The Tragedy of Dogmas.

Science, Religion, Civilization and the Secular Liberal Democratic State.

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Folkert Castelein

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Cover
Front side Source:
http://www.wallpaperhi.com/Space/Moons/moon_earth_blue_marble_115073
Back side Source:
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ISBN: 9789402153668

Slightly revised edition February 2021

For my children and grandchildren in a better and safe world.

About the author:
Folkert Castelein MSc (Amsterdam,1948) studied biology and geology at Leiden University in The Netherlands, followed by business administration and economics, and philosophy. Started his career at the university, worked in the early 80's in education and after 1986 in the Aircraft Industry, and in the 90's in IT business consulting at Cap Gemini.
In 2000 he started working for a subsidiary of Ernst & Young USA in Europe and since 2006 he is an independent consultant developing projects for investment and delivering training in financial management, strategy and leadership. Since 2012 with a focus on project development and capacity building in Rwanda, Africa.
The author is an atheist.

Remarks:
1. This study is based on the philosophical and scientific work of other authors. Many authors did great research in history, science, philosophy, and political systems.
I have used elements of the original texts from the authors in the list of references, as much as possible, summarizing their content and following their arguments. All sources are recognized, however sometimes I had to combine texts because other authors wrote about the same subject including referring to each other.
I made additional remarks, added subjects, and came to my conclusions.
2. Some authors referred shortly (and in most cases referred by authors summarized by myself) are not added to references.
The reader can easily find them on the internet.
3. Most of the images and some text such as definitions are copied from sources like Wikipedia.
4. A study like this is 'never ending'. Every day we are witnesses of developments and innovations in science, philosophy and civilization.
We are confronted with the consequences of our decisions and behavior.
Remarks and Comments are welcome on my website www.tragedyofdogmas.nl

Preface

With this study I try to find answers to questions such as:
How to survive as a growing population on Earth?
How to minimize suffering and how to create the conditions that every talent can unfold in peace?
How to secure the basic rights: the right to live in dignity; equivalence among people; the right for freedom; the right to strive for happiness?
How to create a harmonic secular democratic liberal society for all? (being the best option to me I will argue).
How to stay in control of our urges, drive and imperfections as individuals and as Nation - States?
How to stay in control of our innovations in (bio) technology?

I started my journey developing a comprehensive program in Rwanda, East-Africa, in 2011, just because a good friend told me to go there and look around in that 'un-African' country of opportunities (Links, Rwanda). He was right and I travelled a lot. I was for the first time in the African Sub-Sahara and I studied the history of East-African countries. I learned about their society and am still involved in project development in Rwanda. Rwanda is rather expensive because it does not have many natural resources, has a small industry, and must import almost everything of what we in Western countries find necessity in our homes. It is a challenge but they are creative. The economy's growth rate is 7-8% per year. Population in Africa has doubled from one to two billion people in 30 years. Over 50% of the population is below 25 years old (in Rwanda 60%). They want their share from the planet and with their numbers they will become an important part of our population on earth. Asia has grown with another one billion people.

In 2014, I cleaned my house in The Netherlands because 'the more you have the more you have to store, to protect and to look after'. It became clear to me that I owned too much stuff. My private library had over 80 meters of books and articles. I studied (evolutionary) biology and geology, business economics and finance, read many books about philosophy, and was very interested in these related subjects since 1965. My whole life I was interested in evolution and in the development of our civilization.
Basically, we are just a specific and emerging population on Earth. I feel amazed and sometimes confronted with human behavior, ideas and convictions, fanatic ideologies, difficult to understand and to give it a meaning.

What is the meaning of the, in my eyes, cynical, asocial arrogant politics of conservative USA Republicans? What is the meaning of Brexit? What about populism? Why are one out of five voters in a rich and over-organized country like The Netherlands, voting for rather extreme right, almost xenophobe and nationalistic parties. Voting for parties with elements of resentment, with messages based on fear? The same is true in other

European countries such as Belgium, France, and Germany and equally strong in East-European countries. Why are voters sympathetic to populists and 'strong men'? Why are powerful States still obsessed with geo-politics? Why is the development of the European Communion taking generations? Why do we spend so much money on weapons? Why is there still so much violence in the world? Why is inequality increasing in an immoral way? Why do we have so much 'hate' among people with a different opinion on the internet? I look at it as a biologist, trained in evolution, population dynamics, and ecology, convinced of equality of all human beings. All of this crossed my mind when I was sitting on the floor surrounded by many books and I asked myself three questions; (1) Where are we with science today in biology, cosmology, and technology?; (2) Why are we still so primitive, dogmatic, and even violent to others in the development of our civilization on Earth? Are we still not able to create harmonious societies for all and in uniting our States? Do many feel comfortable with segregation? Where is the trust?; (3) If our civilization is such a thin layer after over 100,000 years of development of our brains, how can we survive as a population of 10 billion (2050) or more people on Earth without becoming inhuman?

Since the past 150 years suddenly everything is growing exponentially: our population on Earth, science and technology, CO2 in the atmosphere. The IPCC 'hockey-stick' (under Climate) is not the only stick. If tensions increase to high levels, will our civilization ethically fall back to the Middle Ages? I made a small selection of my non-fiction books, gave the rest away, and I decided to start this study and to share my thinking about what I believe is the current state.

At the end of this book the reader will find my conclusion: In short, I hope that neoliberalism was / is the last dominant political ideology, however, we still have to deal with religious dogmas and all kind of other fanatic convictions, with fear and with hate. If we look at the human population on earth with all kinds of dogma-driven intolerances, along with climate issues, other environmental issues, clean water challenges, geo-politics, demographical challenges and migration, increasing inequality and social tensions, xenophobic nationalism, genetic manipulation and artificial intelligence, we should conclude that we are running out of time with our primitive and divided responses to all of our challenges and that the only global ideology, even dogma, we must embrace is Ecology, which we are part of. We need a sound agenda forcing us to change our goals and behavior. We are responsible for Earth and for humans and for all other life on Earth. As human species we are one gene-pool, and if we do not act together we are history within a few generations (also that will grow exponentially).

What are the challenges for developing a harmonious liberal, secular, democratic society? Is that the best option? Is that a Utopia? No vision without understanding the past, knowing facts and having insight in science, in understanding its impact, in dominant philosophies and drivers for individuals, groups and States. Only then we might be able to understand tensions and challenges and how to develop a shared vision for a harmonious society at national and international level, at least for an important part of the global population.

Content of this study is my personal summary, interpretation and opinion based on the literature about these subjects in their coherence. The study contains a high density of facts and theories. The reader can skip complex scientific and philosophical parts without missing the dominant arguments and considerations. It concludes with strong arguments for cooperative behavior (behavior is driven by beliefs), and for a completely different attitude with which we look at our fellow citizens, our socio-economic development, national and international, our relationships to other countries (cultures) and to ourselves as individuals of a population on Earth. It concludes also for Tolerant Atheism or Agnosticism (even Theism) in secular liberal democratic multi-identity/multi-ethnical States, working closely together in democratic Supra-national organizations. Finally, this study shows the power of emerging processes in the development of civilization and of the global community if we learn how to deal with our dogmas. There is no similarity between the mystic world and the rational world. The mystic world is based on faith, fear and fantasy; the rational world is based on natural laws, logic, and science.

Reasoning should be the driver behind the development of universal moral standards, not (religious) dogmas. Reasoning based on dogmas is dangerous, like xenophobic nationalism, communism, neoconservatism with aspects of neoliberalism, and all kind of (religious) fundamentalism, as discussed in several chapters. Rationalization has its limits but is by far preferable as the driver behind the development of a harmonic and fair society for all like in an emotional social contract being content plus intentions. Yes, we must respect our emotions as well and many need 'a father' to talk to (religions deliver this option), but we must be aware that we can control ourselves and that we must be open to learn every day. Tolerant atheism (strongly related to humanism) is rational, not a therapy or a neurosis or another dogma but a recovered mental health.
It results in violence going down and promotes 'social contracts' in societies. It develops an alternative meaning why we are here and what are our responsibilities. Tolerant means that we must accept, to a certain extent, religions and ethnic cultural differences and create the conditions that these values can contribute and enrich a pluriform society based on the universal moral standards of neutral secular States and supranational institutions. That requires a certain attitude. Earth becomes too small for narrow minded nationalism, imperialism, fundamentalist religions, and intolerant and indisputable, even aggressive convictions. Many cases show that by reasoning and learning we are able to develop a harmonious society for all, being less fundamentalist with our embraced identities and prejudices. What we need is reason, trust, hope and understanding based on respect for others and we must accept that many need rites, myths and some specific identification. How to deal with all of this? The emerging power of our collective brain is huge and if we push in the right direction, we will find a way to peacefully live together. There is no acceptable alternative. History shows that dogmas are a tragedy in civilization, always causing repression, discrimination, and worse. We must change our attitude because we are running out of time.

In this study I will argue that:
We are vulnerable on Earth because we cannot control all laws of Nature.
Homo sapiens is a singularity in population dynamics, but we are just a temporary population on Earth.
Many are thinking that we are about to become a 'God', with the knowledge and the technology to acquire eternal youth or to destroy Earth. “Man is the master of his own fate”. However, our wisdom and social capabilities are developing slower than our technology or our population on Earth. A dangerous situation.
Science shows that we do not need the concept of God.
Religion is psychology, a type of neurosis.
Religions act as social ‘institutions’, delivering an identity to members.
Religion may give a meaning of life what is acceptable under conditions of the private sphere and respecting the secular democratic law.
An atheist accepts the existence of the Universe and that we are there as a product of evolution. This implies that we only can find meaning *in* life (internal meaning).
We have work to do on Earth and make the best of it being part of nature.
A theist believes that everything is created and he connects his life with the wonders of nature, our being, and that gives meaning *of*/to life (external meaning).
Too many theists claim knowing the truth.
Religion, including ‘the chosen people and God is on our side’ is a human construct.
Tolerant atheism can contribute because its basic value believes in internal meaning / drive of humans, based on ratio in the process of evolution, building a harmonic society in an emerging process with universal ethics and moral duties; a win-win for all.
Our basic morals, values and virtues are the result of an emerging process of our civilization on Earth, which is still under development.
Meaning, reason and morality are discovered rather than created.
In general, dogmas are a threat for our community on Earth.
We really must work on a social contract for all, at national and at international level.

Index

Introduction

My Commandments

1. Do not do to others what you would not want them to do to you.
   In all things, strive to cause no harm
2. Treat your fellow human beings, your fellow living things, and the world in general with love, honesty, faithfulness and respect
3. Do not overlook evil or shrink from administering justice, but always be ready to forgive wrongdoing freely admitted and honesty regretted
4. Live life with a sense of joy, purpose and wonder and contribute where possible
5. Always seek to be learning something new and question everything
6. Always check your ideas against facts, and be ready to discard even a cherished belief if it does not conform to them
7. Never seek to censor or cut yourself off from dissent; always respect the right of others to disagree with you
8. From independent opinions on the basis of your own reason and experience; do not allow yourself to be led blindly by others
9. Do not indoctrinate your children. Teach them how to think for themselves, how to evaluate evidence, and how to disagree with you
10. Value the future on a timescale longer than your own and use your talents to contribute to the development of a peaceful and happy global community for all. That means sharing with and supporting others who need it.

These rules (inspired by Richard Dawkins; find another set in Chapter 4.5) have nothing to do with religion or the belief in a specific doctrine; they are basic values developed in human evolution in a process of civilization being the result of a learning process related to the development of the capabilities of our (collective) brain. We do not need religion to be good (good behavior we also find in some populations of animals) and a utopia based on one specific ideology for all is impossible, as argued in this study. In many instances it is the opposite. History tells us that religion and political ideologies causes more suffering and dead people than anything else. Theists will tell you that it is the consequence of the fall of sin or just part of life on Earth awaiting Heaven; not acceptable, too easy. Our moral sense and ethical rules have an evolutionary origin. The logic of Darwinism (or more in general, evolution / emerging processes) concludes that the unit in the hierarchy of life which survives and passes through the filter of natural selection will tend to be selfish (Dawkins), to survive, but over time we learned that working together and respect nature and other organisms has more benefits than 'survival of the fittest' for the individual (a result of our expanding brain (Dawkins, Pinker). Also reason, empathy, and altruism, developing basic morals, are a subject of evolution. This is what we call civilization, an evolutionary (social) development. Science shows that basically by far most people are good and not beasts. However, at the start of our civilization with agriculture, that was restricted to our own tribe, village, region, State. It will take 10,000 years of civilization to extend this good behavior to all human beings.

I also describe and discuss in this study the evolution of civilization, for many groups living together, in how to deal with religion and other ideologies, with minorities, without intolerance and aggression against others (Chapter 4). The human mind develops in an evolutionary way, from no-mind (simple organisms, plants, all just acting based on information carried by genes, stimulus - action), to instinct (complex behavior but determined in genes), to consciousness, awareness and reasoning based on the ability to learn, to conceptualize information from outside, to compare with memory and ethical feelings, making choices. Morality is not coded in our genes, as I will show, but with our expanding brains we learn very quickly what is good and what is not and this evolves during the process of civilization (Chapters 3 and 4). Race (within Homo sapiens) and culture are also not coded in our genes. For some, race is a belief and they think in terms of superior and inferior, like they do about ethical cultural differences. I will argue why this is wrong.

Some psychopaths or dogmatic fanatics do not learn or arrive at wrong conclusions, causing problems in society. For some nihilists, good and evil have no meaning. They just follow their believed doctrine, their ideology, or their 'nothing'. Also, this is not coded in their genes. It is their own responsibility unless they are completely disabled. Fundamentalists hang around in the past with archaic dogmas.
The change in the 'selfish' *gene or meme* (Dawkins) is remarkable. The function of (the development of) ethical emotion and reason is enabling individuals living together in social relationships. Homo sapiens learned / understand more and more that they cannot survive and develop a better life alone or in an isolated small group. Humans must take care for society and Earth and are part of a growing global community, not just a specific party or Church or Nation-State. We all have a pluriform identity (A. Sen). In many circumstances our chemical processes and genes ensure their own selfish survival by influencing organisms to behave altruistically, being a benefit in emerging processes like evolution and this has nothing to do with a conscious process. It increases the reciprocal altruism in the kin, the group. (Comparable with the laws of game theory). Important for the quality of our life in society is a good reputation. Without a good reputation, there is no trust and no trade.
I show that most of our relationships are based on power and we are still in a (slow) learning process on how to deal with power. There is no reason why evolutionary selfishness necessarily would be paired with psychological selfishness. For many, altruism is psychologically more dominant. Nature designed our universal sense of right and wrong and, like evolution, by developing an advanced brain with the ability to conceptualize; it is a long way for civilization to overcome one-sided, even fanatic, beliefs like religion, all kind of ideologies, racism, discrimination and (xenophobic) nationalism. In this study I argue that religion is a dangerous misunderstanding (Daniel Dennett, under Links) but I also argue that we must respect religion within limits.

We invented the (liberal) democracy 2300 years ago and must develop this to higher standards for a secular tolerant society. A complex process as we can notice today in the disappointment of many in democracy and the 'elite'. History shows that States with a dictatorship / all power in one hand, will not survive as a successful State in the long term but century after century we make the wrong political decisions. We have a short memory. Slowly our brain learns how to control our hormones and basic instincts. Morals and values come from humanity itself and are not coded in the genes or ingrained in our brains by a god. Good behavior and ethical virtues are remarkably universal and still emerging.

Religion has at one time or another been thought to fill four main roles in human life: explanation, exhortation, consolation, and inspiration. We have alternatives now but, under specific conditions, religions have a value in societies (Chapter 4). Explanation is delivered by Evolutionary Biology and Cosmology and scientific proof is increasing every day (Chapter 1). The source of Exhortation (moral instruction) is described above and in the process of civilization (Chapters 3 and 4). Consolation: statistically 90% of religious people feel guilty that they do not obey 'a supernatural' if something bad happens to them or in their environment (or they accept it is part of God's inscrutable plan); and one would expect that they take consolation in that God will take care of them and that they go to Heaven (and not Purgatory, or even Hell). For this whole story there is zero evidence. It is even very improbable (Chapter 2.10) and 80% of people are afraid of dying. Only martyrs are happy to die after killing innocent people not having the same archaic belief, being convinced that they help their God bringing His Kingdom on Earth. This is what I call, and many authors like me, nihilistic infantilism. (Islamic martyrs expect to go to Heaven finding 72 virgins. A mistake again because the original word in the Koran does not mean virgin but 'white grapes 'or, depending on the writing, 'a young woman'; and, nobody seems to care about the rape of 72 women (and young boys). Archaic, like the Old Scriptures. More in Chapters 2 and 4 and under Fundamentalism in references.

"(Christian) Religion has actually convinced people that there is an invisible man – living in the sky – who watches everything you do, every minute of every day. And the invisible has a special list of ten things he does not want you to do. And if you do any of those things, he has a special place, full of fire and smoke and burning and torture and anguish, where he will send you to live and suffer and burn and choke and scream and cry forever and ever 'til the end of time…But He loves you!" (Dawkins).

Also, for many Christians this is an unpleasant truth, so, they claim that all the good comes from God and all the evil is the Devil also being an imagination of the human mind. The truly adult view is that our life is as meaningful, as full and as wonderful as we choose to make it, as part of and contributing to evolutionary development (of mankind). We are all born without sin. We become dust again and our molecules are found in the soil and in other organisms, but we are in the mind of our children and social group and our genes survive. We can improve the quality of our life feeling responsible for society and for Earth. Our contribution, using our talents, is the basic drive and inspiration and for many also happiness and satisfaction. The knowledge that we have only one life should make it all the more precious (even if you believe in re-incarnation). What we have learned about how to create a good life for ourselves and the ones we love, we transfer to our children and social groups. Driven by knowledge and technology we learn that we live in a global society and that Earth is our shared unique home. Biology links ethics to morals. As a bonus our brains turn out to be powerful enough to accommodate a much richer world model than the mediocre utilitarian one that our ancestors needed in order to survive. We developed empathy, self-control, morality and taboo, and reason. We are a witness and we can contribute. These capabilities and knowledge (including belief in positive emerging processes) is our common conscience and responsibility to develop harmony and happiness as good stewards of Earth. That is richer than just materialism and more satisfactory than believing in a myth created by people in the past, with all the contradictions, illogical statements, obey, fear, and related intolerance, dogmatic indoctrinations and violence. Only by not understanding the size of the Universe, the construction and the mathematical logic, the Nature on our planet and its natural laws, human mind constructed something like God. We do not need to develop a concept like a God to explain gaps in our knowledge and to deal with our uncertainties; my motivation to write Chapters 1 and 2. Combined with science and the growth of our brains we develop insight into consciousness and a natural behavior beneficial to our existence in universe; a moral compass. We learn to deal with our flaws and vulnerability without specific dogmas. It goes slowly but this insight is accelerating. Shared welfare and global communication are dominant drivers. Two important subjects: we are part of one population on Earth and we must learn how to create a society for all. No talent should be wasted.

In this study I discuss also books from new-atheists like Dawkins, Stenger, Hitchens, Cliteur, Onfray, Philipse, Verhofstadt, among many others but I do not conclude to new-atheism. I use the term 'tolerant atheism' being not the same as humanism. The reason atheists should tolerate religious views is not because they respect all convictions from them, but because they should find a way of living in peace with the religious, rather than supposing that the phenomenon of religion will simply vanish in the face of rational or scientific arguments (Tim Crane). John Gray calls it "a type of toleration whose goal is not truth but peace". The world according to atheists should not be a world of pessimism or even existential nihilism and also not just based on the rejection of theism, as described in this study. It should be about believing in ourselves.
For an atheist (and an agnostic) it is a challenge: (Swijnenburg)
(1) To explain or understand why he/she exists; (2) To accept that man is not the center of the universe, created by God, 6000 years ago; (3) Getting a compass for good and evil; (4) That there is no life after death; (5) To create a meaningful life and goals.
Comments:
(1) Why is there something and not nothing? $0 = -1 + 1$. We can start with zero and end with zero, quantum mechanics proof. The absolutely nothing is difficult to imagine but

we can calculate it. The WHY is still a 'brute fact'. Universe is there and science tries to find reasonable explanations. (Ch.1).
(2) Man might be a result of evolutionary coincidence but now we are there we might be able to shape our own world. I also discuss the Anthropic Principle. (chapters 2 and 3 and in references).
(3) Partly in our genes and partly developed in an evolutionary way in societies. Collaboration and self-sacrifice are not exceptions. (chapters 2 and 3).
(4) and (5): The past / memories do not disappear and by breeding we are building a future for our genes. We are part of emerging processes of civilization. Our knowledge base is growing fast. We are not just traveling from birth to death. The journey itself is our target. (Meaning IN life. All chapters).

The four chapters in this study provide elaboration and explanation. In all the chapters I also pay attention to discussions between theists and atheists. I quote and combine many authors about these subjects and conclude in Chapter 4. I discuss challenges and I look for ways on how to build a future for all. But more than this, I look at other challenges and conclude that some of them are created by our attitude and behavior and others we only can deal with by working together.

Chapter 1 describes shortly Earth, Evolution, and the current state of science of the Universe and life on Earth. For all we did (and do) not understand man imagined a God / creator, the 'God of the gaps', and we have thousands of gods. Over time science found and finds good explanations and evidences for gaps and this continues. I look at some fascinating details of scientific theories and we must accept that, if we find new facts or phenomena, we might be forced to change the theory. Science is as objective as possible and based on laws of nature, measurable facts and logical calculations. At several places in this study I discuss the philosophy of knowledge and truth and give detailed considerations under references. The overview of science shows us how tiny and vulnerable we are, depending on the laws of Nature including evolution and population dynamics; and we do not need gods to explain our being.

Chapter 2 argues that there is no evidence for a God, even the probability is near zero; that there are many contradictions and illogical statements in the Holy Books, and that the fantasy of humans is unlimited. Even the origin of the books is arbitrary and they are certainly not 'the breath of God' unless you want to believe it. The four Gospels are not written by Mark, Matthew, Luke and John and their stories and views (on salvation) are very different. The chapter describes the history of religion and explains where the concept of God comes from. It discusses the philosophical, ontological, cosmological, and teleological arguments from theists. It describes the process of secularization, the philosophy of a secular world and the meaning of life, specifically since about 1750 AC (the Enlightenment) and the impact on almost all aspects of life and societies. It also argues that religion has a value in civilizations and I will discuss this in Chapter 4 in more detail.

Chapter 3 shows the process of social civilization, being our learning process, and argues that our brain and the social evolution develops in the direction of high moral sense and ethical rules in our communities. Violence is going down. There are many emerging processes developing in our society, and more powerful than top-down implementations of what governments (and Churches) think what is good for people, for countries and for the globe. We need to discuss the background of the kind of processes being able to develop our visions for the future. I also look at the development of political doctrines and of technology and the impact on society and on our civilization.

Chapter 4 discusses the conditions for a harmonious secular State. It describes that religions still have an important impact on the (secular) world. Not reason, philosophy, pragmatism, usefulness, and the results of science, but old dogmas are rather dominant in laws and culture. Islamic fundamentalism projects the tribal culture of the 7th century on modern times. I show in this study that generic ethical rules are much older than the revealed religions and still emerging in an evolutionary way. Our brain develops: "If we can control our interpretations we can control the world". There are threats but history has taught us that we can overcome them. And the good news: tolerance is increasing but we should not end at unlimited freedom for every individual because in that case we will live in an immoral jungle without any cohesion (everyone his own absolute truth). I discuss the conditions on how best to develop our societies and religions and contribute and even enrich a harmonic multi-ethnical-cultural society including the atheistic moral standards of an agnostic liberal, democratic, secular State. I discuss threats and tensions, the 'social contract' and the need of United or even Federal States and supranational organizations, also being emerging processes. I conclude that the future will show that 'Nations' and 'States' is 'old thinking' and very contra productive for our future. All of this in the context of our growing number and impact on Earth. I argue with demography and our resources on Earth that we must change our goals. 3% growth means doubling every 23 years. Endless growth of the GDP (Gross Domestic Product) is impossible and undesirable. We must focus on redistribution of welfare and regeneration of resources. The 'laws' of supply and demand are just a limited component of the economic system.
Not Homo economics but Homo ecological (Raworth Kate, 2020. *Doughnut Economics*).
We humans are and stay a subject to the laws of population dynamics and if we deny this we will not survive. And, how do we want to survive? As a small elite or together as Homo sapiens on Earth?

Under references the reader will find books and links, notes, and attachments for some concepts, definitions and explanations in science and philosophy, and two examples of dogmatic reasoning (The Tunnel Visions of Josh McDowell and of Ernest Mandel).
References includes more explanation about the Bible, Evil and the Devil, and in general, ideologies, knowledge, truth and conscience, and fundamentalism.
See separated index of references.
Notes and links are clustered by subject.

Definition:
(1) Religion is a specific fundamental set of beliefs and practices generally agreed upon by a number of persons or sects.
(2) Religion is the set of beliefs, feelings, dogmas and practices that define the relations between human being and sacred or divinity.
A given religion is defined by specific elements of a community of believers: dogmas, sacred books, rites, worship, sacrament, moral prescription, interdicts, and organization. The majority of religions have developed starting from a revelation based on the exemplary history of a Nation, of a prophet or a wise man who taught an ideal of life in many cases based on a vision. One solid definition for what we call religion is impossible or we must restrict to the phenomenon that all theists believe in the transcendent.
For religion, a universal accepted definition is impossible. There is not one unique characteristic being the essence of religion.

A dogma is a fixed, especially religious or social, belief or set of beliefs that people are expected to accept without any doubts.

Gordon Childe in *Prehistoric Communities of the British Isles*, 1940, identified the criteria of civilization as: the plow, the wheeled cart, animals trained to harness, the sailing boat, the ability to melt copper ore, knowledge of the solar calendar, standards of measurement, writing, specialized craftsmen, city life, and a surplus of food. This we find in Mesopotamia, the Sumer, 3500 BC. What did we add in 5,500 years?

In sociology, culture is an historical transmitted pattern of meanings embodied in norms, values, beliefs, expressive symbols, specific practices. Culture refers to the expressive side of human life and is strongly related to society.

Collective identity is an interactive and shared definition produced by several interacting individuals who are concerned with the orientations of their action as well as the field of opportunities and constraints in which their action takes place (A. Melucci, 1989). They can create a community; community as a territorial concept or/and as a relational concept.

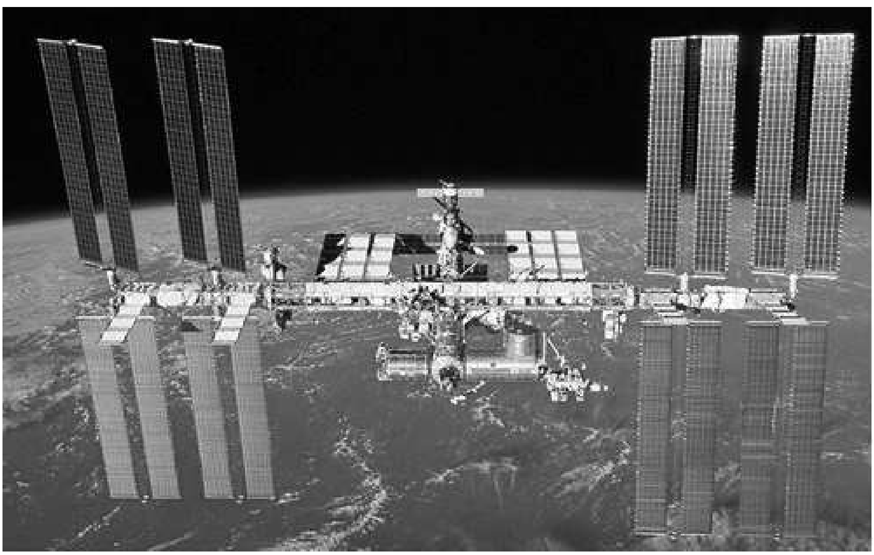
Remark: BCE (Before Common Era) equates to the time Before Christ (BC). CE (Common Era) equates to the time after the birth of Christ (AD) = (AC). BC = BCE; CE = AC.
I will use AC and BC.

Metrics.

1 km = 0.621 mile
1 km2 = 0.3861 sq. mile
1 sq. mile = 640 acres
1 ha. =10,000 m2 = 2.47 acres
1 cm = 0.3937 inch
1 m = 3.28 feet
1 kg = 2.2 pounds
1 kg = 35 ounces
1 ton = 1,000 kg
1 Metric Ton (MT) = 1,000 kg
1,000 kg = 22,041 pounds
1 USA pound = 0.453 kg
1 UK gallon = 4.55 l.
1 US gallon = 3.7 l.

1 lightyear is the distance light (or related particle) goes in 1 year with a speed of 299,792,458 km / sec. in vacuum (about 300,000 km / sec. or 670 million miles per hour). In water it is 255,000 km / sec.
One lightyear = 9,460,800,000,000 km (about 9,500 billion km is 9.5x10^9).
Different dimensions:
Mass of a Proton in kg = 1,672.623.1 x 10^-27 and in Electron Volts it is 938 MeV/c^2
Quantum related definitions under Glossary in Links, Technology.

The reader can skip formulas, mathematics and complex philosophical background information to understand the reasoning in this study. Just focus on the 'big picture' and conclusions and think about how to contribute to the development of our harmonic civilization on Earth.



(NASA). The International Space Station in orbit at 400 km from Earth is an important first step for man in space. The ISS program is international, from USA, Russia, Japan, Canada, Europe with first element launched in 1998. Manned since 2000. Circling around is 92 minutes with 28,000 km per hour.

Chapter 1

Cosmos, Earth, Evolution, Four forces and Elementary particles. Quantum theory. Is all of this created 6004 (or 6200?) years ago or is this the results of the laws of nature?

1.1 Generic information to get a view of the Universe and Life in a scientific context. 'Try to understand where we are'. First, let me present some facts making you humble.

We are like galactic dust in a corner of the universe, and to galactic dust we shall return. The Universe is about 13.82 billion years old as calculated in many ways. Radius is 1.3 x 10^10 light-years (light speed is about 3x10^5 km/sec. being 300,000 km/sec). Same maximum speed for any mass(related) particle. That is 9,500 billion km / year = 1 light-year). The Sun is about 5 billion years old and is 8.3 light-minutes away, which is 149.6 million km. A flight with a Boeing 747 to the Sun will take 18 years. Sub-Planet Pluto is about 6 billion km away. The diameter of Earth is 12,742 km, from Jupiter is 139,822 km, from the Sun is 1,392,000 km. Around the equator, Earth is 40,075 km. The Moon is 10,916 km with a distance to Earth between 363,000-406,000 km (ellipse) and the distance decreases every year with a few cm. Mass of the Sun is1,989 x 10^30 kg being 328,946 times mass of Earth. Mass of Earth is 5.97 x 10^21 MT. Composition: 35% Fe; 29% O; 15% Si; 13% Mg; 2.5% Ni; 1.2% Ca; 1.1% Al. (see table of elements, Ch.1.6). Atmosphere composition: 78% N2; 20.94% O2; 0.93% Ar; 0.04% CO2; 1% water. From the surface 29.8% is land. From every 200 atoms in our body 126 are hydrogen, 51 are oxygen, and 19 are carbon. The other 4 are very diverse but essential. We are 65% water depending age. The Sun is 73.9% Hydrogen and 26.1% Helium. Same compositions have Jupiter and Saturn. In our Solar system 99.86% of the total mass is the Sun, the 0.14% are all planets together: Mercury, Venus, Mars, Earth, Jupiter, Saturn, Uranus, Neptune, including all sub-planets, moons and other waste in our solar system.

The nearest star Alpha Centauri is 4.27 light-years away. Our galaxy the Milky Way has over 200 billion stars like our Sun, circling around a Black-Hole (explained later) with a mass of 2.5 million Suns. Around many of these stars we find planets; estimate is 50 billion. From these planets, maybe 500 million have the condition to develop life. There must be other life on Universe. About 3,500 exoplanets (extra-solarplanets) are found. Closest, with statistical change for life, is Proxima b at 4.2 light-year, part of the nearest galaxy, Andromeda, is - 2.25 – 2,44 million light-years away. Scientists are convinced that life needs water. Nearby candidates for (primitive) life are Mars, Titan (moon of Saturn), and Europe (moon of Jupiter).

Mars has a thin atmosphere of CO2 (95%), Nitrogen (3%), Argon (1.6%), and some Oxygen, Methane, and water. The average temperature at the surface is minus 53 C°. (Venus is +480 C°). The atmospheric pressure on Mars is just about 0.6% of Earth's. Water is really everywhere in the Universe. Scientists have discovered the largest and farthest reservoir of water ever detected in the Universe at distance of 30 trillion miles away into a Quasar—one of the brightest and most violent objects in the cosmos (explained later)—the researchers have found a mass of water vapor that's at least 140 trillion times that of all the water in the world's oceans combined, and 100,000 times more massive than the Sun.

We have been investigating stars and planets since the start of mankind but were limited by our technology being the human eye and telescopes. A breakthrough came in the 20th century. Wernher Von Braun's V-2 was the first rocket to reach space, at an altitude of 189 kilometers on a June 1944 test flight during WorldWar II. Derivatives of Korolev's R-7 Semyorka missiles (Soviet technology) were used to launch the world's first artificial Earth satellite, Sputnik 1, on October 4, 1957. The Soviet space program was at the first years, 1930 – 1991, impressive. (More details under Links, Cosmos).
The USA was challenged and President Kennedy promised that the USA would bring a man on the Moon. At the end of World War II, Von Braun and most of his rocket team surrendered to the United States, and were expatriated to work on American missiles at what became the Army Ballistic Missile Agency. This work on missiles such as Juno I and Atlas enabled the launch of the first US satellite Explorer 1 on February 1, 1958, and the first American in orbit, John Glenn in Friendship 7 on February 20, 1962. As director of the Marshall Space Flight Center, Von Braun oversaw development of a larger class of rocket called Saturn, which allowed the US to send the first two humans, Neil Armstrong and Buzz Aldrin, to the Moon and back on Apollo 11 in July 1969. Additionally, satellites were developed to investigate our Solar System (Links, Cosmos: timeline of satellites in Space).
Our speed in space: NASA's robotic Juno spacecraft arrived at Jupiter on July 4, 2016, and the gas giant's impressive gravity accelerated the probe to approximately 165,000 mph (265,000 km/h) relative to Earth. This made Juno the fastest-moving human-made object in history so far. (Voyager II goes 55,000 km / hour, going out of our Solar system behind Pluto). With the speed of Juno, it takes 17,231 years to go to Proxima b (one way). NASA previously estimated the total number of observable galaxies in the Universe to be around 200 billion. However, a 2016 study showed that the total number of observable galaxies in the universe is around two trillion. We are an incredible and inconceivable tiny part in a 'corner' of the Universe.
The farthest Galaxy observed, Abell 1835 is 13.2 billion light years away (started sending light about 500 million years after the 'Big Bang', calculated start of Universe. (Ch.1.7). Because Universe is expanding since the 'Big Bang' the current distance of Abell is 40 billion light years away. Real space / Universe is much much bigger than we can see (estimate is 10^200 meter against 10^26 meter what we see) and very empty. The density of Universe is about 1.4 x 10^29 g cm^-3 (corresponding to about 1 atom / m3 on average). Also, an atom is very empty. When the nucleus is a golf-ball, its electrons are in a kind of orbit at 100 km (more below).
The Hubble Constant is the unit of measurement used to describe the expansion of the Universe (the distance between elements in Universe is increasing. See later).
The Universe, in fact, is getting faster in its acceleration per unit of time.
The Parallax as a measure of the distance: 1 parsec is the distance from a star with a parallax of 1 arc-second. That is 3.2651 light-year (more under Links, Cosmos).

To understand Universe, we must look at some key-figures. Later in the text of Chapter 1 the reader will find them back in their context.

The Universe:
6 essential numbers, 4 forces, critical for life (Martin Rees).

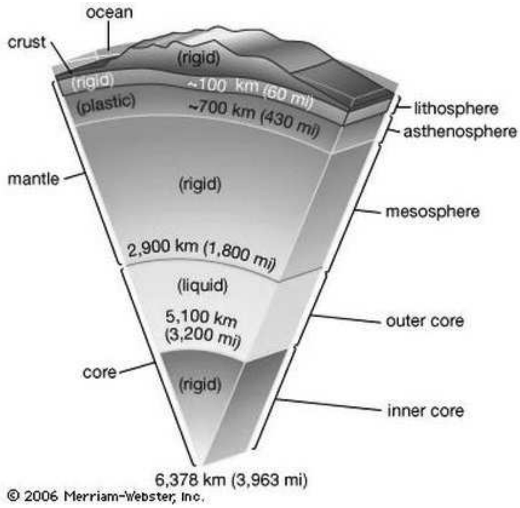
- N is 10^36 (1 with 36 zero), the strengths of the *electromagnetic forces* that hold atoms together (carried by photons).
- Σ is 0,007 defines how firmly atomic nuclei bind together (the *strong force* carried by Gluons keeping Quarks together). There is also the *weak force* carried by Bosons and related to radioactivity. This force is 1^-11 weaker than N, and 10^-13 weaker than Σ.
- Ω measures the amount of material in Universe and is related to G, the gravity. The gravity constant is 6.67428 x 10^-11 Nm^2 kg^-2. (m/s^2 = N/kg. or 1 N = 1 kg x m/s^2). A newton is how much force is required to make a mass of one kilogram accelerate at a rate of one meter per second squared.
  Mass = Energy: E = mc^2 (c is the speed of light.)
- Q is 10^-5. The cosmic microwave background that gives Universe a temperature of 2.728 degrees C. above absolute zero (being−273.15 °C) shows some ripple amplitudes. The fluctuation is about 1/100,000 and that is Q. These fluctuations are the seeds for all cosmic structures.
- D is the 3+1 dimensions. Space (3D) and time.
- Λ (lambda) is very small and is a cosmic 'antigravity' that controls the expansion of Universe. The vacuum energy. See the Cosmological Constant.

I add: The fine-structure constant **α** is of dimension 1 and very nearly equal to 1/137,035.999.206. It is the "coupling constant" or measure of the strength of the electromagnetic force that governs how electrically charged elementary particles (e.g., electron, muon) and light (photons) interact.

1.2 The Earth.

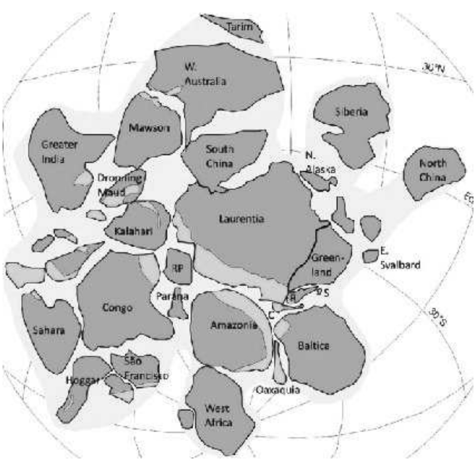
Earth is our world and is moving. Our knowledge about Earth accelerated in the 18th century. First, because new innovative technology was developed, and second, the religious ban on free objective science was broken (Ch. 3.4). The Earth is a result of clustering cosmic dust (solar nebula) shortly after the emergence of the Sun, 4.6 billion years ago. Much of the Earth was an ocean of magma and molten because of frequent collisions with other bodies which led to extreme volcanism. One very large collision is thought to have been responsible for forming the Moon (current theory). The Moon is 4.53 ± .01 billion years old. But here is something strange with the Moon. The density of the moon is 3.35 kg / liter; from Earth it is 5.5 kg / liter. The density of the Sun is 1.41 kg/l; Mercury 5.43 kg/l; Venus 5.24 kg/l; Mars 3.93 kg/l. The Moon must have been part of the mantle from Earth, not the core (see below). The Moon contains about 1-liter water (ice) / m^3 soil. Over time, the Earth cooled, causing the formation of a solid crust, the continental plates, and allowing liquid water to exist on the surface (Holmes).

The outer core of the Earth is a 'fluid' layer about 2,300 km thick and composed of iron and nickel that lies above Earth's solid inner core and below its mantle. Its outer boundary lies 2,890 km beneath Earth's surface. The transition between the inner core and outer core is located approximately 5,150 km beneath the Earth's surface. It's not as solid unlike the inner core. The temperature of the outer core ranges from 4,030 °C in the outer regions to 5,730 °C near the inner core. Because of its high temperature, modeling work has shown that the outer core is a low viscosity fluid (about ten times the viscosity of liquid metals at the surface) that is turbulently.

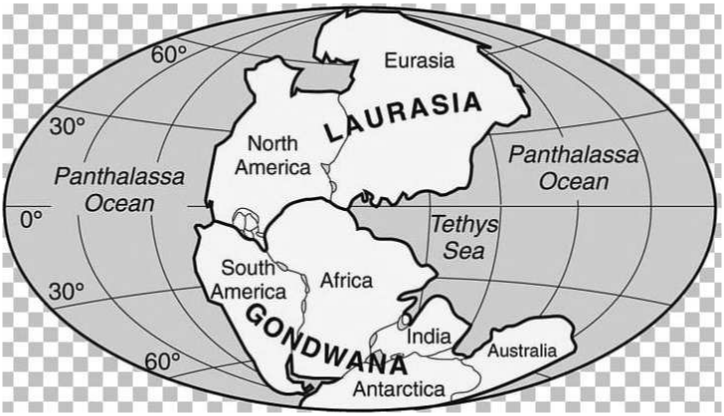


The lithosphere is subdivided into tectonic plates (our continents). 200 million years ago there was one huge landmass, Pangaea. 130 million years ago. This landmass started to break into pieces caused by tectonic forces. Tectonic plates are able to move because the Earth's lithosphere has greater strength than the underlying asthenosphere. Lateral density variations in the mantle result in convection.

Plate movement, Continental drift, was predicted by Alfred Russell Wallace in 1889 and argued by Alfred Wegener in 1912; but the theory (definition of theory versus hypothesis under references) was rejected because it seemed improbable and it was unclear what caused the drift. A plausible driving force was missing. It took until 1968-1972 that tectonics and the heat from Earth; gravity and radioactivity were accepted as the driving forces. In the 1960's it was found that samples from the ocean floor at the



mid-Atlantic ridge were quite young and grew progressively older as you moved away from it to the East or the West ocean floor.The first 'picture' we have is about 800 Million years in the past. A Hypothesis called Rodinia. After Rodinia (1.2 – 0.8 Billion years) we know Pannotia / Greater Gondwana (600 – 540 Million years), and Pangaea (300 -180 M. years ago).
When Earth was cooling, there was a clustering of mass (1100 – 750 M. years ago). The drifting repeated several times in different ways.



Pangea: Laurasia in the North and Gondwana in the South.

Pangaea is, unlike than Rodinia, not a hypothesis but a solid theory. Fossil evidence for Pangaea includes the presence of similar and identical species on continents that are now great distances apart. We found palm trees on the Antarctic. Additional evidence for Pangaea is found in the geology of adjacent continents, including matching geological trends between the eastern coast of South America and the western coast of Africa. Glacial deposits, specifically till, of the same age and structure (definition structure under references) are found on many separate continents which would have been together in the continent of Pangaea. Paleomagnetic study of apparent polar wandering paths also support the theory of a supercontinent. Gondwana formed prior to Pangaea. Pangaea began to break apart about 170 M. years ago.

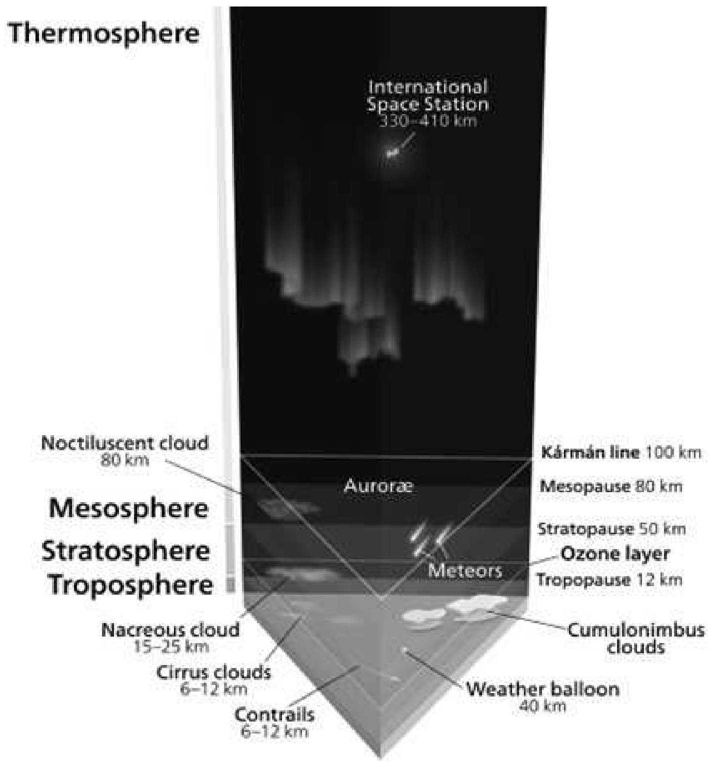
The continuity of mountain chains provides further evidence for Pangaea. Plate movement is thought to be driven by a combination of the motion of the seafloor away from the spreading ridge (due to variations in topography and density of the crust, which result in differences in gravitational forces) and drag, with downward suction, at the subduction zones. Basaltic magma rises up the fractures and cools on the ocean floor to form new sea floor. Older rocks will be found farther away from the spreading zone while younger rocks will be found nearer to the spreading zone. Examples: the Indian Plate split from Madagascar starting 100 million years ago. It began moving North, at about 20 cm. per year and is believed to have begun colliding with Asia as early as 55 million years ago. Australia moves with 7 cm / year to the North in the direction of the equator. North-America moves with 9 cm per year away from Europe. Continental drift, mantle dynamics, is causing volcanoes and earthquakes and the creation of mountains, pressing of sediments into rocks, the fold up and disturbing from layers in the soil. First indications were found by James Hutton in 1787 and 1795. He described the lifecycle of stones (erosion-sediment-compression-stone-rock-erosion) and concluded that shells and other marine fossils on the top of mountains came from Earth (mantle) dynamics, not from the Deluge. That time we notice the 'battle' of Neptunists versus Plutonists. Neptunists explained shells on mountain tops by rising and fall of sea levels (including the Deluge. A good example of a tunnel vision

because against all evidence from Plutonists, “it must have been caused by the Deluge”). Plutonists were convinced that volcanoes, earthquakes and other mantle dynamics continually changed the face of the planet. Charles Lyell published ‘*The Principles of Geology’* (1831-1833) describing all kind of geological processes and Plutonists won 150 years later the dispute because Neptunists could not show by calculations where all the water, covering all mountains, should come from and new methods for measuring plate tectonics and age determination of soil and rocks showed that geological dynamics existed (Holmes). Earthquakes and eruptions from volcanoes are extremely destructive and they have huge influence on climate.
A Caldera is a large cauldron-like volcanic depression, a type of volcanic crater (from one to dozens of kilometers in diameter), formed by the collapse of an emptied magma chamber. A famous one is the Yellowstone Caldera, USA. Famous old ones we find in Greece and in Italy.
The deepest point in the ocean is the Mariana Trench in the Pacific 11,300 m. below sea-level. At the bottom of the trench the water column above exerts a pressure of 1,086 bars (sea level is 1 bar). The highest point on Earth is the Mount Everest 8,850 m. The real highest mountain is the Hawaii volcano, 4205 m. above sea level and 5998 m. below (in total 10,203 m). Remarkable is that only 4 people reached the bottom of the Mariana Trench (1960, 2012, 2019). The Moon was reached by 12.

Magnetism.
I look at some details of magnetism because it is a promising force in new technologies in the near future (Chapter 3.15). It also introduces the concept Field, important for Chapters 1.10, 1.11. Magnetism is also used by many animals (and humans) for navigation. The outer core convection of Earth is causing the geomagnetic field around the Earth. The magnetic field that extends from the Earth's interior out into space, where it meets the solar wind, a stream of charged particles emanating from the Sun. A magnetic field is the magnetic effect of electric currents and magnetic materials. The magnetic field at any given point is specified by both a direction and a magnitude (or strength); as such it is a vector field (Chapter 1.11). Magnetic fields can be produced by moving electric charges and the intrinsic magnetic moments of elementary particles associated with a fundamental quantum property, their spin (Chapter 1.14). In everyday life, magnetic fields are most often encountered as a force created by permanent magnets, which pull on ferromagnetic materials such as iron, cobalt, or nickel, and attract or repel other magnets. During the solidification of magma crystals are formed in the direction of the magnetic field from Earth at the time of solidification. An indicator for geological research.
Earth's magnetic field is not constant—the strength of the field and the location of its poles vary. Earth's magnetic field changes over time because it is generated by a geo-dynamo (in Earth's case, the motion of molten iron alloys in its outer core). The North and South magnetic poles wander widely over geological time scales, but sufficiently slowly for ordinary compasses to remain useful for navigation. The last two years the North pole moved with 55 km / year in the direction of Siberia. A geomagnetic reversal is a change in a planet's magnetic field such that the positions of magnetic North and

magnetic South are interchanged. The Earth's field has alternated between periods of normal polarity, in which the direction of the field was the same as the present direction, and reverse polarity, in which the field was the opposite. These periods are called Chrons. The time spans of Chrons are randomly distributed with most being between 0.1 and 1 million years with an average of 450,000 years. Most reversals are estimated to take between 1,000 and 10,000 years. The latest one, the Brunhes–Matuyama reversal, occurred 780,000 years ago and happened very quickly. The magnetic field also changes in power from time to time. 150M – 75M years ago it was 3 times stronger as today. We can expect a change again and that is dangerous because during the change we are less or not protected from the radiation of the Sun and we and many animals will have problems with navigation. It will really impact life on earth. More under Links, Geology.

The atmosphere.



The ionosphere is comprised of the outer portion of the mesosphere, thermosphere and exosphere and it is so named because it is composed of plasma, meaning it is ionized by radiation from the sun.

Picture: https://en.wikipedia.org/wiki/Atmosphere_of_Earth

Northern lights is a common name for the Aurora Borealis (Polar Aurorae) in the Northern Hemisphere and Aurora Australis in the South. The Northern Lights are actually the result of collisions between gaseous particles in the Earth's atmosphere (ionosphere, 50 – 1000 km) with charged particles released from the sun's atmosphere. Variations in color are due to the type of gas particles that are colliding. Other planets also have magnetic fields like Jupiter, ten times stronger than Earth being 8 Gauss. The magnetosphere is the region above the ionosphere and extends several tens of thousands of kilometers into space, protecting the Earth from the charged particles of the solar 'wind' and cosmic rays that would otherwise strip away the upper atmosphere, including the ozone layer that protects the Earth from harmful ultraviolet radiation.

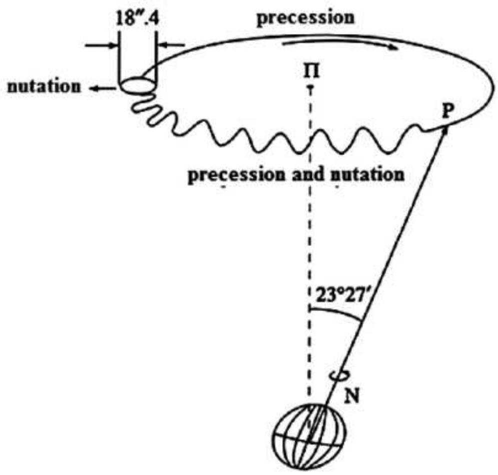
Orbits.

One galactic year is the time the Sun needs to complete its orbit in the Milky Way (Chapter 1.6): 220 M years. The rotation of Earth is slowing down.

There are three general factors that determine the forcing changes in the Milankovitch cycles.

- Eccentricity (the elliptical changes in the Earth's orbit around the sun)
- Obliquity (the tilt of Earth's axis toward and away from the sun)
- Precession (the wobble of Earth's axis toward and away from the sun)

Today, standing on the equator, our speed is almost 1,800 km/hour but gravity keeps our feet on the ground. (Geological Time table Chapter 1.3)



During the Devonian era (416-359 million years ago) the duration of a day was 22 hours and a year got 400 days. Earth circles around the Sun in an almost perfect orbit, with and eccentricity of just 2%, from 147 – 152 million km from the Sun. (Mercury shows 20%, with temperature differences of 90˚C)

Earth's orbit is 365.256 days with a speed of 108,000 km/h. Warm and cold (ice ages) periods on Earth are following the Milankovitch cycle of on average 100,000 year.

The Earth's axis completes one full cycle of precession approximately every 26,000 years. At the same time, the elliptical orbit rotates more slowly. The combined effect of the two precessions leads to a 21,000-year period between the astronomical seasons and the orbit. In addition, the angle between Earth's rotational axis and the normal to the plane of its orbit (obliquity) oscillates between 22.1 and 24.5 degrees on a 41,000-year cycle. It is currently 23.44 degrees and decreasing. Earth's spin axis drifts slowly around the poles; the farthest away it has wobbled since observations began is 37 feet (12 meters). These wobbles don't affect our daily life, but they must be taken into account to get accurate results from GPS satellite positioning. Around the year 2000, Earth's spin axis took an abrupt turn toward the east and is now drifting almost twice as fast as before, at a rate of almost 7 inches (17 centimeters) a year. It's no longer moving toward Hudson Bay, but instead toward the British Isles.

Ice-ages.
(Holmes and other sources like Wikipedia and climate reports).
Earth is currently in an interglacial period of the Quaternary Ice Age, with the last glacial period having ended approximately 11,700 years ago with the start of the Holocene Epoch (see end of Chapter 1.2). On a lower level there are the small cold cycles of 21 and 11 years: the cycles of the Sun spots. During ice ages the CO2 content in the atmosphere was 180 ppm (parts per million), in the interglacial periods on average 280 ppm (by thawing permafrost), but since the Industrial revolution we have a content of 415 ppm currently. This is just a small fluctuation in the geological timetable. During the Cretaceous, 100 M years ago, the CO2 content was up to 20 times higher. Do not expect that global warming keeps the ice-ages away. More in Chapter 3.14 and in Links. During 4.7 billion years of Earth history only 600 million years we find ice at the poles. At least four times the whole globe was ice. It is likely that we're going to keep seeing smaller wintertime maximums in the future because in addition to a warmer atmosphere, the ocean has also warmed up. That warmer ocean will not let the ice edge expand as far south as it used to, although the maximum reach of the sea ice can vary a lot each year depending on winter weather conditions. We are seeing a significant downward trend, and that's ultimately related to the warming atmosphere and oceans. Since 1979, that trend has led to a loss of 620,000 square miles of winter sea ice cover, an area 2.5 times the size of France.
Known ice ages (Ma = million years ago)

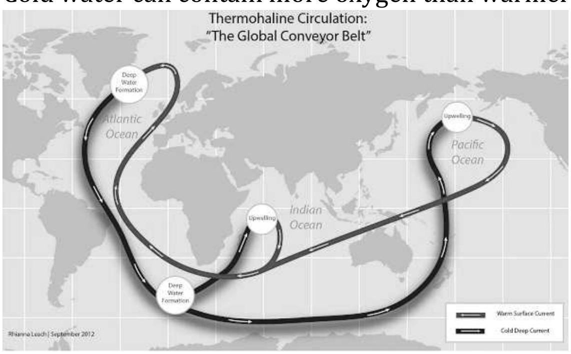
Name	Period (Ma)	Period	Era
Quaternary	2.58 – present	Neogene	Cenozoic
Karoo	360 – 260	Carboniferous and Permian	Paleozoic
Andean-Saharan	450 – 420	Ordovician and Silurian	Paleozoic
Cryogenian (or Sturtian-Varangian)	850 – 635	Cryogenian	Neoproterozoic
Huronian	2400 – 2100	Siderian and Rhyacian	Paleoproterozoic

Temperature and CO2 in 400,000 thousand of years: average temperature fluctuates about 10˚C and CO2 between 180 ppm and 400 ppm.
The Antarctic ice on land is on average 2300 m thick with a maximum of over 5000 m. Studies show that globally, the decreases in Arctic sea ice exceed the increases in Antarctic sea ice. Since the late 1970s, the Arctic has lost an average of 20,800 square miles (53,900 square kilometers) of ice a year; the Antarctic has gained an average of 7,300 square miles (18,900 sq km). See National Snow and Ice Data Center. Recently we measure with advanced methods that the gap has changed into a surplus in the Antarctic region but that can change again (More in Chapter 3.14).

The average temperature on Earth today is + 15 degrees C. Without the primary greenhouse gases in Earth's atmosphere like carbon dioxide, methane, nitrous oxide, and ozone, the temperature would be in average minus 16 degrees C. Since 1900 there

are area changes in temperature from -0.6 (some small areas) up to + 2.5 degrees C. specifically on the Northern hemisphere and East Africa.
Our atmosphere is not very stabile as we know from wind, rain, snow, areas with high and with low barometric pressure. Clouds can rise up to 15 km with up draughts and down draughts of over 150 km/hour. That works, combined with differences in temperature and humidity as a power engine. The negative electric charges have a powerful urge to rush to the positively charged Earth.
We count 40,000 thunders / day. A bolt of lightning travels at 435,000 km / hour and can heat the air around it to decidedly crisp 28,000 degrees Celsius (causing the bang we hear). At 9,000-10,000 m. up we have Jet streams of 300 km/h. (used by our Airplanes). Caused by the rotation of Earth, an airstream curves to the right in the northern hemisphere and to the left in the southern hemisphere (the Coriolis Effect, Coriolis 1835. An artillery shell fired 15 miles would derivate by 100 yards without the right adjustments).

Water on Earth.
For about 3.8 billion years Earth has 1.3 billion cubic kilometers of water. The number of molecules is stable in a closed system like Earth. Out of all the water 97% is in seas, 3% is fresh water. From the fresh water 0.036% is found in rivers and lakes, 0.001% in the air, the rest is ice with 90% of it Antarctica.
The oceans are not a uniform mass of water. There are differences in temperature, salinity, density all causing convections. The ocean is a complex environment and always on the move. Colder water and saltier water are denser and dense water sinks. Cold water can contain more oxygen than warmer water.

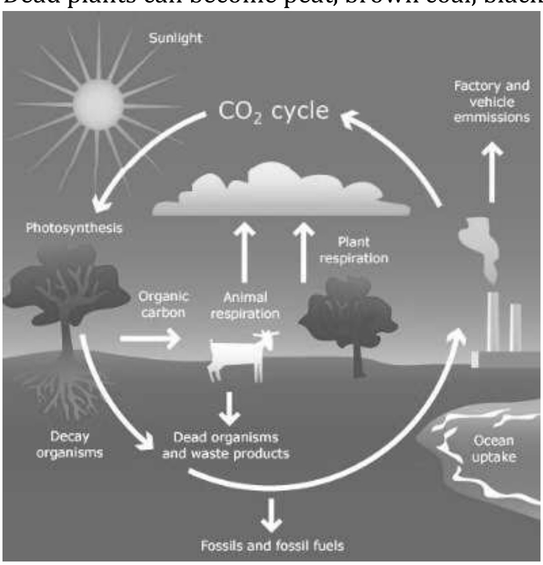


In the oceans we find 'Jet streams', the thermohaline circulation moves heat and also nutrients around. (Picture: Robert Simmon, NASA). The Gulfstream from the Gulf of Mexico along the Eastern Atlantic coast to Iceland moves 55 Sverdrup of water with a speed of 8 km / hour. (1 Sverdrup = moving 1 million m^3 water / second). That is the amount of all rivers together.
We find tides, waves (up to 26 m. high), turbulence, currents, waterfalls (from colder or saltier water), tsunamis, and underwater landslides.
The Agulhas Current is the western boundary current of the southwest Indian Ocean. It flows down the east coast of Africa from 27°S to 40°S (South of Cape Town). It is narrow, swift and strong with an estimated net transport of 70 Sverdrups (Sv, millions m3/s) and a speed of 9.3 km/hour. Oceans are important for the circulation of CO_2.
(The counter current (black arrows) is cold, going North in deeper water).

Since 1850 we humans blew an estimated 100 billion tons of CO2 into the air but nature produces 200 billion tons every year. (Almost) all of this is absorbed again by nature, in specific by oceans (More details in Chapter 3.14). Until 1930 when ocean research started we knew more from the Sun than from 70% of Earth. Now we know that life is everywhere and we describe how it evolved. The ocean shows several habitats. The sub-Littoral zone (0 – 200 m with photosynthesis), the Bathyl zone (200 – 2000 m), the Abyssal zone (2000 – 6000 m with bioluminescent fishes up to 4000 m), the Hadal zone > 6000 m with many one-cell organisms and with sea-stars, worms and even fish like *Pseudoliparis swirei,* found at 10,900 m. deep.

Cycles in Nature.
Almost all phenomena we know in nature are part of a cycle. In nature there is no waste. Time and calendar cycles; planetary cycles with astronomical cycles; climate and weather cycles; geological cycles; organic cycles with agricultural cycles, biological and medical cycles; physics cycles with mathematics of waves cycles, electromagnetic spectrum, and sound waves. We also know of other miscellaneous cycles such as economic and business cycles; music and rhythm cycles; religious, mythological, and spiritual cycles; social and cultural cycles; military and war (see Chapter 3.18). Examples are the cycle of stone – sediment; cycle of water; of oxygen, of carbon; of nitrogen. Complex cycles are the Photosynthesis & the Calvin cycle; the Krebs or TCA or Citric Acid cycle.

Life cycle of Carbon.
Within this cycle there are many sub-cycles. The global carbon budget is the balance of the exchanges (incomes and losses) of carbon between the carbon reservoirs or between one specific loop (e.g., atmosphere <-> biosphere) of the carbon cycle.
Dead plants can become peat, brown coal, black coal, oil. (Also: Links, Geology).



The calcium carbonate in plankton sinks to the bottom and can transfer into thick layers of limestone. With geological tectonic processes this limestone is lifted to the surface and by erosion it dissolves and produces Carbon again. When humans burn fossil fuels, most of the carbon quickly enters the atmosphere as carbon dioxide. Sedimentation is the collective name for processes that cause mineral or organic particles (detritus) to settle in place. The particles that form a sedimentary rock by are called sediment.

The study of the sequence of sedimentary rock strata is the main source for an understanding of the Earth's history, including Paleogeography, Paleoclimatology and the history of life (Paleontology).

The waters of the world are the main oxygen generators of the biosphere; their algae are estimated to replace about 90 percent of all oxygen used. Oxygen consumption by respiration, decomposition, rusting, and combustion. Oxygen generation by photosynthesis and sunlight (via reaction with water vapor). All living things are made of carbon. Carbon is also a part of the ocean, air, and rocks. In the atmosphere, carbon is attached to some oxygen: carbon dioxide (CO_2). Science can explain the evolutionary development of complex cycles.
(1) From sunlight to chemical energy: Photosynthesis and the *Calvin cycle* in the Chloroplast of green plant cells.
The sum of reactions in the Calvin cycle is the following:
$3\ CO_2 + 6\ NADPH + 5\ H_2O + 9\ ATP \rightarrow$ glyceraldehyde-3-phosphate (G3P) $+ 2\ H^+ + 6\ NADP^+ + 9\ ADP + 8\ P_i$ (P_i = inorganic phosphate. Pictures on internet).
The light-independent reactions of photosynthesis are chemical reactions that convert carbon dioxide and other compounds into a sugar. These reactions take the products (ATP and NADPH) of light-dependent reactions and perform further chemical processes on them. There are three phases to the light-independent reactions, collectively in the Calvin cycle: carbon fixation, reduction reactions, and ribulose 1,5-bisphosphate (RuBP) regeneration.
(2) The Citric acid cycle – also known as the tricarboxylic acid (TCA) cycle or the *Krebs cycle* – is a series of chemical reactions used by all aerobic organisms (like humans) to release stored energy through the oxidation of acetyl-CoA derived from carbohydrates, fats and proteins into carbon dioxide and chemical energy in the form of adenosine triphosphate (ATP). In addition, the cycle provides precursors of certain amino acids as well as the reducing agent NADH that is used in numerous other biochemical reactions. Its central importance to many biochemical pathways suggests that it was one of the earliest established components of cellular metabolism on earth.

1.3 Life on Earth.

(Darwin, Huxley, Lynch, Ayala, and others)

Earth is 4.6 Billion years old. If we take this as one year, starting January 01, the Cambrian explosion of life started November 19, the extinction of the Dinosaurs was December 26 around 8.00 pm, and our civilization started December 31, 40 seconds before midnight. See the Geological Time table below. The first life forms appeared between 3.8 and 3.5 billion years ago. That were the Prokaryotic cells without a nucleus membrane and nuclei and they developed the chemical process of photosynthesis. Since then oxygen was produced. It took another 1 billion years before the Eukaryotic cells appeared, with a cell nucleus, membrane and nuclei like us. (Pictures and more details below). After again 1 billion years, multi-cellular life appeared (Brasier. Also, under Links, Climate; Biology). The real explosion of life took place starting in the

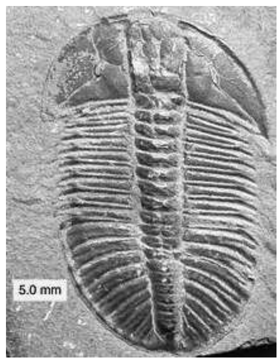
Cambrian, 542 million years ago. Since then we can notice several massive extinctions and also explosions of new organism again. More than 99 percent of all species, amounting to over five billion species that ever lived on Earth are extinct. Detailed studies between 1820 and 1850 of the strata and fossils of Europe produced the sequence of geological periods still used today.

Table 11.1 Geological Time Scale (To be read from below upwards)

Era	Period Age in million years	Epoch Age in million years	Some Important Fauna (Animals) & Flora (Plants)
Coenozoic (Era of Modern life)	Quarternary	Recent (Holocene) 0.01	Modern man dominant, Modern mammals, birds, fishes, insects. Rise of herbaceous plants, decline of woody plants.
		Pleistocene 1.8	Ice ages, humans appear. Evolution of human society and culture.
	Tertiary	Pliocene (Age of mammals) 5	Ape-like ancestors of humans appear. Adaptive radiation of flowering plants, origin of man.
		Miocene 23	Continued radiation of mammals and angiosperms.
		Oligocene 34	Origin of most modern mammalian orders including apes.
		Eocene 57	Angiosperm dominance increases, further increase in mammalian diversity, origin of horse.
		Palaeocene 65	Major radiation of mammals, birds and pollinating insects Primitive primates appear
Mesozoic (Era of Med-ieval life)	Cretaceous 144		Extinction of dinosaurs and toothed birds. Angiosperms (flowering plants) appear
	Jurassic 208 (Age of Reptiles)		Dinosaurs dominant, origin of toothed birds (first birds). Gymnosperms were dominant.
	Triassic 245		Origin of dinosaurs and mammals.
Palaeozoic (Era of Ancient life)	Permian 285		Extinction of trilobites. Origin of mammal-like reptile and most modern orders of insects.
	Carboniferous 360 (Age of Amphibians)		Origin of reptiles, amphibians dominant, extensive forests of vascular plants, first seed plants
	Devonian 408 (Age of fishes)		Origin of amphibians, diversification of bony fishes, origin of gymnosperms.
	Silurian 438		Origin of jawed fishes, colonization of land by plants and arthropods, origin of vascular plants.
	Ordovician 505 (Age of invertebrates)		Origin of first vertebrates, *e.g.*, Ostracoderms (jawless fishes), Invertebrates and marine algae abundant.
	Cambrian 544		Origin of most invertebrate phyla, origin of trilobites.
Precambrian (From 570 to 4600 million years ago)	570		Diverse algae.
	700		Origin of first animals
	1500		Oldest eukaryotic fossils
	2500		Oxygen begins accumulating in atmosphere
	3500		Oldest definite fossils known (prokaryotes)
	4600		Approximate origin of earth

The largest defined unit of geological time is the super-Eon, composed of Eons. One Eon is 1 billion years (is 1 Ga). Eons are divided into eras, which are in turn divided into periods, epochs and ages. Geological timetable (in million years. Ma). (Links, Geology)

Geochronology is the science of determining the age of rocks, fossils, and sediments using signatures inherent in the rocks themselves. Absolute geochronology can be accomplished through radioactive isotopes, whereas relative geochronology is provided by tools such as paleo-magnetism and stable isotope ratios.
The identification of strata by the fossils they contained, pioneered by William Smith, Georges Cuvier, Jean d'Omalius d'Halloy, and Alexandre Brogniart in the early 19th century, enabled geologists to divide Earth history more precisely. It also enabled them to correlate strata across national (or even continental) boundaries. If two strata (however distant in space or different in composition) contained the same fossils, chances were good that they had been laid down at the same time.
Cambrian, 541 – 544 million years ago, shows an explosion of life. Practically all major animal phyla started appearing in the fossil record. It lasted for about 13 – 25 million years and resulted in the divergence of most modern metazoan (multi-celled) phyla.



The first discovered Cambrian fossils were trilobites. Picture: *Ogygopsis klotzi* from the Mt. Stephen Trilobite Beds (Middle Cambrian) near Field, British Columbia, Canada.
The largest trilobites may have been 45 centimeters long and weighed 4.5 kilograms. The Cambrian explosion, as it is called, produced arthropods with legs and compound eyes, worms with feathery gills and swift predators that could crush prey in tooth-rimmed jaws. Extinction of trilobites was in Permian, 285 M years ago. Source: Wikipedia.
Flowering plants developed since Cretaceous, 144 M years ago.

Earlier fossil evidence has since been found. The earliest claim is that the history of life on earth goes back 3,850 million years: Rocks of that age at Warrawoona, Australia, were claimed to contain fossil stromatolites, stubby pillars formed by colonies of microorganisms (cyanobacteria). Fossils (Grypania) of more complex eukaryotic cells, from which all animals, plants, and fungi are built, have been found in rocks from 1,400 million years ago, in China and Montana. Picture: Trilobite *Opabinia*.

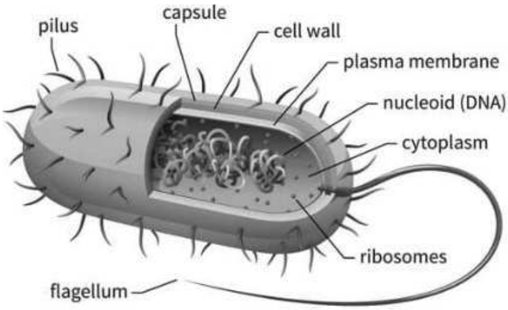
Number of species described.
Estimates on the number of Earth's current species range from 10 million to 14 million, of which about 1.5 million have been documented and over 80 percent have not yet been described. Biologists have work to do.

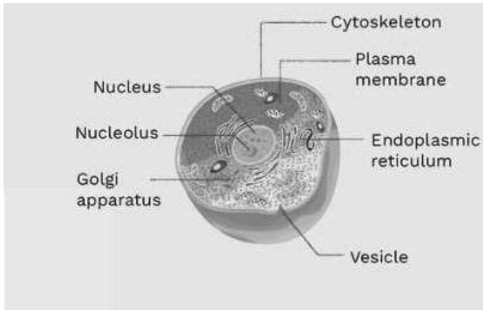
The total estimate is millions more like insects 5 M; virus 400,000; fish 40,000; spiders 600,000; crustaceans 150,000; mollusks 200,000; nematoda 500,000; prokaryota 1 M.

Category	Species	Totals
Vertebrate Animals		
Mammals	5,513	
Birds	10,425	
Reptiles	10,038	
Amphibians	7,302	
Fishes	32,900	
Total Vertebrates		**66,178**
Invertebrate Animals		
Insects	1,000,000	
Spiders and scorpions	102,248	
Molluscs	85,000	
Crustaceans	47,000	
Corals	2,175	
Others	68,827	
Total Invertebrates		**1,305,250**
Plants		
Flowering plants (angiosperms)	268,000	
Conifers (gymnosperms)	1,052	
Ferns and horsetails	12,000	
Mosses	16,236	
Red and green algae	10,386	
Total Plants		**307,674**
Others		
Lichens	17,000	
Mushrooms	31,496	
Brown algae	3,127	
Total Others		**51,623**
TOTAL SPECIES		**1,730,725**

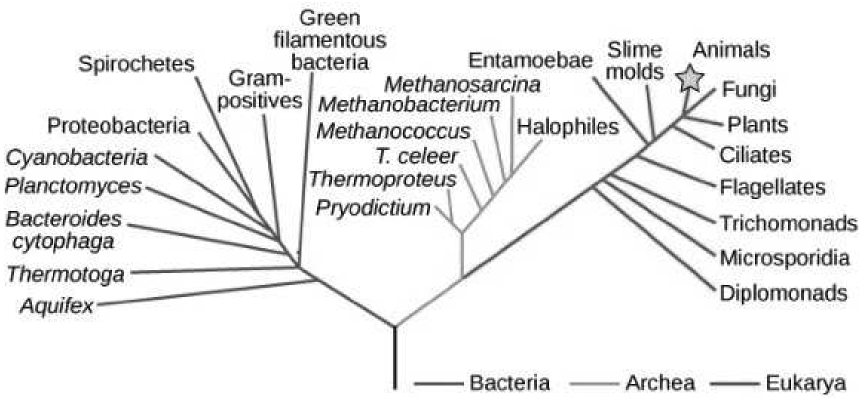
Until the discovery of radioactivity in 1896 and the development of its geological applications through radiometric dating during the first half of the 20th century (pioneered by such geologists as Arthur Holmes) which allowed for more precise absolute dating of rocks, the ages of various rock strata and the age of Earth were the subject of considerable debate. I come back on this in Chapters 2, specifically 2.13, and 4.3, 4.5. Until the 1980's with the advent of genomic sequencing techniques, bacteria were the only recognized group of single-celled organisms to have prokaryotic cells not containing a nucleus. Phylogenetics enabled the discovery of another group of prokaryotes that was initially and informally named "archae-bacteria" (they were renamed Archaea since their genomes are far distant from that of bacteria). Actually, many Archaea had long been studied extensively, but with the idea that the Archaea were bacteria; sequence analysis revealed that this group of prokaryotes needed placement within the Universal Tree of Life as a distinct Domain, alongside Bacteria and Eukarya (see picture below).

Prokaryotic cells are very tiny, 1 micron across (10^{-6} m), compared to 10 to 100 microns in most eukaryotic cells. Prokaryotes exhibit an amazing diversity of types of metabolism to power themselves that is nonexistent in eukaryotes. For example, the metabolic processes of nitrogen fixation (conversion of atmospheric nitrogen gas to ammonia) and methanogenesis (production of methane) are unique to prokaryotes and enormously impact the nitrogen and carbon cycles in nature. Most of the Earth's atmospheric oxygen was produced by free-living bacterial cells. Scientists found complex Archaea that might bridge the gap between prokaryotes and eukaryotes (Nature Magazine, 2016). Recent studies have provided support for the emergence of the eukaryotic host cell from within the archaeal domain of life, but the identity and nature of the putative archaeal ancestor remained a subject of debate.





Left Prokaryotic cell; Right Eukaryotic cell.
Source: https://diffzi.com/prokaryotic-cells-vs-eukaryotic-cells/



(a) Rooted phylogenetic tree

Bacteria at the left; Archaea in the middle; Eukarya at the right.
Humans are under Animals.

Prokaryotes are found everywhere eukaryotes are found, as well as in many environments too extreme for eukaryotes. Instances of prokaryote and eukaryotes symbiosis abound. Despite their diminutive size, prokaryotes are the most abundant and ubiquitous form of life on Earth. They comprise some 90% of the total biomass in the seas. Homo is just a small twig. The organelles of eukaryotes (like mitochondria in animals and chloroplasts in plants) are thought to be evolutionary descendents of Bacteria and Archaea that invaded, or were captured by, primitive eukaryotes as early as 3.5 billion years resp. 2.3 billion years ago in an evolutionary leap described by the theory of endosymbiosis (Margulis 1966)
New is the discovery of 'Loki-archaeota', a novel candidate archaeal phylum, which forms a monophyletic group with eukaryotes in phylogenomic analyses, and whose genomes encode an expanded repertoire of eukaryotic signature proteins that are suggestive of sophisticated membrane remodeling capabilities. 'Our results provide

strong support for hypotheses in which the eukaryotic host evolved from a bona fide archaeon, that underpin eukaryote-specific features were already present in that ancestor'. During the early stages of the genomic era, it also became apparent that eukaryotic genomes were chimaeric, comprising genes of both archaeal and bacterial origin, in addition to genes specific to eukaryotes. To determine the phylogenetic affiliation of Lokiarchaeum and the Loki2/Loki3 lineages, maximum-likelihood and Bayesian inference (Bayesian theory: see Intermezzo in Chapter 2.10, and Links, Technology) phylogenetic analyses were performed, using sophisticated models of molecular sequence evolution. The defining feature that sets eukaryotic cells apart from prokaryotic cells (Bacteria and Archaea) is that they have membrane-bound organelles, especially the nucleus, which contains the genetic material and is enclosed by the nuclear envelope. Eukaryotic cells also contain other membrane-bound organelles such as mitochondria and the Golgi apparatus (find below). In addition, plants and algae contain chloroplasts. Eukaryotic organisms may be unicellular or multicellular. Eukaryotes represent a tiny minority of all living things.

There are essential differences between the highly developed plant-cell and the animal cell. Animal cells are distinct from those of other eukaryotes, most notably plants, as they lack cell walls and chloroplasts and have smaller vacuoles. Due to the lack of a cell wall, animal cells can adopt a variety of shapes. (Nice pictures at Wikipedia).
We humans have many types of cells like Stem Cells, Bone Cells, Blood Cells, Muscle Cells, Fat Cells, Skin Cells, Nerve Cells, Endothelial Cells, and more. (Links, Biology). The data indicate that the archaeal ancestor of eukaryotes was even more complex than previously inferred and allow us to speculate on the timing and order of several key events in the process of the development of eukaryote cells (eukaryogenesis). RiboNucleic Acid (RNA, see later) is a polymeric molecule implicated in various biological roles in coding, decoding, regulation, and expression of genes. RNA and DNA are nucleic acids. Mitochondria have been described as "the powerhouse of the cell" because they generate most of the cell's supply of adenosine triphosphate (ATP), used as a source of chemical energy (more below). There are also many types of plant cells and tissues composed of several types of cells (Links, Biology). Chloroplasts are organelles, specialized subunits, in plant and algal cells.

1.4 Our genes and evolution.

Life makes order from chaos while expending energy. Essential in the cells are DNA (the macromolecule DesoxyriboNucleïneAcid) for storing information like how to produce enzymes (protein) for making order (structures), and ATP (Adenosine Tri-Phosphate molecule) as the medium of energy exchange. Key for the processes is RNA (RiboNucleic Acid). RNA can both storage information like DNA and catalyze reactions like amino acids into proteins. There are just 22 different amino acids essential for life, coded by nucleotides from DNA.
On the bottom of the ocean we find hydrothermal vents ('black-smoker' vents) with cells storing energy by pumping electrically charged particles, usually sodium or

hydrogen ions, across membranes. Four billion years ago the ocean was acidic, saturated with carbon dioxide, no oxygen. There was a steep proton gradient across the thin iron-nickel-sulphur walls of the pores that formed at the vents. Inside these mineral pores chemicals would have been trapped in a space with abundant energy, which could have been used to build more complex molecules, as mentioned before. With the energy from the proton gradients they can replicate themselves. This is shown in laboratories as well and the step to create ATP can be simulated. Key for our existence on Earth.
A bacterium is limited in how large it can grow by the quantity of energy available to each gene. That is because the energy is captured by the cell membrane by pumping protons, and the bigger the cell the smaller its surface area relative to its volume. However, 2 billion years after life started, huge cells began to appear with complicated internal structures, the eukaryotes, as described before, and this was possible by a merger from bacteria living inside archaeal cells; a groundbreaking theory of Lynn Margulis (1938-2011). She was the primary modern proponent for the significance of symbiosis (more below) in evolution. These bacteria are now the mitochondria. Mitochondria only have 13 genes with DNA and their own RNA and ATP. They generate much more energy than used by the mitochondrion itself. That is why eukaryotic cells can grow with more DNA. Each gene plays its little role; no gene comprehends the whole plan. There are no 'master' genes. There can be order and complexity without any management. "We are The Selfish Gene", survival machines blindly chemically programmed to preserve the selfish molecules known as genes (Dawkins). There are still many gaps in science to explain how life evolved in detail.

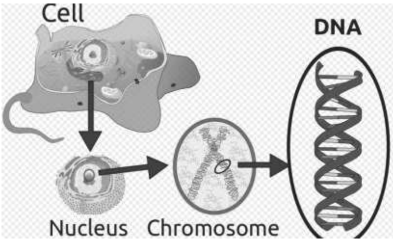
Life has two characteristic features: metabolism and heredity. It is proven that from specific chemicals step by step RNA can be formed and RNA can catalyze specific reactions and RNA can duplicate itself. Man has about 300 different types of cells. The embryo starts as one cell and during the first days of multiplying every cell (the stem cells) has still the capacity to grow a whole human being (details later). In mammals, there are two broad types of stem cells: embryonic stem cells, which are isolated from the inner cell mass of blastocysts, and adult stem cells, which are found in various tissues. After some time, embryonic stem cells start to differentiate into other types and the capability to create every type of cell is blocked. Finally, we have as an adult about 37x10^12 cells (Bianconi, 2013). In laboratory we can create the conditions to construct complex proteins, even DNA and we can grow cells to organs. But (1) this is not creating life (however, see *Synthia*, Chapter 3.15, Synthetic Biology, since 2010 we can 'create' life in a laboratory but not just from a mix of chemicals) and (2) it is difficult to simulate how these laboratory conditions developed spontaneously in the geological history. By far not all organisms are reproducing by combining a cell from a male and from a female. There are many ways to reproduce. Asexual reproduction includes fission, budding, fragmentation, and parthenogenesis, while sexual reproduction is achieved through the combination of reproductive cells from two individuals. The ability of a species to reproduce through fragmentation depends on the size of part that breaks off, while in binary fission, an individual split off and forms two individuals of

the same size. Budding may lead to the production of a completely new adult that forms away from the original body or may remain attached to the original body.
Sexual reproduction, the production of an offspring with a new combination of genes, may also involve hermaphroditism in which an organism can self-fertilize or mate with another individual of the same sex. An interesting discussion is about immortality. Just dividing into two new organisms, fragmentation, budding, and both parts continue to live and divide again later. No parent dies. *Turritopsis dohrnii* is a small jelly-fish that never dies. After some time, it just renews its own cells.
The gene in its little role interacts with other genes. The development of an embryo into a body is perhaps 'The Greatest Show on Earth", Dawkins calls it. The key point is that there is no choreographer, no leader (gene) as mentioned. Order, organization, structure, these all emerge as by-products of rules which are obeyed locally and many times over. There is no overall plan / management, just cells reacting to local effects, and sometimes it goes wrong. It is like the organic growth of many cities. Like the construction of a termite mound. It is like the evolution of language. Not only does it evolve by itself, words changing their meaning even as we watch, despite the railings of the mavens, but it is learned, not taught.

Population genetics.
A population is a summation of all the organisms of the same group or species, which live in a particular geographical area, and have the capability of interbreeding producing fertile offspring. The area that is used to define a sexual population is defined as the area where inter-breeding is potentially possible between any pair within the area. Around a large bay on a coast we found population(s) of small sea snails. From the South to the North along the bay, step by step, the animals of the neighbor population have the capability of interbreeding. But the snails from the right and the left area cannot. Are these populations still one species? Difficult where to point the split into 2 species in this case. When a geographical subset of a population becomes isolated it evolves very rapidly at first (genetic drift). Later the population becomes more stabile. That is what we see in the development of humans since 130,000 BC and 80,000 BC when humans started migrating from Africa to all areas of Earth, and we find this phenomenon after extinctions.

The body is an emergent phenomenon consequent upon the competitive survival of DNA sequences, and so, natural selection that results in evolutionary change is far from random; the mutations in the DNA are random. (In biology, a mutation is the permanent alteration of the nucleotide sequence of the genome (see below) of an organism, virus, or extrachromosomal DNA or other genetic elements). It is a process of trial, error, coincidence, and survival of genes. Bacterial resistance to antibiotics, and chemotherapeutic drugs resistance within tumors, is both pure Darwinian evolutionary processes as well: the emergence of survival mechanisms through selection. The use of antibiotics selects for rare mutations in the genes in bacteria (even it might be junk genes) that enable some of them to resist the drugs. This works because the bacteria are multiplying very quickly. For cancer, somewhere in the body one of the cancer cells happens to have or acquire a mutation that defeats the drug (or radiation). When the rest of the cancer dies away (caused by treatment), the descendents of these cells gradually begin to multiply, and the cancer returns. This happens is many cases. Patients are happy that they seem to be clean after difficult treatment and within one year after, they die.

The amount of DNA in many organisms is much more than strictly necessary for building them. This DNA is just surviving like a parasite / 'useless' passenger. For the organism it seems to be junk. The human genome has about 25,000 genes and 20,000 of them are protein-coding genes. We use 9% of this (some authors claim it is 20%). However, this was the theory until 2012. See modern views at the end of Chapter 1.5. Some humble protozoa, onions, salamanders have far bigger genomes as humans. Grasshoppers have three times as much (60,000 genes); lungfish forty times as much. Bacteria with larger populations and brisk competition to grow faster than their rivals, generally do keep their genomes clear of junk. They do not have enough energy for junk. Large organisms have more than enough energy and there is no evolutionary survival pressure to clean up junk. We will see later that junk can be negative and positive in survival of the species. The modern synthesis in evolutionary biology bridged the gap between the work of experimental geneticists and naturalists and paleontologists.
It states that:
1. All evolutionary phenomena can be explained in a way consistent with known genetic mechanisms and the observational evidence of naturalists.
2. Evolution is gradual: small genetic changes regulated by natural selection accumulate over long periods. Discontinuities amongst species (or other taxa) are explained as originating gradually through geographical separation and extinction.
3. Natural selection is by far the main mechanism of change; even slight advantages are important when continued. The object of selection is the phenotype in its surrounding environment.
4. The role of genetic drift is equivocal. Though strongly supported initially by Dobzhansky, it was downgraded later as results from ecological genetics were obtained.
5. Thinking in terms of populations, rather than individuals, is primary: the genetic diversity existing in natural populations is a key factor in evolution. The strength of natural selection in the wild is greater than previously expected; the effect of ecological factors such as niche occupation and the significance of barriers to gene flow are all important.
6. In paleontology, the ability to explain historical observations by extrapolation from microevolution to macroevolution is proposed. Historical contingency means explanations at different levels may exist. Gradualism does not mean a constant rate of change. Chromosome (the double helix) picture below.

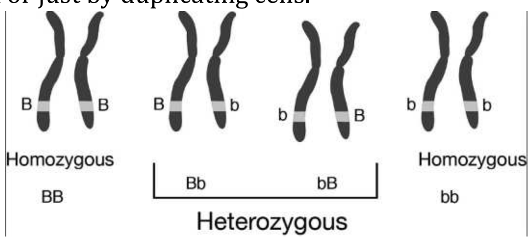


A *Centromere* – the point where the two chromatids touch. A chromosome is a long, stringy aggregate of genes that carries heredity information (DNA) and is formed from condensed chromatin.

An *allele* is an alternative form of a gene (one member of a pair) that is located at a specific position on a specific chromosome.

Diploid cells have two homologous copies of each chromosome (the double helix DNA), usually one from the mother and one from the father. Each single strand of DNA is a chain of four types of nucleotides (A, G, C, T). Nucleotides in DNA contain a deoxyribose sugar, a phosphate, and a nucleobase. The four types of nucleotide correspond to the four nucleobases *Adenine, Cytosine, Guanine*, and *Thymine*, are located in a specific order. A combination of 3 (like AGC) is a code for a chemical reaction. Something can go wrong during duplication or caused by radiation or chemicals. The change might be lethal, a disadvantage or an advantage. We call this a *mutation* if it effects the new generation. The replication mechanism is complex. In prokaryotic cells, there is just one chromatid, occurs free-floating in cytoplasm, as these cells lack organelles and a defined nucleus. The DNA-bound macromolecules in the nucleus are proteins, which serve to package the DNA and control its functions. Compaction of the duplicated chromosomes during cell division results either in a four-arm structure (in Eukaryotic cells). These DNA codlings determine distinct traits that can be passed on from parents to offspring through sexual reproduction or just by duplicating cells.

A cell is said to be homozygous for a particular gene when identical alleles of the gene are present on both homologous chromosomes. A diploid organism is heterozygous at a gene locus when its cells contain two different alleles of a gene (one might be dominant, one recessive).



See later under epigenetics.

Genetic polymorphism describes the inter-individual, functionally silent differences in DNA sequence that make each human genome unique. Genetic polymorphism is actively and steadily maintained in populations by natural selection. Most genes have more than one effect on the phenotype (the appearance) of an organism (pleiotropism).

The time frame for the evolution of the genus Homo out of the pre-Chimpanzee alike–human last common ancestor (more below), is roughly 10 to 2 million years ago (arbitrary what you call a Homo alike), that of Homo sapiens out of Homo erectus roughly 1.8 to 0.2 million years ago. However, for the development into a higher order / more complex species, we need a combination of advantageous mutation(s) in the genes plus natural selection as the driving mechanism. Calculations show that this process for a development from 'Chimpanzee ancestor to Homo' based on mutations only is up to 10,000 times too slow if we calculate with an average in mutations / year. The mechanism alone cannot explain the diversity on Earth. May be the total gene pool is more important than we think and has (part of) junk DNA a specific roll in this process? No, there are more forces. See end of Chapter 1.5. We cannot say 'from Chimpanzee to Homo' because we are not in a direct line from the Chimpanzee, we just have the same ancestor. From fossils we learn that many species are the same over a long period and suddenly we find new forms / species. It looks arhythmic. Still a gap in the scientific knowledge, but we find interesting phenomena such as analogy in organs and skeletons and homology like the body shape of tuna-fish and dolphins (Tuna is a fish, with organs like all fishes. Dolphins are mammals like whales (and humans) who developed during the evolution from land to sea and their organs are completely different from fishes. They have lungs, like us). Not all species are migrating over the Earth and every continent has its own characteristic species. The ecological niche describes how an organism or population responds to the distribution of resources and competitors. The notion of ecological niche is central to ecological biogeography, which focuses on spatial patterns of ecological communities and there are many examples.

Over 100 different species of insects developed resistance against DDT insecticide independently. Mutations are randomly but natural selection is not. If a mutation is not lethal and the individual with that mutation can survive in the population, the mutation becomes part of the gene pool from that population. If circumstances change, that mutation can become the key for the population to survive as proved many times (or can spread a decease and the population dies). The gene pool growth with time and with the number of generations. Bacteria have a new generation every 10 - 20 minutes. From Homo erectus to Homo sapiens we count about 50,000 generations. The placenta of mammals developed 100 million years ago. Independently also some fishes developed a placenta, like Poeciliopsis, a livebearer. The mother delivers nutrients to the embryo during the embryonic process through the placenta. More fishes developed a placenta independently from other species.

For Humans we find about 1 mutation / 1 million sex cells (sperm, ovum). The 2 sets of DNA from our parents have different 1 or 2 genes / 1000. The Human genome has over 3 billion nucleotides. So, we have about 3 -million differences between the genome / person / parent. The frequency of mutations is 10^{-8} that is one nucleotide mutation / 100 million nucleotides or 30 new mutations / person / generation. A new generation has 60 mutations in average (30 / parent). For mankind that is 420 billion mutations / generation. With 7.5 billion people on Earth our gene pool is huge (and do not call individuals with different mutations different races). We know mutation for one A, G, T, or C, from an allele, a chromatid, a chromosome, and some species have multiple chromosomes, called Polyploidy as mentioned. This hybridization is a natural process in evolution as described in Chapter 1.5 but if we create this with genetic manipulation in labs or force it in greenhouses, some call this criminal (Chapter 3.15).

Polyploidy occurs in highly differentiated human tissues in the liver, heart muscle and bone marrow. It occurs in the somatic cells of some animals, such as goldfish, salmon,

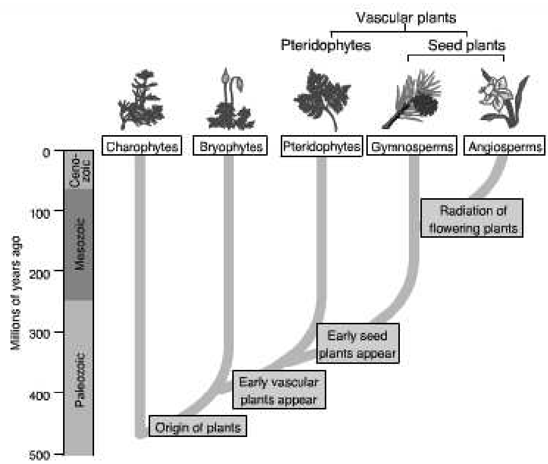
and salamanders, but is especially common among ferns and flowering plants, including both wild and cultivated species. Wheat, for example, after millennia of hybridization and modification by humans, has strains that are diploid (two sets of chromosomes), tetraploid (four sets of chromosomes) with the common name of durum or macaroni wheat, and hexaploid (six sets of chromosomes) with the common name of bread wheat. The sequence of A, G, T, C in DNA is the genetic code and it is all information, and that code can change, as said, but there is more. Molecules do not have intelligence. About 10 years ago scientists found piRNA. Piwi-interacting RNA is the largest class of small non-coding RNA molecules expressed in animal cells. piRNAs form RNA-protein complexes through interactions with piwi proteins. These piRNA complexes have been linked to both epigenetic (end of Chapter 1.5) and post-transcriptional gene silencing of retrotransposons and other genetic elements in germ line cells, particularly those in spermatogenesis (Retrotransposons are genetic elements that can amplify themselves in a genome and are ubiquitous components of the DNA of many eukaryotic organisms). Many piRNA factors have been identified; however, both the molecular mechanisms leading to the production of mature piRNAs and the effector phases of gene silencing are still enigmatic.
Self-organization theory deals with how global coordination within a system can result out of the local interactions between member parts. The theory of self-organization has grown out of many different areas from computer science to ecology and economics. Out of these areas has emerged a core set of concepts that are designed to be applicable to all self-organizing systems, from galaxies to living cells. Example is a multipolar neuron from our brain. Self-organization occurs in many physical, chemical, biological, robotic, and cognitive systems. Examples can be found in crystallization, thermal convection of fluids, chemical oscillation, animal swarming, and artificial and biological neural networks.

The behavior of insects that live in colonies, such as ants, bees, wasps and termites, has always been a source of fascination. Individual insects seem to do their own thing without any central control, yet the colony as a whole behaves in a highly coordinated manner. Researchers have found that cooperation at the colony level is largely self-organized and one of the ways they coordinate is with Pheromones (a secreted or excreted chemical factor that triggers a social response in members of the same species). The group coordination that emerges is often just a consequence of the way individuals in the colony interact. Further reading: Len Fisher, 2009, with a link to human behavior. Comparable mechanisms we find in swarms and schools (birds, fishes).
It is clear that there are more sources for information transfer in cells than DNA. Scientists do not know yet how self-organization exactly works but are researching this phenomenon. Identical twins with exactly the same DNA show differences as a result of self-organizations of proteins and cells.
Self-organization in biology can also be observed in spontaneous folding of proteins and other bio-macromolecules, formation of lipid bilayer membranes, pattern formation and morphogenesis in developmental biology. There are many examples of

self-organization, in life and in dead matter, as described in the study of Philip Ball in *Branches*, 2009. (Take the development of branches of veins and the lungs in the body. These detailed networks are not genetic).
With modern technology a new world opens at atomic level in cells en tissues with the Cryo-electron microscopy (cryo-EM), or electron cryo-microscopy, a form of transmission electron microscopy (TEM) where the sample is studied at cryogenic temperatures (generally liquid-nitrogen temperatures being -196 C). Cryo-EM is gaining popularity in structural biology. The resolution of cryo-EM maps is improving steadily and in 2014 some structures at near-atomic resolution had been obtained, including those of viruses, ribosomes, mitochondria, ion channels, and enzyme complexes as small as 170 kDa at a resolution of 4.5 Å (The angstrom is a unit of length equal to 10^−10 m. 1 Carbon-12 atom has a mass of 12 u (12 Da) and is 1.2 Å) and with this technology 2-3 Å is possible like a 2.2 Å map of a bacterial enzyme beta-galactosidase, published in June 2015. A version of electron cryomicroscopy is cryo-electron tomography (CET), where a 3D reconstruction of a sample is created from tilted 2D images.

1.5 Evolutionary systematic (Taxonomy).

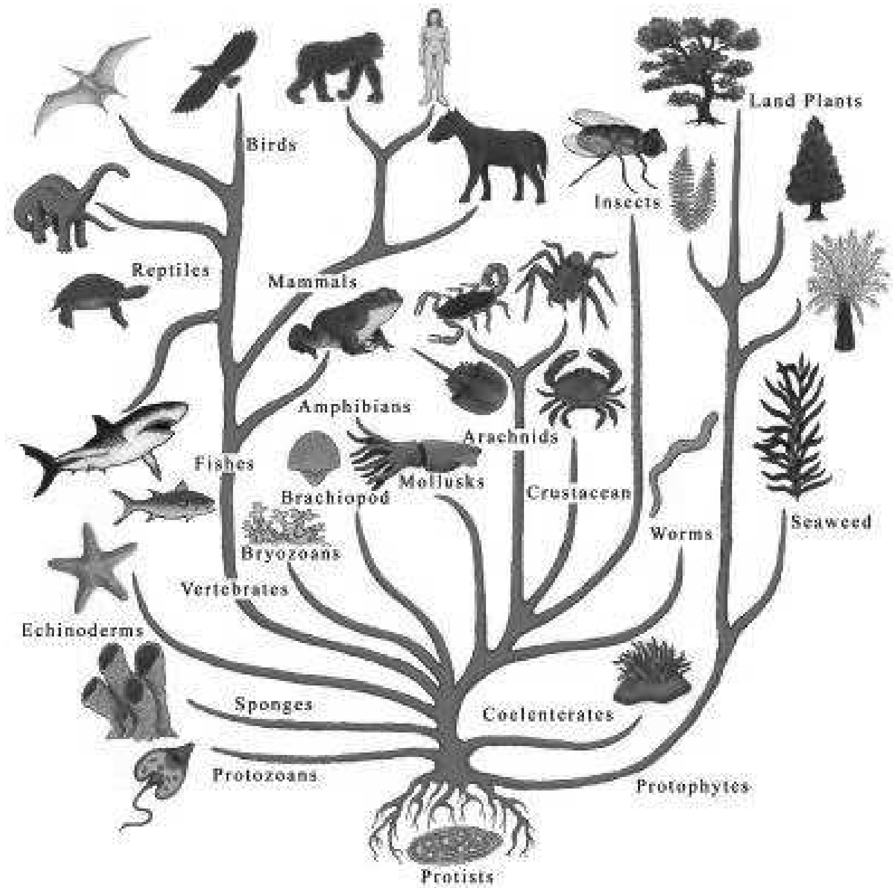
Evolutionary taxonomy / systematics is a branch of biological classification that seeks to classify organisms using a combination of phylogenetic relationship (shared descent), progenitor-descendant relationship (serial descent), and degree of evolutionary change. Efforts in combining modern methods of cladistics, phylogenetics, and DNA analysis with classical views of taxonomy have appeared and one can visualize the relationships. Additionally, we use the results of Paleontology, the scientific study of life that existed prior to the Holocene Epoch (roughly 11,700 years before present). It includes the study of fossils to determine organisms' evolution and interactions with each other and their environments (their paleoecology) and studies the link between biology and geology. Body fossils and trace fossils are the principal types of evidence about ancient life, and geochemical evidence has helped to decipher the evolution of life before there were organisms large enough to leave body fossils.



Left the plants, picture below animals.

Vertebrates comprise all species of animals within the subphylum Vertebrata (chordates with backbones). Vertebrates represent the overwhelming majority of the phylum Chordata, with currently about 70,000 species described. Vertebrates include such groups as the following: jawless fishes, jawed

vertebrates, which include the cartilaginous fishes (sharks, rays, and ratfish), tetrapods, which include amphibians, reptiles, birds and mammals, bony fishes, and mammals.
The taxa joined together in the tree are implied to have descended from a common ancestor. Phylogenetic trees are central to the field of phylogenetics. (There are many types of trees in scientific literature like Dendrogram, Cladogram, Phylogram, Chronogram, and more). Many taxonomy pictures of evolutionary trees on the internet.



Mammals.
Taxonomy terms used: We are part of the *Kingdom* Animalia; *Phylum* Chordata; *Class* Mammalia; *Order* Primates; *Family* Hominidae (Hominids); *Genus* Homo; *Species* Homo sapiens. We are mammals and mammals are any vertebrates (Chordates with backbones. Chordates possess a notochord, a hollow dorsal nerve cord, a post-anal tail, metameric segmentation, and a circulatory system), within the class Mammalia, a clade of endothermic (is an organism that maintains its body at a metabolically favorable temperature) amniotes ("membrane surrounding the fetus"). They are distinguished from the anamniotes (fishes and amphibians), which typically lay their eggs in water,

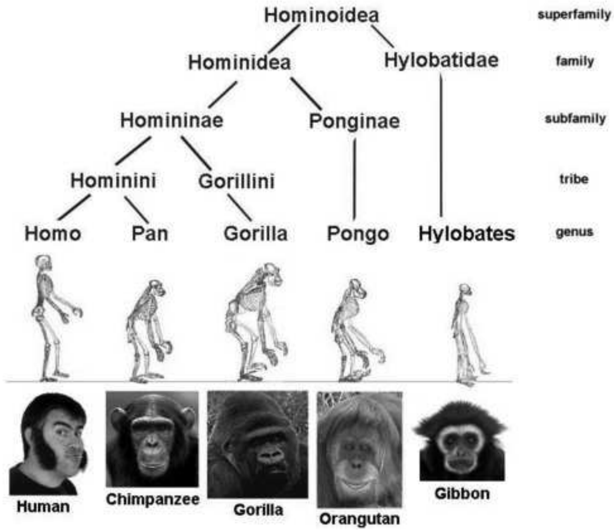
distinguished from reptiles (including birds) by the possession of a neocortex (a region of the brain), hair, three middle ear bones, and mammary glands. Females of all mammal species nurse their young with milk, secreted from the mammary glands.

Mammals include the currently biggest animals on the planet, the great whales (up to 30 m. and 190 tons). Some plants are much bigger (over 100 m). (The biggest fish is the Whale-shark, 10 m. and 20 MT). The basic body type is a terrestrial quadruped, but some mammals are adapted for life at sea, in the air, in trees, underground or on two legs. The largest group of mammals, the placentals, have a placenta, which enables the feeding of the fetus during gestation inside the female body. With the exception of the five species of monotreme (Australia). There are currently around 5,450 species of mammals. Half of all mammal species are rodents and bats.
The first mammals appeared in the late Triassic epoch (about 225 million years ago), 40 million years after the first therapsids. They expanded out of their nocturnal insectivore niche from the mid-Jurassic onwards. Most, if not all, are thought to have remained nocturnal, accounting for much of the typical mammalian traits. Mammals took over the medium- to large-sized ecological niches in the Cenozoic, after the Cretaceous–Paleogene extinction event (65 Ma) emptied ecological space once filled by non-avian dinosaurs and groups of reptiles that were now absent. Then mammals diversified very quickly; both birds and mammals show an exponential rise in diversity.
Man is a mammal of the order Primates. Based on fossil evidence, the earliest known true primates, represented by the genus Teilhardina, date to 55.8 million years old. Hominins are from the end of Miocene, Pliocene (5.33M – 2.58M) and in Pleistocene (2.58M – 0.011) up to recent (Holocene), and many extinct. Only the species Homo sapiens is successful and found all over the world.

The origin of man is not a simple, one line, based on the size of the brain. It is complex, more a family bush than a tree, combined with characteristics of the skeleton. Even in modern *Homo sapiens* we find brain sizes between 1000 cc - 1800 cc; on in average 1200 – 1400 cm^3. Important for what we call Hominins is that all of them walked upright.

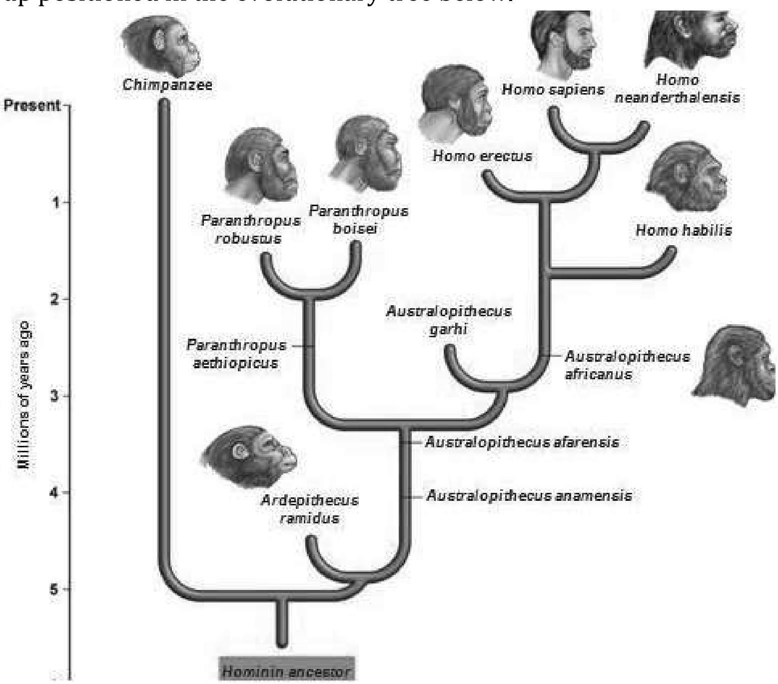
The first primates appeared 80-90 M. years ago. The oldest primate fossil is from Ida *(Darwinius masillae*), living 47 M. years ago. Much more about the development of Primates in Colin Tudge, 2009. *The Link. Uncovering Our Earliest Ancestor*.

Below the tree of Hominoidea leading to our species Homo.
We Homo sapiens are not from monkeys but we share early stages in evolution. See second picture below.



From all other groups, 5 are left (including Homo) and 4 are exposed for extinction: Gorilla (vulnerable in DRC, Rwanda, Burundi); Chimpanzee (incl. Bonobo. In Central – West Africa); Orang Utan (Borneo, Sumatra); Gibbon (Malaysia).

Homo group positioned in the evolutionary tree below.



Pinterest.com Also: Smithsonian: http://humanorigins.si.edu/evidence/human-family-tree

Homo sapiens, 300,000 – recent. Brain 1100-1500 cc; H. neanderthalensis 200,000 – 20,000. Brain1200 -1900 cc. (In France we found a 'Stonehenge' from Neanderthaler in a cave, 176,500 years old. Stonehenge in Wales is 4300 yr. old).
H. floresiensis 100,000 – 50,000; H. heidelbergensis (Denisofa) 700,000 – 200,000; H. naledi 500,000 – 200,000 South Africa; H. erectus 1.89 M – 143,000. Brain 850-1100 cc; H. rudolfensis 1.9M – 1.8 M; H. habilis 2.4 M – 1.4 M. Brain 510-700 cc (The earliest

documented representative of the genus Homo, which evolved around 2.8 million years ago may be from Australopithecus, and is arguably the earliest species for which there is positive evidence of the use of stone tools); H. erectus with fire, hand axes, stone knives. Peking man (last H. erectus) developed language(?).
Paranthopus group: robustus 1.8-1.2 M; boisei 2.3-1.2 M; aethiopicus 2.7-2.3 M.
Australopithecus group: africanus 3.3-2.1M.; garhi 2.5 M; afarensis 3.85-2.95 M. Brain 380-430 cc; anamensis 4.2-3.9 M.
Ardipithecus group: ramidus 4.4 M; kababba 5.8-5.2 M; tugenensis 6.2-5.8 M; tchadensis 7 – 6 M. (Brain Bonobos, Chimpanzees 380-500 cc; Gorilla 400-500 cc).

Table: (Johanson & Edey)

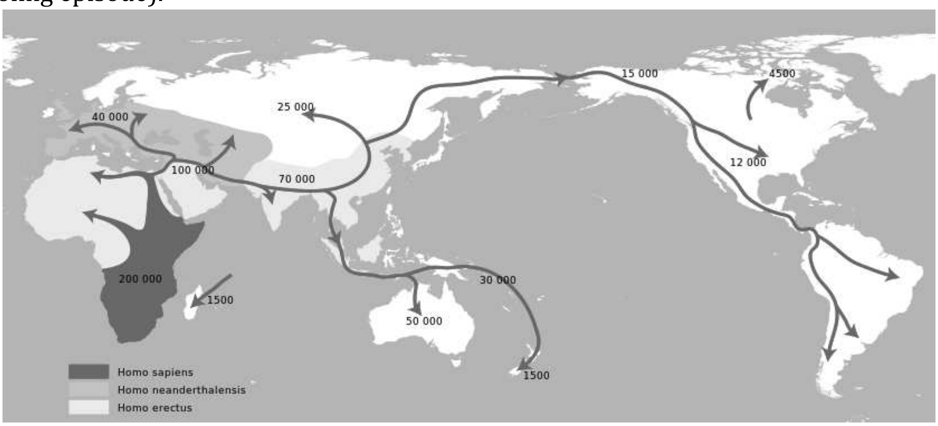
Hominids	*Pongids incl. Gorilla*
Living on the ground	Living in trees or partly on the ground
Walking upright	Not walking upright
Pair formation into a family	No pair formation. Only family at Gibbon
Small mobility. Home forming	No home forming
Distributing of food in the group	No distribution of food
Construction and using of tools	Some primitive tools like a stone or branch
Brain size growth	No brain size growth
Permanente sexual active	Only sex during fertile period
Taking care of more young at a time	Taking care of one young at a time

Australopithecus was a hominid, not a pongid, but it was not a Homo. The Australopithecus afarensis, found in Ethiopia in 1974 (by Donald Johanson) and called 'Lucy' is the 'first Hominid' found, walking upright. It took 7 years to find exactly the old age, check and double check with 5 different techniques: geology, potassium-argon, 'fission-track' dating with uranium, paleo-magnetism, and bio-stratigraphy. (That is because there is a fanatic competition between paleontologists and all want to find the oldest Homo and missing links and they reject the findings of others until they cannot deny the facts anymore). The results are that Lucy is 3.5 M years old, and some other parts found of A. afarensis 3.9 M years old. They have found whole families of them in the area Ethiopia, Tanzania, Kenya. One can say that Hominids walking upright is about 3.7 M years.

Homo sapiens.
East Africa to all over the world. 300,000 – 130,000 years (see under Africa migration – recent). One study (1995) used 15 DNA sequences from different regions of the genome from human and chimpanzee and 7 DNA sequences from human, chimpanzee and gorilla. They determined that chimpanzees are more closely related to humans than gorillas. Using various statistical methods, they estimated the divergence time human-chimp to be 4.7 MYA and the divergence time between gorillas and humans (and

chimps) to be 7.2 MYA. Another study (2001) using the molecular clock the authors estimated that gorillas split up first 6.2-8.4 MYA and chimpanzees and humans split up 1.6-2.2 million years later (internodal time span) 4.6-6.2 MYA. This comes close to study 1. Genetic differences between Humans and Chimpanzees is about 3% of the complete genomes differ by deletions, insertions and duplications. That looks close but we are talking of 90,000,000 different nucleotides. Additional background is available if the reader searches for 'Mitochondrial Eve' and 'Y chromosome Adam'. If we say that about 200,000 years ago Homo sapiens evolved, then a total of 108 billion people on Earth have existed until today. In April 2020 the total count is 7,777,700,000 people. The net growth is 135,000 / day and we might stabilize around 10 billion and that is an important issue as described at the end of Chapter 4.6 under Demography.

Africa migration.
The first dispersal of Homo sapiens took place between 130,000-115,000 years ago via Northern Africa, but died out or retreated (?) Chinese researchers question this extinction, claiming that modern humans were already present in China 80,000 (+) years ago. These Homo species must be the result of a first migration out of Africa 1 M. BC. In that case there was a parallel evolution. Recently it is found that several Home sub-species interbreeded already since 300,000 years ago. Home sapiens is a mixture.
A second dispersal took place via the so called Southern Route, about 80,000 years ago, before the Toba event. (The Toba super-volcanic eruption occurred sometime between 69,000 and 77,000 years ago at the site of present-day Lake Toba (Sumatra, Indonesia). It is one of the Earth's largest known eruptions. The Toba catastrophe theory holds that this event caused a global volcanic winter of 6–10 years and possibly a 1,000-year-long cooling episode).

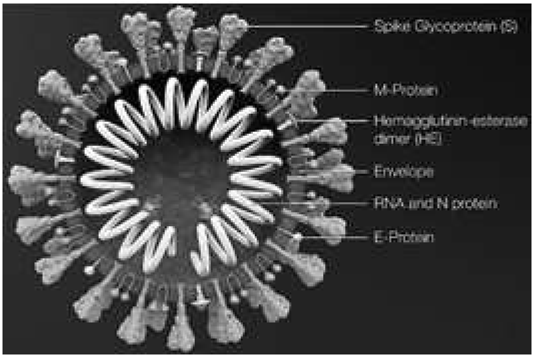


This dispersal followed the Southern coastline of Asia, crossing about 250 kilometers (155 mi) of sea, and colonized Australia by around 65,000 years ago (2017). According to this theory, Europe was partly populated either by a migration out of India, which was repopulated from Southeast Asia after the Toba-event (pre-Toba hypothesis), or by an early offshoot which settled the Near East and Europe (post-Toba hypothesis).

The biological definition of Race is a geographically isolated breeding population that shares certain characteristics in higher frequencies than other populations of that species, but has not become reproductively isolated from other populations of the same species. There is a wide consensus that the *racial* categories for humans that are common in everyday usage are socially constructed, and that racial groups cannot be biologically defined. Described 150 years ago by Charles Darwin in *The Descent of Man, and Selection in Relation to Sex*, 1871. Race, as a social construct, is a group of people who share similar and distinct physical characteristics, mostly influenced by the region they are living. Even though there is a broad scientific agreement that essentialist and typological conceptualizations of race are untenable, scientists around the world continue to conceptualize race in widely differing ways, some of which have essentialist implications. While some researchers sometimes use the concept of race to make distinctions among fuzzy sets of traits, others in the scientific community suggest that the idea of race is often used in a naïve or simplistic way, and argue that, among humans, race has no taxonomic significance by pointing out that all living humans belong to the same species, Homo sapiens, and subspecies, Homo sapiens sapiens. Other researchers contend that changes in the ways in which genetics is being practiced and promoted, as well as the "confusion of analytical domains in making assertions about race," are undermining the validity of the position that race is a social construct (more in Chapter 4.6). History followed different courses for different people because of differences among people's environments, not because of biological differences among people themselves (Diamond). The 'black primitives' are certainly not less intelligent as proved in many cases from the bushman in New Guinea to the 3 years old boy, son of a TWA with a bone through his nose, living as a hunter-gatherer in Eastern DRC. At 6 years old the boy goes to the public school campus in Bukavu for free and at 23 he graduates with a Bachelor degree from the University in Kigali and then gets a Master's scholarship from Carnegie Mellon University in the USA. More about differences and Race under Links (Biology).

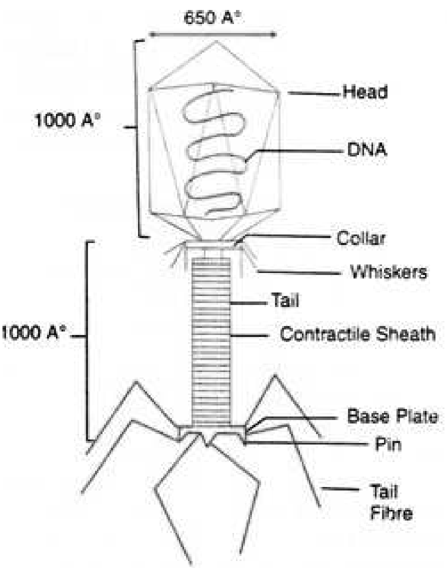
What do we call Life?

Characteristic for what we call life is having a metabolism, self-reproduction, and being separated from the environment (cell). An individual human being, or a mule, cannot self-reproduce but they are alive. A man and wife is a system and a system might be subject to self-reproduction (a species in a population). All of them are built out of cells and cells are self-reproductive. All organisms with which we are familiar must contain such cells in order to be able to repair damage. Self-reproduction is still not sufficient for a lump of matter to be considered living. A single crystal of salt, NACL, dropped into a super-saturated salt solution would quickly reproduce itself in the sense that the basic crystal structure of NACL would be copied many times to make up a much larger crystal than was initially present. If quarks (Chapter 1.11) which compose a meson are pulled sufficiently far apart, the nuclear bonds which hold them together will break. But some of the energy used to break these bonds will be converted into new quarks which did not previously exist, and these new quarks can combine together to form a number of new meson pairs, but they are not alive.



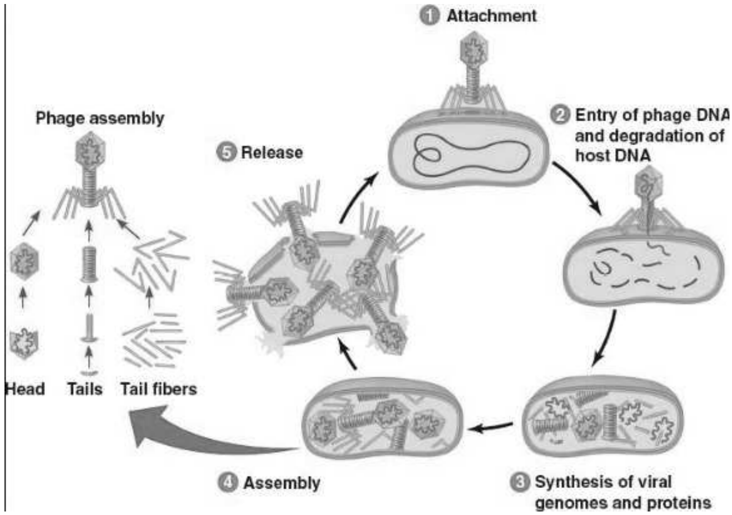
Let's look at a virus.
Left: Intersection Corona virus Covid-19 (Wikipedia). Size 120 nm = 1200 Angström = 1200 x 10^-10 m.
Microbiota are "ecological communities of commensal, symbiotic and pathogenic microorganisms" found in and on all multicellular organisms studied to date from plants to animals.

Microbiota includes bacteria, archaea, protists, fungi and viruses.
Humans are colonized by many micro-organisms; the traditional estimate is that the average human body is inhabited by three times as many non-human cells as human cells but it is eight times. Some micro-organisms that colonize humans are commensal, meaning they co-exist without harming humans; others have a mutualistic relationship (both have a net benefit) with their human hosts.
There are for example many Corona type viruses like A (229E, NL63), B (OC43, HKU1), MERS-CoV, Sars-CoV, and Sars-Cov-2 = Covid-19 (Corona).



Left: The T2 virus, a bacteriophage ('bacteria eater'). A°= Angström = 10^-10 m.
A virus satisfies the reproduction condition using another cell.
The protein coat of the virus remains outside the attacked cell. The virus uses the reproductive power of that cell. See below.
The key distinction between living cells and self-reproducing crystals and mesons is the fact that the reproductive apparatus of the cells stores information (like DNA) and this information is preserved by natural selection.

Both, self-reproduction and that the system contains information which is preserved by natural selection is essential for living organisms. Below: life cycle of a virus.



Are we autonomous? Tardigrada (Chapter 2.1) can be dehydrated completely, and which can be stored in this state for many years. There is no metabolism at all. Are they dead? If water is added, the Tardigrades resume their living functions. Same is known for some bacteria and even insects. How autonomous should a living system be? A virus cannot reproduce outside the cell of a host. Humans cannot synthesize many essential amino acids and vitamins, but many bacteria can. More in Morange, Links, Biology.

Life is adapted to its environment.
As described in this Chapter 1, the specific figures in Cosmos and at quantum level are very characteristic, 'fundamental forces', like the charge of the electron, the gravitation constant, and the speed of light, and the structure-constant α in the nucleus being 137^-1 (Chapter 1.11). Life on Earth has its limits. That is related to the characteristics on Earth like the mass, the atmosphere, the temperature, the radiation, the elements and their specifications. These are different numbers per planet. (Barrow & Tipler:) The reason why organisms cannot be constructed with arbitrarily large size was first spelt out by Galileo in 1638. When the size of an organism is L, its mass growth is L^3 and its strength (like the bones) is L^2. The largest animal on Earth on land ever was the Brachiosaurii of 80 tons (an elephant is 7 tons). The maximum is 1 – (density of water / density of animal) = 0.5-.07 (otherwise it sinks). Also flying animals have their restrictions because flying is complicated and needs a lot of energy from the muscles. Read also *What is Life*, 1944 from Erwin Schrödinger about these types of calculations. The largest organism is the Fungus *Armillaria solidipes*, 4 sq. miles in the soil.

The elements essential in living organisms: (and needed in our food), below.
More about all elements in Chapter 1.6.

Class one elements:	Class two elements: ions	Trace elements:
Oxygen, Carbon, Nitrogen, Hydrogen, Phosphorus, Sulfur	Na+; K+; Mg2+; Ca2+; CL-	Mn, Fe, Co, Cu, Zn, B, Al, V, Mo, Si, Sn, Ni, Cr, F, Se

Water, H2O, is one of the strangest substances known to science. The fact that its solid phase (ice) is less dense than its liquid phase is a unique property. Compared with the characteristics of various hydride molecules, the boiling point should be -100 C° but it is +100 C° (at sea level). This implicates that here is a very strong force acting between the molecules of water. The basic four types of chemical bonds are: the ionic bond; the covalent bond; the hydrogen bond; the Van Der Waals bond. (Chapters 1.6; 1.11). All types of chemical bond result from the distributions of electrons around the nuclei comprising a molecule. The steady-state distribution is that which corresponds to the lowest energy. In ionic bonds it is achieved by one of the atoms pulling the electron from the other to complete an electronic shell. A covalent bond is formed when two (or more) atoms complete their outer electron shells by sharing electron pairs. In a hydrogen bond the electronegative atom in the molecule attracts the electron of the hydrogen atom, leaving a bare proton. The positive charge on this proton can then attract the negative charged electronegative atoms in other molecules. The Van Der Waals bond is due to the attraction between the nucleus of an atom and the electron cloud of another atom. This is a very weak bond. Covalent bonds bind typically with an energy of 100 kcal/mole, hydrogen bonds with 5 kcal/mole, and Van Der Waals with 0.3 kcal/mole. (MeV in Links, Technology. Compare these forces with the tiny forces in the atom and nucleus, described in Chapters 1.11; 1.14). The anomalous melting and boiling points of water are due to the fact that water forms strong hydrogen bonds. The shape of the water molecule is special. The H-O-H angle is 104.5 degrees, only slightly less than the ideal tetrahedral angle (109.5 degrees). This structure is rigid in ice. This is due to the fact that ice floats. Water tends to polymerize into an open structure as ice. The lowest density is at zero degrees when ice forming starts; the highest density of water is at +4 C°. Ice isolates the water below the ice and keeps it liquid for water organisms. It takes a lot of energy to melt ice or to boil water. The high specific heat of water allows water to be used as a store of heat, and also serves to stabilize the temperature of the environment. The thermal conductivity of water is also higher than that of most liquids. Water has a higher heat of vaporization than any known substance. This makes water the best possible coolant by evaporation, and living organisms make extensive use of this by transpire. Water molecules have a tendency to ionize (basic atom model end of Chapter 1.6). This provides the high mobility transport for H+ and OH -, which speed up chemical reactions. This also means that a change of pH (acidity) in a water solution is transmitted with great rapidity throughout the solution. Looking at all characteristics, water is unique for life and for example Ammonia is not an alternative for living organisms (a theory about possible life at other planets). Strange stuff is Ice-18 (under Links, Biology).
Hydrogen is the lightest element with just one electron around the nucleus and it can either donate it to other atoms or accept an electron from other atoms to complete the K-shell. Hydrogen is very active chemically; more compounds of hydrogen are known than any other element, with Carbon as close second. Hydrogen forms particularly strong and stable covalent bonds with Carbon.
Oxygen is the most abundant element in both the outer crust of Earth and in living organisms. It also comprises 21% in the Earth's atmosphere and this molecular Oxygen

is very reactive. It is oxidizing (absorbing electrons) almost everything. Very little of our present land vegetation would survive if the Oxygen percentage goes to 25%. We would face spontaneous fires everywhere. Also Oxygen is essential (search the O-cycle mentioned in Chapter 1). Oxygen makes Ozone (O_3), caused by thunders and UV radiation, high in the atmosphere and Ozone protect us against deadly radiation.
Carbon. At many places in Chapter 1 I, shows how important it is for life. Carbon has 6 electrons with 4 in the L-shell. It can make many different bonds. Carbon can form strong bonds with itself in polymers. A wide variety of carbon compounds, for example as found in amino-acids, have been demonstrated experimentally to be spontaneously formed under conditions which are thought to mimic conditions on the Earth just after it formed. Carbon as carbonic acid is very important in maintaining a constant pH (acidity). See under Links, climate. CO_2 also plays a crucial role in regulating the temperature of the Earth's surface (Chapter 3.14).
Nitrogen is one of the building blocks of the 21 amino-acids. Essential amino-acids cannot be made by the human body: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Nitrogen is also essential in the purines adenine and guanine and in the pyrimidines cytosine, thymine and uracil, all part of DNA. N only presents in the atmosphere.
Phosphorus and *Sulfur* act as energy and group transfer agents in chemical reactions. Most reactions are conducted by organic phosphates like ATP. The complete oxidation of glucose to form ATP is rather efficient and yields 686 kcal./mole (typical other reactions yield 1 kcal./mole). The efficiency is 66% (our modern engines around 40%). An interesting molecule is chlorophyll, essential for photosynthesis, using Mg. We would expect that natural selection would have picked out the molecule which absorbed light in that frequency band at which Sunlight is most intense, but chlorophyll in its various forms has peak absorbance at frequencies where Sunlight is not very intense. The biochemist George Wald has made a reasonable guess as to why Nature has utilized chlorophyll. "Chlorophyll possesses a triple combination of capacities: a relatively high receptivity to light, an inertness of structure permitting it to store the energy and relate it to other molecules, and a reactive site equipping it to transfer Hydrogen in the critical reaction that ultimately binds Hydrogen to Carbon in the reduction of CO_2".

Now I have described what a virus is we can dig deeper into the forces behind evolution. Evolution takes place through the action of natural selection on a single source of genetic change, mutation, being non-creative but random, is simply one part of the story. We know at least four drivers in evolution: mutations, hybridization, symbiogenesis and epigenetics.
Mutations are shortly discussed before. Summarizing: In biology, a mutation is the permanent alteration of the nucleotide sequence of the genome of an organism, virus, or extrachromosomal DNA or other genetic elements. Mutations result from errors during DNA replication (especially during meiosis) or other types of damage to DNA (such as may be caused by exposure to radiation or carcinogens or specific chemicals), or cause an error during forms of repair, or else may cause an error during replication

(translation synthesis). Mutations may also result from insertion or deletion of segments of DNA due to mobile genetic elements. A second force / mechanism is symbiosis. Where does our genome come from?
The 46 chromosomes of Homo sapiens, 21 from the mother and 21 from the father plus 1 X-chromosome from the mother (with 800 protein-coding genes) and a X-chromosome from the father (two times X is a female), or X-chromosome from the mother plus 1 Y-chromosome from the father (with just 70 genes) and with XY you are a male. The 46 chromosomes are carrying about 20,000 protein coding genes, 1.5% of the total, and this total genome was initially analyzed in 2001. This process is still not fully completed. (We also have a small DNA molecule found within individual mitochondria in our cells, as mentioned). Many of our genes are not unique. Comparison of whole genome sequences provides a highly detailed view of how organisms are related to each other at the genetic level. Genes, which carry the specific instructions necessary to make proteins do the work of the cell, vary by only about 0.025 percent across all humans, being 3 million differences in the total gene pool. The more closely related two people are, the more similar their genomes. We are all over 99.9 percent the same, DNA-wise. For protein-coding genes we share 85% of our genes with the mice but it depends how you define the different parts of the genome. We share for example 2,758 (out of 20,000) of our genes with the fruit fly, 2031 with the nematode worm, but it is not about numbers but about complexity. We can produce many more and complex proteins than they can.

Over 98% of our genome is associated with non-coding RNA molecules, regulatory DNA sequences, introns, and sequences for which as yet no function has been determined.
One can find more about introns on the internet.
Further research teaches us that about 43% of the Human genome came from viruses and related cells, a process of hundreds of millions of years during our evolution (Frank Ryan). Many viruses were lethal which implies that we modern humans are descendants of the survivors of this remorseless evolutionary legacy. Human endogenous retroviruses (HERV-K) make up 8% of the human genome. Under special conditions these viruses originated genes play a role in cancer. Tumor viruses come in a variety of forms: Viruses with a DNA genome, such as adenovirus, and viruses with an RNA genome, like Hepatitis C virus, can cause cancers, as can retroviruses having both DNA and RNA genomes (Human T-lymphotropic virus and Hepatitis B virus). Another example is HERV-W: Human Endogenous Retrovirus-W makes up about 1% of the human genome and is part of a superfamily of repetitive and transposable elements (A transposable element (transposon) is a DNA sequence that can change its position within a genome, sometimes creating or reversing mutations and altering the cell's genetic identity and genome size. Transposition often results in duplication of the same genetic material). These imported genes are, other than mutations, another powerful force in speciation.
John Maynard Smith (1920 – 2004): “There is no contradiction between Darwin’s belief that complex adaptations arise by the natural selection of numerous intermediates, and the possibility that new evolutionary potentialities may arise suddenly if genetic

material that has been programmed by selection in different ancestral lineages is brought together by symbiosis".

Symbiosis is the living together of two different species being more or less dependent on each other. A *Lichen* act as one species but they are a symbiosis of an alga and a fungus (described in 1868). They play an important role in the world's ecology as pioneer organisms (living on stones, rocks). Orchid mycorrhizae are symbiotic relationships between the roots of plants of the family Orchidaceae and a variety of fungi (over 17,000 species). Most readers are familiar with the 'cleaner station' symbioses, where fierce predators, such as sharks and groupers, will patiently queue up at key sites on the ocean bottom and allow their skins, and even the interior of their mouths, to be cleaned of parasites and debris by smaller fish and shrimps. Many forms of symbiosis involve both behavioral and metabolic exchanges, for example the wide variety of pollination partnerships involving plants and insects, or hummingbirds.

Some terms and phenomena below.

Parasitism is a kind of symbiosis in which one symbiont gains to the detriment of another partner; *Commensalism* is a symbiotic relationship in which one partner benefits without harm or benefit to the other partner; *Mutualism* is a type of symbiosis in which two or more partners benefit; *Symbiogenesis* is an evolutionary change arising from symbiosis. Example is Elysia: *Elysia chlorotica* is a hermaphroditic sea slug with a life cycle of 9 months. Its eggs hatch out as a larvae and the larvae starts eating the alga Vaucheria litorea, becoming a slug. The alga has chloroplasts, which capture energy of sunlight (photosynthesis). The gut of the growing slug expands, branching out into various tiny channels all over the body, so that the precious chloroplasts end up in a confluent layer immediately beneath its skin (a type of endosymbiosis). This way the slug becomes solar-powered for the remainder of its life. The chloroplasts are no longer connected to the algal nucleus in its cells so, how proteins are produced? Key genes have been transferred from the nucleus of the alga cells to the nucleus of the slug cells. The exact mechanism remains unknown but it might be done by a retrovirus, transporting RNA and using its own reserve transcriptase enzyme to produce DNA from its RNA genome. The whole mechanism has created the new species *Elysia chlorotica* by several types of symbiosis. Investigations in symbiosis have taught us that many viruses show a co-evolution with the evolution of their host. A virus may appear inert outside its hosts (HIV1 and HIV2, Ebola, Polio, Influenza, Hanta virus, Noro virus, Rabies virus, and Corona), but when it enters the host cell, the lifecycle starts. Another example is the polydnavirus being a member of the family Polydnaviridae of insect viruses. There are currently 53 species in this family. Polydnaviruses form a symbiotic relationship with parasitoid wasps (about 25,000 species) but these wasps are themselves parasitic on moths and butterflies. Find the complex lifecycle on the internet.

The descent of mitochondria from bacteria and of chloroplasts from cyanobacteria was experimentally demonstrated in 1978. The endosymbiosis theory of organogenesis became widely accepted in the 1980s, when the genetic material of mitochondria and chloroplasts was found to be different from that of the symbiont's nuclear DNA. Also viruses are capable of creating complex genes all by themselves, stitched together from bits and pieces, mainly from other viruses. Additionally, this is speciation not by means of the linear branching dynamic of modern Darwinism but through the reticulate union of disparate genomes implicit in viral symbiogenesis.

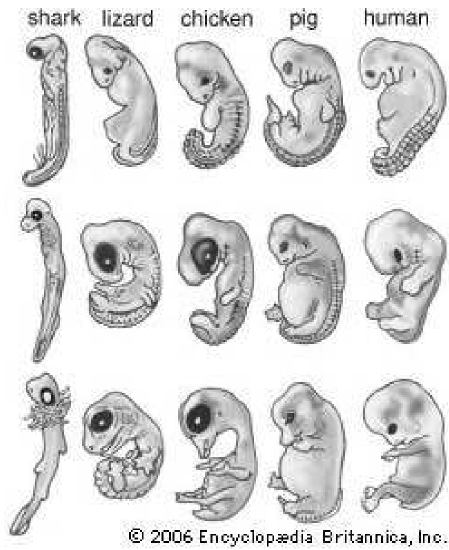
Hybridization. A hybrid is a sexual cross between two different species. A mule is the hybrid offspring of a mare (64 chromosomes) and a donkey (62 chromosomes) but this mule (63 chromosomes) is sterile. For hybridization to contribute to evolution, it is essential that hybrid offspring must themselves be fertile. This demands that the hybrid overcome considerable genetic and reproductive barriers. The offspring must be fit, sometimes fitter than the parents to be able to compete in the original ecology or is able to explore a new ecology (niche). The doubling of chromosomes, through tetraploidy, has the potential to increase the complexity of a life form. It can arise in two ways, through mutation that prevents the reduction of chromosomes during the formation of the germ cells, or through the sexual union of two different genomes, through hybridization.
Ryan describes that the sunflower hybrid was the first discovered hybrid which survive in extreme environments (such as the dry, sandy soils of Nevada and Utah and the salt marshes of West Texas). They were not polyploidy but retained the normal number of chromosomes. It was the first confirmation of what we call 'homoploid hybridization'. Definition: Homoploid Hybrid Speciation (HHS) is the formation of a new-hybrid—species, independent from its parents, via hybridization with no whole-genome duplication and thus no increase in ploidy. We now know this kind of speciation by hybridization from, among more, wheat, maize, sugar cane, coffee, cotton, and tobacco. In 2006 it was also found in animals (the butterflies *Heliconius cydno* and *H. melpomene).* The butterflies *H. cydno* and *H. melpomene* did not recognize the new hybrid butterfly called *H. heurippa* (different wing colors) and the new species was immediately in reproductive isolation expanding its numbers. We know the same mechanism from for example Cichlids (fishes) and fruit flies. Much more common is (non-homoploid) hybrid speciation, in specific in plants. As said, a hybrid may occasionally be better fitted to the local environment than the parental lineage and as such natural selection may favor these individuals. If reproductive isolation is subsequently achieved, a separate species may arise. Reproductive isolation may be genetic, ecological, behavioral, spatial, or a combination of these. Examples of hybrid speciation in animals are also found in frogs, the duck Anas, and the American Red Wolf (parents were a Grey Wolf and a Coyote).
We humans are certainly partly polyploid. It is assumed that there had been two whole genome duplication events in the evolution of the vertebrates, the first early on during the shared lineage of the primitive chordates and early fish (510 M. years ago), and the second later on in vertebrate evolution, somewhere around the divergence of fish and amphibians (420 M. years ago). This is called the R2 hypothesis. For example, mammals, birds and most fish have four HOX – gene clusters. Hox genes play critical roles in embryological development, in specific the development of structures such as limbs, lungs, the nervous system, and eyes. Homologous Hox genes in such different animals as insects and vertebrates control embryonic development and hence the form

of adult bodies. These genes have been highly conserved through hundreds of millions of years of evolution. But, where insects and sea urchins only have a single Hox cluster, humans (and mice) have four.

Epigenetics. Epigenetics is about the heritable changes in gene expression (active versus inactive genes) that do not involve changes to the underlying DNA sequence (non-genetic), a change in phenotype without a change in genotype, which in turn affects how cells read the genes. However, there are many chemical mechanisms in DNA which do not concern Mendelian genetics about dominant and recessive genes. Gene expression can be controlled through the action of repressor proteins and other molecules that attach to silencer regions of the DNA such as DNA methylation.
Be aware, all our very different cells, in every tissue and organ of our bodies, contain exactly the same nuclear and cytoplasmic inheritance as the zygote, they all contain the same nuclear DNA, both vertebrate and viral (as discussed before), and the same mitochondrial DNA in the shape of a bacterial ring genome. After dividing several times this zygote produces very different cells (more below). An amazing example is the Stem Cell of the (Human) embryo: as a single fertilized egg cell, the zygote, continues to divide, the resulting daughter cells change into all the different cell types in an organism, including neurons, muscle cells, epithelium, endothelium of blood vessels, etc., by activating some genes while inhibiting the expression of others.
Epigenetic mechanisms are Cytosine Methylation, the modification of proteins known as Histones, and regulatory RNA which includes short molecules of RNA that can interfere with the translation of genes into proteins (RNA interference: RNAi which can destroy a single 'targeted' messenger RNA). This epigenetic process would switch certain genes on or off in particular cells at particular times. Histones are highly basic proteins that act as spools around which DNA winds in chromatin. Histone modifications typically provide short-term epigenetic memory and can be reversed after a few cell division cycles. But how exactly are the methyl groups added or taken away? We know now that there is an influence from the environment and one specific factor are medicines against specific diseases. To understand how global DNA methylation levels changed under environmental influence during vertebrate evolution, science analyzed its distribution pattern along the whole genome in mammals, reptiles and fishes showing that it is correlated with for example body temperature or ecological stress, and chemicals, and independently on phylogenetic inheritance. Epigenetic variation can provide the first substrate for selection during the course of evolutionary divergence. The changes may result in novel morphology, behavior, or physiology, and ultimately reproductive isolation. As said, epigenetics can be manipulated in very specific ways for specific genes, by the environment, by medicines, by age, and even by food. More knowledge about this phenomenon will help us to prevent and to treat diseases (Ryan).

Let's finally look at the development of a human zygote (fertilized egg).

The development of an embryo is very similar in vertebrates.
After the conception you are two cloned cells. The uterine tube epithelium consists of ciliated cells that are moving the secreted fluid and zygote towards the uterine body.
By day 4 you are a solid ball of 16 cells (morula) and day 5 a hollow ball of 32 cells (blastula) with a small cell-mass inside. With chemical reactions from your symbiotic endogenous retroviruses you attach yourself to the lining of your mother's womb.



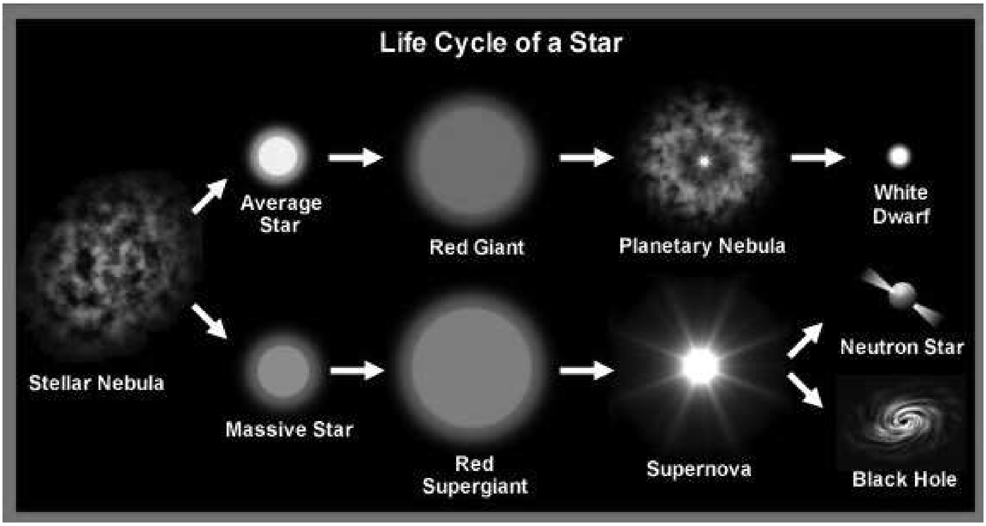
Then you begin to secrete the hormone HCG, which enters your mother's circulation, letting her know that you are there and stimulating her ovaries to produce oestrogen and progesterone and this will also prevent a new menstruation, kicking you out.
Over day 7-10 an indentation pushed into your blastula wall indicates the start of your internal cavities. With this gastrulation the differentiation of your cells starts with three groups of cells. Group one is the 'ectoderm' that will become your skin and nervous system, group two, the 'endoderm' that will form the lining of your gut and internal organs, and group three 'mesoderm' that will become your muscles, bones, and heart. The first indentation will become your anus. By day 15-21 your HOX genes kick in and the forming of a head starts. By day 21 you have vestigial gills, relict of a marine past. They disappear and transform into other parts of the body, including the jaw, the middle ear, and the larynx. In the context of human evolution, human vestigiality involves those traits (such as organs or behaviors) occurring in humans that have lost all or most of their original function through evolution. Examples: the vermiform appendix; the tail bone; the wisdom teeth (our third molars); ear muscles; the plica semilunaris is a small fold of tissue on the inside corner of the eye; some elements in our internal genitalia; and a series of muscles. Around 12 weeks most of your organs and body parts are developed, with the exception of your brain and lungs. Around day 16 one of the X-chromosomes in females is inactivated, an important stabilizing mechanism during the embryogenesis. Cytosine methylation is one of the major epigenetic mechanisms that decide the fate of cells during the formation of the embryo.

Chapters 1.3-1.5 show that science has made major progress in understanding the phenomena of life on Earth. Evolution is a dominant and solid theory in this. Step by step we find out what life is and how it evolves and with every step we become more impressed by the complexity and the chemical logic. At the end of this Chapter I will pay attention to the God hypothesis related to evolution, and to what is called the

Anthropic Principle (also in references). Chapter 2 starts with the discussion around Intelligent Design (Creation verses Evolution). First let us examine the Universe.

1.6 Cosmos.

(Hawking, Seargent, Bryson)



(From Natural Schools' Observatory).

Only 5% of stars are massive enough to explode as a Supernova.

The Universe is all of space and time (space time, Chapter 1.16) and its contents, which includes planets, moons, stars, galaxies, black holes, dust, the contents of intergalactic space being all matter and energy we can observe and calculate. There are many competing hypotheses about the ultimate fate of the Universe (theists versus atheists) as discussed later. Massive stars are important because only Supernova's can create most of the elements needed for life, other than Hydrogen (discussed below). The relationship between stars is visualized in the Hertzsprung-Russell diagram (under Links, Cosmos). Brown dwarfs are like White dwarfs but without energy/ radiation. A Neutron star is at least 1.4 times as massive as the Sun but only 20 km across. White dwarfs are stars that started their life comparable with the Sun but with a volume like Earth. In parallel their outer layer with a lot of hydrogen swells and the star becomes a red Giant. Exactly what we can expect for our Sun. At the end the nucleus can explode if the mass is bigger than 1.4 of the Sun. A Black Hole is a few times smaller but heavier than a Neutron star. Even light (photons) cannot escape from a Black Hole caused by extreme gravity (Chapter 1.10). Pulsars are fast-spinning Neutron stars (they spin up to 700 revolutions / sec.) Quasars or quasi-stellar radio sources are the most energetic and distant members of a class of objects being extremely luminous. Their luminosity can be 100 times greater than that of the Milky Way. Most quasars were formed approximately 12 billion years ago in a young cosmos caused by collisions of galaxies and their central black holes merging to form a super-massive black hole. More than