, and symbiosis are essential types of interactions also contributing to the survival and diversification of living organisms on earth.

Within a species

There are many examples of **mutual assistance** and **cooperation** in social species such as primates, dolphins, and ants. Marmots, for example, take turns standing guard near their burrows.

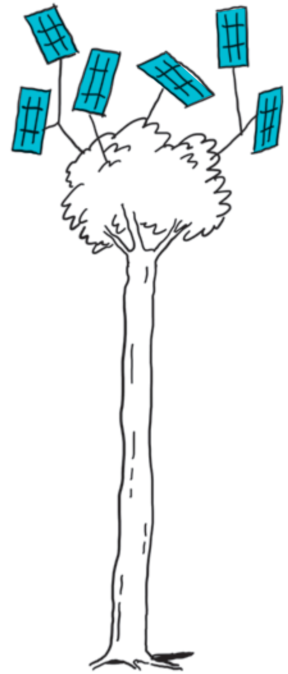
Between species

Symbiosis is broadly defined as an **enduring coexistence** between two or more different species. When each organism benefits, we call this mutualism. Lichens are a classic example, being fungi that obtain nourishment through symbiosis with microscopic green algae. The fungus forms a “home” protecting the algae, while the latter “pays its rent” foremost in the form of sugars that it manufactures by photosynthesis from solar energy, water and carbon dioxide.

We now recognize that symbioses are found throughout the tree of life. These organisms, in effect, **give each other a “boost”, and evolve in combination, not as isolated individuals**. *For example, the micro-organisms that colonize our intestines, skin, and mucosa (our microbiome) are as numerous as all the cells in our body. Some are just passing through, while others, more specialized and essential to our survival, have accompanied us throughout our evolution. We are true microbial ecosystems—holobionts—and this is true for the great majority of multicellular organisms on our planet.*

Two revolutionary symbioses

Variation / Transmission / **Interactions**



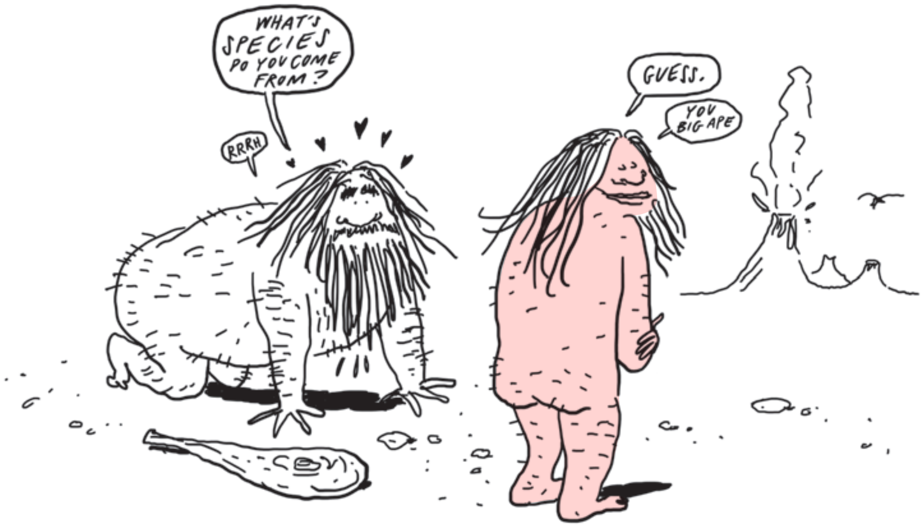
Energy factories: the advent of mitochondria

Around two billion years ago, in the water, a bacterium set up house inside another primitive or primordial host-cell. Over the course of evolution, these bacteria were transformed into minute “power plants”—called **mitochondria**—specializing in producing energy for host cells. This symbiosis gave rise to the large group of organisms to which we belong: the eucaryotes. Nearly all plants, mushrooms and animals have mitochondria in each of their cells, the mitochondria providing energy thanks to oxygen taken in through **respiration**. The advent of mitochondria was probably essential for the emergence, over the course of evolution, of the complex organisms we see today.

Integrated solar panels: the advent of chloroplasts

Several hundred million years later, again in an aquatic environment, a similar event gave rise to organisms that would be the foundation for all known plants today. A bacterium capable of using solar energy to transform atmospheric carbon dioxide and water into sugars, while giving off oxygen, in turn set up house inside a eucaryotic cell. Over the course of evolution, these bacteria were transformed into built-in “solar panels”—**chloroplasts**—allowing the series of reactions called **photosynthesis**. As a result, plants, including trees, herbs, mosses and algae, are capable of photosynthesis, manufacturing sugars while producing oxygen.

Species can be hard to recognize!



Describing species is very useful for naming and classifying living things—a horse, a fly, an edelweiss. It is difficult, however, to arrive at a single definition of a species that applies to all organisms. Generally, we recognize a species, at a given moment, as a set of populations whose individuals are **capable of reproducing with each other,** bearing **viable and fertile offspring**. Nonetheless, some well-recognized species rarely if ever reproduce sexually. Such is the case with dandelions, many lichens, and some worms and insects. Each criterion has its limitations, and many species are difficult to circumscribe.

For example, we know today that the vast majority of plants can hybridize with closely related species. They benefit in this way from a source of new variants that could prove useful for future adaptations.

We now realize that this phenomenon is much more common among animals than we imagined.

Among humans, for example, *our* Homo Sapiens *genome carries traces of earlier hybridization with Neanderthals and Denisovans, two hominid species that coexisted with us in Eurasia but disappeared 30 to 40,000 years ago.*

How do new species arise?

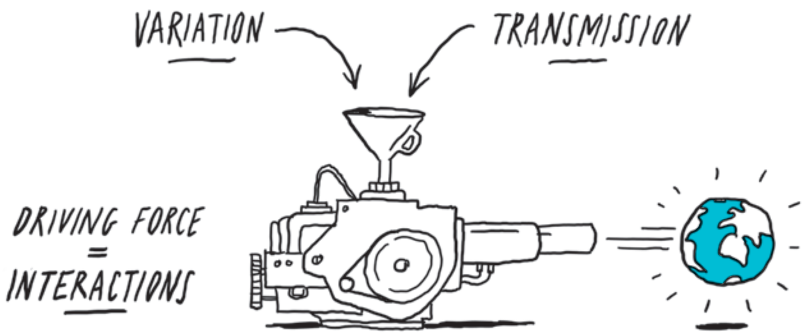
Imagine a population of a species. It separates into two populations, because a continent splits apart, due to continental drift, or because a chain of mountains rises, creating a physical barrier. The two populations no longer are in contact, and can no longer interbreed.

Each population will then evolve independently owing to natural selection, mutations, and genetic drift. If the two populations remain separated long enough, their differences will become so great that they will no longer be capable of reproducing with each other, even if they came into contact again. We would then need to give them different names: they have become two distinct species.

Populations can also diverge in the same place, due to different behaviors or adaptations.

This is what occurred with **Rhagoletis pomonella***, an fly whose larvae developed exclusively in American hawthorns. After the introduction of European apples to North America, however, certain variants of this fly gained, through mutations, the ability to develop in these hosts as well. In this way, two populations of flies began to differentiate a little over a century ago. Since apples ripen a month before hawthorn fruits, the development stages of the two fly populations began to fall out of synch. They barely encountered each other any more, and therefore ceased exchange genes. We are witnessing in real time the formation of a new species!*

What Evolution tells us



Evolution is at the origin of all the diversity of life we encounter today. Only a tiny portion of what has existed has endured to our time, because species arise and go extinct when they are no longer sufficiently adapted to their environment. This is a continual process, though particularly evident during mass extinctions.

The mass extinction we are witnessing today is intimately linked to the actions of humans, but it follows at least five others that have occurred over the last 500 million years. Those mass extinctions were probably caused by massive volcanism or the impact of meteorites on Earth.

Chance plays a large role in evolution. If the conditions that prevailed over 3.5 billion years were brought together again, these would lead to a very different world than the one we have now.

Evolution entails cooperation between individuals and symbiotic interactions between species, but also competition, predation, and parasitism.

Evolution is neither moral nor predictable. Neither beautiful nor ugly, it never leads to perfection and tends toward a minimal adaptation of organisms to their environment. Evolution can take a variety of courses and at times seems rather makeshift.

There are no more evolved or less evolved organisms, but simply organisms that are more or less adapted to their environment. Evolution is fascinating for the diversity of forms it has been able to produce.

Today, we have an enormous impact on this biodiversity. In caring and preserving it, we take care of ourselves. We need it so much!

Further reading

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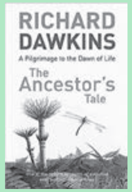

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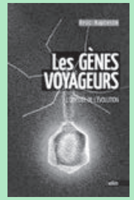

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For Video enthusiasts

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PBS Eons
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Primer
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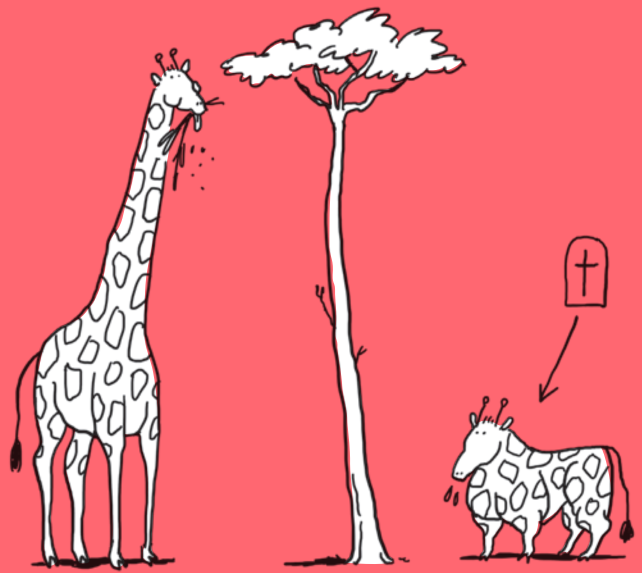
RTS Découverte
www.rts.ch/decouverte-evolution



THE LAW OF THE STRONGEST...?

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To understand evolution is to apprehend our surroundings and better respect and protect the extraordinary biodiversity that inhabits our planet.

The theory of evolution refers to a body of observations, scientific experiments, principles, models, and laws. Only the theory of evolution, in this sense, rationally explains how life diversified on our planet.

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