Chapter 2
Evolutionary thinking before Darwin
(Complementary notes)

Your book does not contain a lot of information when it comes to evolutionary thinking before Darwin. Yet this is a fascinating subject which allows a better understanding of the theory of evolution. These few pages will give you more information on this subject.

Study guide: For the exam, it is important to associate the concepts and ideas with the person and era. I will never ask the year of birth/death of a person.

Evolutionary thinking before Darwin

The origin of evolutionary thinking can be found in the philosophical and theological traditions dating back more than 2000 years.

During the last two millennia, the notion of evolution has changed with various philosophical trends and ideas but also, with the accumulation of data on nature.

During the last two centuries, the progression of evolutionary thought intensified because of the refinement of research methods from a technical standpoint but also from a philosophical point of view. The main turning point was the rejection of the notion of fixity of the world and species in the western civilization of the 19th century.

The concept of a static, unchangeable world in western theological thought is associated with the concept of the Creation of the world; a unique event that would have resulted in the creation of the universe and of all life forms.

2.1 Transformism in Antiquity

2.1.1. Anaximander (610-546 BCE)

The first theories of evolution come from the Ancient Greeks such as Anaximander (610-546 BCE). He believed that:

- Life came from water
  ("Animals are born from the sea, by solar heat on water. They were first wrapped in spiny bark. As they aged, they migrated to the mainland. When the bark bursted, they survived briefly in their new lifestyle").
- The simplest forms preceded more complex ones.
- Humans originated from fishes that tried to invade mainland. This theory of origin can be explained as follows: most species can find their food almost immediately after birth, whereas, humans are weaned after a long period of time. This long maternal dependency means that humans did not appear as they are now. Humans were created inside creatures resembling fishes and stayed inside the creatures until maturity. Then, these creatures simply burst and released men and women capable of defending themselves and found their own food.

2.1.2 Empedocles (483-423 BCE)

Several Greek philosophers have adopted Anaximander's transformism. However, Empedocles refined it by stating that matter was composed of four elements: earth, water, air, fire. According

to him, two major forces were always acting on these elements: love (attraction or harmony) and hate (repulsion or discord).

Thus, when love (internal heat) dominates, the elements join to form matter. This random arrangement of matter into parts of beings and the random assemblages of these parts led to the creation of living beings with a harmonious morphology. Monstrous living beings or beings lacking a harmonized morphology disappeared quickly. More harmonious forms survived. Empedocles also believed in a succession of fauna.

2.1.3 Democritus (460-360 BCE)

Democritus reality consisted of emptiness and atoms. Mixing both resulted in the diversity of objects and life forms. This is the theory of atoms. Democritus perceived matter as an ensemble of moving atoms. These atoms could not be created or destroyed.

Democritus did not believe in an underlying driving force behind the creation of living beings. Instead, he believed in an intrinsic force or a property of atoms that created forms. According to his theory, humans and other animals were born from the Earth. Humans, through a random process, emerged from water and slime (spontaneous generation).

2.1.4 Conclusion

Other Philosophers could be mentioned. Lucretius (98-55 BCE), of Ancient Rome, wrote a remarkable book (in fact, a long poem) named “On the nature of things” (*De rerum natura*), which resumes the materialistic theories of the Greeks. Lucretius attributed to randomness a central role in the creation of life.

There are two interesting aspects to retain from these Greek philosophers:

1. The acts of creation are not those of Gods; that is to say that Earth and life are not the result of divine action but rather the result of the inner strength or force of the matter.
2. The origin of all life is not theological (with an ultimate goal), but, to the contrary, the origin of all life is the result of luck or of an irrational necessity.

This could be considered as the first scientific revolution characterized by the acceptance of materialistic explanations.

2.2 The classical tradition

There was hope for a scientific explanation of life that came out from the materialistic philosophers: the notion of time without limit, spontaneous generation, environmental modifications and the ontogenetic changes in individuals.

This state of affairs did not last. This materialistic philosophy was abandoned for a more abstract view of life: the classical tradition.

2.2.1. Socrates (469-399 BCE)

A more abstract view of life began with Socrates (469-399). Socrates abandoned the quest for scientific knowledge for a nobler cause: the contemplation the soul. For Socrates and his followers, the most important questions were not material, but linked to a quest for beauty, wisdom, justice and sanctity.

2.2.2 Plato (427-347 BCE)

Plato's biggest contribution, from a scientific standpoint, was his Theory of Forms or essentialism. For Plato, the world we observe every day is imperfect and changing. It is a poor imitation of a perfect world. A permanent and real world: the world of Ideal Forms. According to this philosopher, we are born with this concept of ideal forms in our minds.

The beauty of a woman or that of a flower is ephemeral, but the notion of beauty is eternal since it belongs to the world of Forms. A triangle, whatever the combination of its angles, will always be a triangle (the sum of all its angles is always 180°). It is important to note that in this philosophy of ideal forms or in the definition of the essence of Forms (essentialism), the variability within forms is not important.

Finally, Plato modified the concept of "spontaneous generation" by adding the action of an external creative force. He refers to the actions of the demiurge, a god creator of the universe.

2.2.3 Aristotle (384-322 BCE) and the Great chain of being

Aristotle (384-322 BCE) was a disciple of Plato and one of the most important biologists of the Antiquity. Aristotle was a meticulous observer.

He did not believe in the innate nature of Ideal Forms. He thought that the observation of forms had to be done in nature and that the essence of things was to observe and define in the real world. He then took the time to examine the world that surrounded him.

He described multiple species with a peculiar attention for details. He studied the development of species and was particularly surprised by the lack of resemblance between the larvae and adult stages within the same species (epigenetic concept of development vs a preformist concept). He is the father of the comparative method.

Aristotle applied the Theory of Forms of Plato in his study of the living world. He reinforced the anti-evolution aspect of this theory by emphasizing the importance of describing animals or living beings by their essence. Morphological variation was only illusion or imperfection.

Plato and Aristotle were vitalists because they believed that living organisms had a soul. Thus, they believed that a living being was more than the sum of its parts because it contained a vital force which could not be described in physical or chemical terms.

Aristotle perceived three levels of souls: vegetative, animated, and rational. Thus, he established a hierarchy (a scale of complexity) in the world of the living beings (plants – animals – humans) or a **Chain of beings**.

Aristotle's concept of the **great chain of beings** is still relevant today. In Aristotle mind it does not represent an evolutionary hierarchy, but is a static unchangeable hierarchy illustrating the different levels of perfection found in nature.

2.3 The Impact of Christianity

Following the decline of the Roman Empire, Christianity became the main ideological paradigm in the Western World. It is the Dark Ages for evolutionary thought. An era of unprecedented intellectual stagnation. The perception of life changed and freedom of speech disappeared. No more ambitious speculations on the origin of life were possible, because God is the measure of all things, and the Bible the Word of the day.

The concept of the **great chain of beings** became institutionalized in western thinking when Christianity began and was transformed into a purely metaphysical concept proclaiming the perfection and the ultimate goodness of God. According to this idea, all objects that existed (that has the property of being) are more perfect than all identical objects that do not exist; thus, God created all the degrees of imperfection, because the omission of one of these degrees would have made creation difficult.

The notion of the great chain of being was omnipresent in all works done in Biology from medieval time to the 18th century. The chain of beings was clarified with every new species discovery. God, evidently, remained at the top of the chain, followed by angels, humans, animals, plants, etc.

During the renaissance (14th to 17th century), there was a gradual return towards experimentation and the observation of nature. The new knowledge was used only to clarify or identify the links of the great chain of beings.

2.4 The decline of essentialism: from fixity of species to transformism

During the Renaissance (14th to 17th century), a more materialistic way of thinking (less metaphysical) became more influential. It was a great era of discoveries: expeditions to new worlds, new flora and fauna, etc. Some philosophers, like Bacon (1561-1626), insisted that it was important to observed nature directly. The Protestant reform attacked the Pope's authority by indicating that every human can interpret the Holy Scriptures as he wishes and should always listen to his own conscience.

The French Revolution greatly contributed to the decline of the classical tradition and of essentialism. During the 17th and 18th centuries, every scientist was searching for the ultimate order. Researchers, like Linnaeus, searched the order in the plan of Creation. The social science theorists were attempting to find the ideal political and social systems; that is to say, systems that are well-organized and easy to govern. They believed that these systems would bring stability and durability.

However, with the French Revolution, everything changed. The search for ordered systems morphed into a quest for progress. The French Revolution and the Industrial Revolution represented progress. Even governments and social systems reoriented themselves on a quest for progress.

The same phenomena occurred in natural sciences. For example, in geology, scientists discovered that sedimentary layers were deposited in different geological eras. They also realized that the Earth could be older than what they had previously believed.

2.4.1 Linnaeus (1707-1778)

Linnaeus (an influential Swedish scientist) greatest contribution was the binomial system of nomenclature inspired from Aristotle.

Linnaeus is the greatest taxonomist of all time. In Linnaeus's time, great expeditions towards the New World were still in fashion. Thus, new fauna and flora were discovered frequently. Also, Linnaeus's contemporaries had a passion for nomenclature.

Linnaeus recognized different phyla (animal, plants, and minerals). He divided animals into classes (mammals, birds, amphibians, fishes, insects, worms). Every class was also divided into orders that included one or multiple genera. It was a system of words that allowed him to describe all animals and plants known at the time.

Every species was considered as being static and created by God. With his classification system, Linnaeus was certain that he was discovering every piece of the ultimate puzzle, the Plan of Creation. Such work was viewed in the 18th century has a very noble task that had a much higher purpose than just naming organisms.

In his last publication, he seems to doubt the concept of the fixity of species. In his book "Academic delights," Linnaeus wrote: "For a long time, I have nourished the suspicion, and I dare not present it as a hypothesis, that all species of the same genus were originally only one species, which has diversified by way of hybridization. There is no doubt that this will become a major issue in the future and that many experiences will be done to transform this hypothesis into an axiom: species are the result of the action of time."

Except for this statement, Linnaeus's work is seen as a masterpiece filled with essentialism.

2.4.2 George Louis Leclerc, Comte de Buffon (1707-1788)

Buffon was an ambitious man. He undertook, at a relatively young age, the task of describing the world. This ambition was materialized by the production of an encyclopedia made of 44 volumes (Title: *Histoire naturelle, general et particulière /* Natural history general and particular).

Buffon, at the beginning of his career, had doubts about the fixity of species. He indicated (around 1740) that: "every family, as well as animals and plants, have a common origin, all animals come from a single animal that over the century has produced all the species of animals that exist now."

In 1744, he wrote his theory of the Earth and established its age around 75 000 years. According to Buffon, Earth original temperature was very hot. Since that time, the climate has slowly cooled down; the temperature currently being temperate. He predicted that in another 75 000 years the Earth would be cold. According to Buffon, the presence of fossils is explained by environmental changes associated with changes in temperature.

The Faculty of theology of the Sorbonne censured, in 1751, many of Buffon propositions. In 1753, Buffon retracted his theories": I declare that I have no intention to contradict the Holy Scriptures; I firmly believe that everything reported about Creation is true … and I abandon the theory formulated in my book on the creation of Earth and anything that could be contrary to the narration of Moses. The hypothesis dealing with the formation of planets should only be perceived as pure philosophical discussion."

It is important to understand that Buffon's retraction was purely political. Being a courtier and a *protégé* of Madame Pompadour, the king's mistress, he couldn't do otherwise. Besides, his nomination as director of the Royal Botanical Gardens and his quick accession to the Science Academy are attributed to the fact that he was one of the King's *protégé.* Eventually, he married a rich heiress and became a worldwide celebrity. When he died in 1788, a statue was erected and more than 20000 people attended his funeral.

However, glory is ephemeral. During the French Revolution, his statue was broken and his tomb was ransacked by revolutionaries.

All in all, we can say that Buffon, regardless of his official retraction, was in favour of a certain type of transformism probably resulting from the combined influence of time and environmental factors.

2.4.3 Jean Baptiste Pierre Antoine de Monet, Chevalier de Lamarck (1744-1829) an environmental determinism

Son of a patriotic family, Jean Baptiste is the youngest of 11 siblings. He distinguished himself as a military before retiring to Paris. He took an interest in Botany and wrote a book (*La Flore française)*, which became very popular. He was hired by Buffon to tutor his son, Buffonet (born in 1764, guillotined in 1794).

Lamarck took interest in invertebrates, considered the least interesting animals of creation. He survived or went unnoticed, during the French Revolution, and became the director of the Department of Invertebrates at the Museum national d'histoire naturelle in Paris.

Lamarck literally transformed the chain of being a static entity representing levels of perfection to a dynamic and progressive chain. It went from a ladder to an elevator. Lamarck is responsible for this shift. He is the first true evolutionist: someone who believes in a gradual modification of a species through time. In his book "*Philosophie zoologique/* Zoological philosophy" published in 1809, he expressed clearly his theory of evolution.

According to Lamarck inferior animals appear spontaneously and transform gradually from simple to complex forms (notion of progress and acquisition of perfection); this is transformism. This progress is channelled by the environment; a changing environment that influences the needs of organisms and its characteristics. The characteristics acquired during the life of an individual are transmitted to the next generation. This is the **inheritance of acquired characteristics**.

Thus, the morphology is transformed by **the use or disuse of certain organs**. In the Lamarckian thought, the environment is the main motor of the transformation (environmental determinism) and is responsible for the evolutionary phenomenon. It is important to note that the process suggested by Lamarck was gradual, adaptive and that the animal had an inner ability to become more complex. Lamarck firmly believed in the concept of the great chain of beings and in the linearity of this chain.

How was Lamarck's theory perceived by his contemporaries? It was a global rejection. Why?

1. Because he could not prove his theory. He could not demonstrate if he was right or wrong.
2. Also, his University professor, Cuvier (1769-1832) with his strong and loud personality vehemently rejected Lamark's transformism. Lamarck, with his subdued personality, did not oppose his mentor.

2.4.4 Georges Léopold Chrétien Frederic Dagobert, Baron Cuvier (1769-1832)

Cuvier, armed with a strong and flamboyant personality, made his mark at the same institution as Lamarck by working on more interesting animals: mammals. He was a specialist in comparative anatomy. He established that every part of an animal had an essential function. This harmonious morphology is fixed and allows the animal to live normally. From this, he elaborated his "principle of the correlation of parts," which states that it is possible from a bone (e.g. a toe) to completely reconstruct an animal.

Also, Cuvier established the basis of paleontology. His research allowed him to observe that the deeper rocky layer in the ground have fossils that are very different from the living species. Thus, he recognized the phenomenon of extinction.

However, Cuvier believed in the fixity of species, thus he developed concepts in accordance with religious beliefs to explain his observations.

These concepts are:

- Catastrophism: according to this doctrine, natural catastrophes are responsible for the periodical annihilation of all animals in a specific era. These cataclysms are followed by the creation of species.
- Progressionism: it is a doctrine which stipulates that God improved the quality, complexity and perfection of his creations after each cataclysm or catastrophe.

In Lamarck's defence, Cuvier worked mostly with mammalian fossils. Evolution in this group was rapid from a geological standpoint. Thus, species found in the different layers were often very distinct morphologically. Lamarck studied molluscs which evolved more slowly. It was possible for him to recreate phylogenetic lineages from old fossils to living species or even to demonstrate that very old fossils were similar to living species.

Finally, Cuvier threw the final blow to the unifying concept of the great chain of being by indicating that God created the four major types of animals (*Radiata, Mollusca, Artiticulata, and Vertebrata*).

2.4.5 James Hutton (1728-1799) and Charles Lyell (1797-1875)

Hutton, a Scottish philosopher and geologist, was interested in mathematics and logic. He was particularly impressed with Newtonian lucidity. He hated everything that could not be demonstrated or verified. He rejected the theory of catastrophism simply because the basis of the theory is theoretical and cannot be verified in nature.

He elaborated a new principle: uniformitarianism or the **principle of uniformity**. This principle indicates that we can interpret past geological events from events or processes that are currently happening. Thus, Hutton confirmed that the forces that created and shaped the Earth are identical to forces that are affecting it now. The laws of nature are not affected by the passage of time and the study of the present is the only way to understand the past. The science of geology cannot allow explanations based on miracles or cataclysms.

According to Hutton, it is a vision of the world “without a glimpse of a beginning and without a hope of an end.” The process is slow, continuous and eternal. Reason cannot perceive it, due to the slow speed of the processes compared to our own longevity.

However, meticulous observation allows us to perceive certain changes. For example, it is possible to see large rocks falling from the side of a mountain. Once it hits the ground, it breaks into smaller rocks which also break because of environmental factors. Rocks become gravel, then becomes sand which is carried towards the oceans.

Furthermore, according to Hutton, the creating force that counterbalances this progressive degradation is the Earth’s heat, volcanos and the pressure of the crust.

Hutton’s work was ignored by the scientific community at that time. Charles Lyell, the father of modern geology, was the one who undertook the task of convincing his peers of the validity of Hutton’s ideas.

Lyell, a son of a rich Scottish family, was able to devote his whole life to the study of geology. He was the first geologist to clearly strip geology of its cosmology and transform it into an empirical science. He adopted the principle of uniformity and reaffirmed Hutton’s ideas.

He was opposed to Cuvier’s progressionism, claiming there was no obvious progress or global changes according to the principle of uniformity. Thus, all life forms, including mammals, can be found in all geological layers.

He did not believe in Lamarck’s ideas on evolution. He claimed that individuals that deviate from the ideal individual shape were more susceptible to disappear than individual close to the ideal form or the essence of a species.

His main work (Principles of Geology) was published in two volumes, the first in 1830 and the second in 1832. His work was re-edited twelve times. At first, he vehemently opposed Darwin’s idea of natural selection. But later on, he accepted Darwin's idea of evolution and added it to the latter edition of his work.

. His philosophy and his persona had a great influence on Charles Darwin.