

COSMOS ** II

Evolution – From Microbe to Man (Origin of the Universe, Life and Man)

A Comprehensive Pre-Release

PRECIS

by

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Acknowledgements are not obligatory, but where appropriate would be appreciated.

Preface

About Precis

This precis is a self-contained summary of **Cosmos** II – Evolution From Microbe to Man**, which is being edited for release in early 2026.

It incorporates the preliminary conclusions of **Cosmos*** III – Evolution Beyond Materiality?** which will be released in mid 2026 after the above.

About Cosmos** II

This volume attempts a synthesis across the many disciplines covering **the greatest saga of them all**, Evolution, the physical origin of the universe, life and man, and where we are heading.

About Cosmos*** III

This volume looks at the experience of man in the metaphysical, philosophic, religious and arcane domains as a basis for reflecting on whether evolution (man) has a pathway and terminal objective beyond materiality.

The Bottom Line

Intelligent man was a quantum leap, a turning point.
Evolution continued thereafter through civilisation, with man in charge.
The study questions, inter alia, its terminal objective
and whether the next quantum leap
may be beyond materiality.

Overall Scope of the Study

The object of the study has been to understand the latest thinking on the origin and evolution of life, where evolution is heading, and the role of man. The study looks for a grand design, if there be one. It comprises these three volumes (see Genealogy).

COSMOS II – Evolution From Microbe to Man**

The study does so in the **Part A – The Physical Universe** by reviewing the pre-biotic development of the universe, which may be thought of as the preparatory phase. The study seeks to understand the processes by which the pre-conditions for life came to be distributed and located on planet Earth. In fact, the first question arising is whether this was unique to the Earth.

The study proceeds in the **Part B – The Earth-Life Cosmic Dance** to trace the emergence of life in the single-cell prokaryote, and its progression to multi-cellular eukaryotes, to soft-bodied life, to animals and plants, and to Homo Sapiens, interacting at each stage with and influenced by our maturing physical environment.

The study proceeds in the **Part C – Evolution of Man** to follow the emergence of the human, from early modern man to modern man, and finally to Man as the apex and turning point of evolution, and to identify his role.

The study finally asks Quo Vadis? (what Next?), where is evolution heading, whether its terminal objective is in the temporal domain or may lie beyond materiality.

COSMOS* III – Evolution Beyond Materiality?**

This volume reviews three areas: (a) man's intellectual quest of the unknown, focussed on the "metaphysical issues", (b) man's knowledge architecture, doctrine and experience within the major religious domains, and (c) the experience of arcane faculties that some humans possess to perceive the unknown, as a basis to speculate whether there is an evolutionary pathway for man beyond materiality representing the terminal objective of evolution.

PRECIS

A comprehensive Pre-release of the preceding.

Genealogy of this Book

After my second retirement, and sundry other research work, I decided to do a roundup of the frontiers of science, moving onward on a piece by piece basis, and inevitably focussing on evolution.

By professional habit (as a career administrator and consultant) I captured the outputs, and over the years released them as follows:

Volume	Title	Description
1	Quantum Mechanics, A Non-Technical Brief ISBN 978-981-14-9875-6 2020	Coinciding with the first quantum computers
2	Virus* The Biological Predator ISBN 978-981-18-3046-4 2021	Coinciding with and including a detailed coverage of Covid-19
3	Cosmos* The Physical Universe ISBN: 978-981-18-7401-7 2023	An historical survey of man's discovery of the universe. It summarises what we know today, and looks to the future. Written in preparation for and timed with the launch of the James Webb Space Telescope (25 Dec 2021)
4A (This work)	Cosmos** II, (Precis of) Evolution – From Microbe to Man ISBN 978-981-94-5191-3 2026 (Feb)	Pre-release of Volume 4
4	Cosmos** II (The full work) Evolution - From Microbe to Man ISBN 978-981-94-5192-0 2026 First Quarter (due)	Covering the Origin of Life, Role of Man - and Way Forward
5	Cosmos*** III (under edit) Evolution - Beyond Materiality? ISBN 978-981-94-5007-7 2026 Mid (due)	Covering evolution beyond materiality

I have completed the work on both Cosmos** II and Cosmos***III, but the editing will take some time, as a lot is technical and needs checking for a "non-technical" person like myself. I thought therefore I would issue this Precis to capture the my overall findings fresh, and serve for easier digestion by others.

I have released the above as self-publications on the Internet at <https://geraldpillay.wordpress.com/>, and will do the same for those due.

All my publications, including the above, are also available at <https://independent.academia.edu/GeraldPillay>

Dedication

To my grandsons
Christian Lowen Pillay
and
Derrick Ng

(I hope they read the main Volumes sometime.)

Editorial Note 1

This review has been an Internet-based research exercise. To the extent that the various search engines today incorporate first-line AI, the exercise has benefitted from the latter. I have not otherwise used AI tools.

I am by career fact-centred, with wide experience in assessing technical matters for policy decision. I am comfortable the output is a factual picture of our subject at the informed non-specialist level.

While the areas covered are technical, and technical terms cannot be avoided, the content is generally expressed in ordinary language.

Editorial Note 2

For convenience,
I use the masculine to include the feminine,
“man” (and its derivatives) to include woman,
and I refer to the Supreme Being in the masculine.
I make no apology.

(Table of Contents From Microbe to Man

Part	Title	Page
	<u>Object of the Study</u>	9
One	<u>Pre-biotic Preparatory Phase</u>	9
Two	<u>The Saga of Terrestrial Evolution</u>	14
	<u>Rise of the Prokaryotes</u>	15
	<u>Emergence of the Eukaryotes</u>	19
	<u>The Home Stretch - Evolution of Animals and Plants</u>	21
Three	<u>Evolution of Man</u>	29
	<u>Human Ancestry</u>	29
	<u>Modern Man</u>	31
	<u>Evolutionary Status of Man</u>	32
	<u>Our Record – Good</u>	35
	<u>Our Record – Not So Good</u>	38
	<u>The Quest</u>	39
	<u>The Temporal Pathway</u>	40
	<u>The Parallel Pathway Evolution Beyond Materiality?</u>	45
	<u>The Way Forward</u>	47
	<u>The Evolutionary Strategy</u>	49
	<u>Concluding Remarks</u>	51
Annex	<u>About Gerald F Pillay</u>	53

COSMOS ** Evolution II

– From Microbe to Man

(Origin of the Universe, Life and Man)

(A Precis)

Object of the Study

The object of the study has been to understand the latest thinking on the origin and evolution of life, where evolution is heading, and the role of man.

The study looks for a grand design, if there be one. The study does so in the **Part One** by reviewing the pre-biotic development of the universe, which may be thought of as the preparatory phase. The study seeks to understand the processes by which the pre-conditions for life came to be distributed and located on planet Earth. In fact, the first question arising is whether this was unique to the Earth.

The study proceeds in the **Part Two** to trace the emergence of life in the single-cell prokaryote, and its progression to multi-cellular eukaryotes, to soft-bodied life, to animals and plants, and to Homo Sapiens.

The study proceeds in the **Part Three** to follow the further development of the latter, from early modern man to modern man, and finally to Man.

The study finally asks Quo Vadis? (what Next?), which will be addressed in the next Volume 5 - Cosmos*** III - Beyond Materiality.

(Editorial Note: For convenience, I use “man” (and its derivatives) to include woman, and I refer to the Supreme Being in the masculine. I make no apology.)

PART ONE

Pre-biotic Preparatory Phase

Definitions

In this part, unless the context otherwise requires:

“cosmos” means the universe and all that exists or may exist beyond it, known, unknown and conjectured, and unknowable.

“universe” means the physical world within our time-space, including all biotic or living things

“pre-biotic” means before the emergence of life.

“metaphysical”, appertaining to all speculative thought relating to existence, being, reality, the origin and causes of things, and the purpose of man; and to knowing about these matters.

“philosophic”, the application of metaphysical (and related understandings) to what constitutes moral behaviour, a good life and the ultimate satisfactions of human existence.

“exoplanet”, planets found beyond our solar system, in orbit around other stars or as free-floating “rogue” planets.

Overview

The study finds that, spectacular and separate as they were, the many concatenated events in the universe, together, may be viewed in the light of the end results as a single preparatory programme of stage-setting, to set up the conditions required to engender life.

It does not appear that the above was incidental, subsidiary or adjunct to some other purpose or objective of the development of the universe, or to have occurred by chance. On the contrary, the preparatory programme appears to be itself the primary purpose of the developing universe.

It would not be wrong to say that the universe was being set up to enable life according to the factors assembly therein - at the appropriate place and time.

We may add a qualifier. There are major areas within the universe still not understood. Among these are dark matter, dark energy, gravity, the apparently accelerating universe, and the time barrier. Therefore, as we progress, we shall be reformulating our understandings of the universe. However, as far as we can see, they will not change the facts as they already happened. The pre-biotic preparatory activities did take place, enabling evolution of life. This study proceeds on that basis.

Unfolding of the Universe

Scientists have established that the whole of the universe is made up of the same matter, and the same physical laws of nature apply everywhere. This means in the first order of its development the universe created a common material base for different possible forms of life to emerge, subject to local conditions.

It is in the creation of local conditions that the preparatory programme excelled itself. Nothing could have been more spectacular or wide-ranging in the disposition of matter and local conditions than the modus operandi chosen, the grand opera of the big bang¹, followed by nucleosynthesis, the galaxies, the stars and the planets, the whole encapsulated in space-time.

The big bang contained the sum total of all the potential energy that drove, and still drives the universe. The universe expanded in space by a factor of the order of 10^{26} over a time frame of the order of 10^{-36} seconds. At the same time, the universe supercooled down sharply to 10-22 Kelvins. The primary purpose of the big bang was to install (or if you like “enspace”, my term) the universe.

But, whether by design or happenstance, when it initially attained the right temperature, pressure and energy level (of several million Kelvins) to perform nucleosynthesis, it first fused its payload of primeval matter, from quarks, protons and electrons, into atomic nuclei. Nucleosynthesis peaked at hydrogen, which was the lightest element, at one atom - with some spillover into helium, lithium and beryllium. Looking downstream, this represented some. 73% of all matter, and it would appear it greatly facilitated the subsequent build-up of the universe, while providing the fuel for energising the stars. All hydrogen atoms were created about 380,000 years after the big bang.

Progressing in stages, the universe first stretched out in giant filaments of hydrogenous gases, forming the cosmic web. As the latter cooled, the web formed the primary large-scale structures of the universe.

As things cooled further, galaxies began to form within the latter, again from nebulae of hydrogenous gases, accreting as star-clusters and giant stars. The first stars began to appear about 100 million years after the big bang.

With their gravitational collapse, the temperatures and pressures at the cores of these stars rose to fusion levels, in fact to levels above that initially achieved at the big bang, enabling fusion of heavier elements.

¹ - Scientists speculate how it occurred, whether from a singularity, a perturbation or hyper-inflation, for our purposes. It did occur..

The fusion of hydrogen into helium, the next dense element, released a tremendous amount of energy. This was the start of stellar nucleosynthesis, which is the creation of new, heavier atomic nuclei from lighter ones. As the star continued to evolve and its core got even hotter, helium fused to form carbon, and subsequent fusion reactions created even heavier elements like oxygen.

Stellar nucleosynthesis went on to produce the rest of the elements. Under the energy released, the stars “lit up” and heated the universe for the first time, and we had the Cosmic Dawn, by roughly one billion years after the big bang.

Both carbon and oxygen, critical components of our biology, were made at this time. Nature further arranged it so that they got distributed to the universe when their stars terminated their life cycles in a supernova, by collision, assimilation, etc, aided by “stellar winds”.

Needless to say, as the stars spun on their axes and cooled externally, they in turn formed the planets from their loose material, offering an almost infinite combination of life-friendly conditions.

The materials also got distributed to the planets and other locations by lesser forms of transport like comets, asteroids, dust, debris, icicles and even “solar winds”, bringing complementary resources for life formation.

The net result of all the preceding was that the planets emerged as the practical locations for life as we know it on Earth to emerge, the only possible places where the right temperature ranges and other conditions could come together, depending on their orbit. These planets are said to be within the “habitable zones” of their stars.

It has been gestimated that there are 200 billion billion (6 sextillion) stars in the universe, and some 100 billion stars in the Milky Way alone. Even if we assume that there might be only one planet on the average per thousand stars in the Milky Way, we are looking at 100 million exoplanets. At one *per million*, there could be 100 habitable exoplanets in the Milky Way alone.

No new galaxies are being “born”, However, galaxies are still growing through mergers and collisions, and star formation continues. There have in fact been three generations of stars, our Sun belonging to the youngest generation.

On this basis, one might say the universe was pretty much set up to take on life in any number of places over a wide swiipe of time, subject to local conditions. It is possible life may have emerged and died out many times before we even began.

Life is dependent on local conditions. These include the terrain, topography, tectonics and heating conditions, the availability and disposition of water, the atmosphere and climate – and importantly but not essentially to start off, the presence of organic compounds.

Water

We will end here by touching on two compounds, critical to life as we know it. The first is water (H₂O). Oxygen was made in the stars, and therefore water only began to appear with the Cosmic Dawn. The oxygen had to disperse and unite with hydrogen in significant amounts to form water. They must be subjected to an energy charge for this to happen.. It is thought water was formed when dust and debris, also created by stars, passed through oxygen in hydrogen-filled space, delivering the necessary energy, forming icicles. Water was therefore first formed in deep space.

In time, it got delivered to the planets by bombardments of various kinds. Some scientists think the universe is saturated with water. It is thought the early Earth was a “water-world”. 71% of Earth is still covered by the oceans.

Carbon

The universe was about 200 million years old when the first stars began their fusion processes that created carbon, the fourth most plentiful element. Evolution chose carbon as the basis of its biology. All living matter is formed of organic compounds, which includes carbon.

Technically, an organic compound is a chemical compound containing carbon, covalently bonded to other atoms, most commonly hydrogen, oxygen, and nitrogen. Carbon has the ability to form very long chains of interconnecting bonds. This property allows the complexity and diversity of the organic molecules necessary to form the backbone of life.

Interestingly enough, we know of no other element in our universe with this or similar capability. This is thought to pretty much narrow the possibilities of other life forms based on other elements, say iron. We are a carbon life-form.

All organic compounds are biological. They have each evolved to serve a biological function. Every living thing on Earth is a skinful of organic compounds.

Life itself functions through the structures and chemical reactions of organic compounds, and it evolves new organic compounds as needed. Thus, there are standard substances like proteins, carbohydrates, fats, and nucleic acids. Additionally living things make other organic compounds as “biological tools” and “molecular muscles” for specialised purposes. Among the latter are enzymes. These are functional as well as catalytical, serving to trap photons, transmit energy, breakdown food, remove waste, medicate and repair, and engineer replication. There are myriads of organic compounds.

I think myself of carbon’s ability to enable us to make the next new organic compound as the first frontier of evolution.

Origin of Organic Compounds

New lines of enquiry have opened up in recent years exploring the possibilities that organic compounds may have been formed in space (like water) and transported to Earth in the inter-stellar exchanges. These and other complex molecules, like those found in meteorites, could have been delivered to early Earth from space, providing the raw materials for life to begin. Confirmation of this would mean, organic compounds are standard to all parts and planets of the universe, like water, simply waiting our discovery. They do not, however, explain how life got going, here or anywhere.

Aside from the evidence of transfer of organic compounds (and possibly microorganisms) from space, the standing theory of the origin of life on Earth is the primordial soup theory, which is the backdrop of our investigations in Part Two.

The thesis is that life on Earth arose from a mixture of inorganic compounds in the early oceans or atmosphere, which when energised by sources like lightning or UV radiation, formed simple but essential organic molecules like amino acids and purines. These molecules then combined to form more complex compounds, eventually leading to the first self-replicating life.

Researchers suggest these metabolic cycles could also have occurred in hypothermal vents on the ocean floor, where chemical reactions might be driven by geothermal energy. The further thesis is that the vented gases could have included methane, ammonia, water vapor, and carbon dioxide, which could have formed the organic molecules.

The Miller-Urey experiment² was a 1953 simulation of early Earth conditions that successfully produced amino acids from inorganic molecules by passing electrical sparks through a mixture of methane, ammonia, hydrogen, and water. The experiment demonstrated that the basic chemical building blocks of life could form through natural processes, establishing chemical evolution as a fundamental process of life formation.

In retrospect, the experiment focussed on creation of the organic compound, not life generation. The experiment demonstrated the (natural) formation of organic molecules, but did not show how these molecules would combine to form life. Various follow up experiment have been carried out since, generally upholding the finding of this experiment, but there is no report of any advance further.

² - Conducted by Stanley Miller and Harold Urey at the University of Chicago, https://en.wikipedia.org/wiki/Miller%E2%80%93Urey_experiment

Up to 1828, it was thought that organic compounds could only be synthesised by the living bodies. Today, we can artificially produce a considerable range of organic compounds to supplement our health. It does not bely their biological character, but we are far from understanding how to make life.

What finally it boils down to is that the universe included provision for organic compounds as a preparatory step.

[\(Back to TOC\)](#)

PART TWO

The Saga of Terrestrial Evolution

Definitions

Unless otherwise required in their context,

“respiration” or “cellular respiration” is the process of extraction of energy. It is “aerobic” if done with oxygen, and “anaerobic” if done without oxygen.

“food” or “nutrients” means organic compounds consumed (broken down) to release their energy and raw materials

“consumption” means the breaking down of organic compounds.

“prokaryote” is any organism that lacks a distinct nucleus and other organelles due to the absence of internal membranes. There are two broad domains, namely archaea and eubacteria (bacteria).

“eukaryote” is any organism whose cells contain a nucleus and other membrane-bound organelles . There is a wide range of eukaryotic organisms, including all animals, plants, fungi, and protists, as well as most algae.

“Quantum leap” is a forward shift in complexity for which there is no scientific basis. In time, we have come to understand how most quantum leaps took place and even (from the results) why. The only two outstanding are: why was life started and why man acquired his intellectual capacities.

Overview

In Part Two, we capture in considerable detail what followed the preparatory stages, and what happened in evolution up to today. I find the best starting perspective to take is that we, man, are the current end-product of evolution; and this study seeks to trace what were the steps and processes that brought things together to make us what we are.

The saga of evolution emerges as a dramatic (the word that occurs to me is unquenchable) upsurge of life, on the stage of a tectonically turbulent planet, on the longest possible swathe of time, and with cycles of new growth, destruction, regeneration, quantum leaps and triumphs.

I make the point that we are the same micro-organism of yore that grew up, a future model of the same thing.

The Four Fronts

I find that evolution, after picking on carbon as the base substance for building our life-form and identifying Earth as the place to start things, proceeded with its purposes on four interacting fronts

- .1 Firstly, establish a system to capture, store, unpackage and deploy energy.
- .2 Secondly, invent a biochemistry (previously non-existent) that could work with organic compounds to make and functionalise the living organism.
- .3 Thirdly, develop the necessary metabolism, that is the set of all chemical reactions necessary to sustain life and develop.
- .4 Fourthly, be able to reproduce itself, and in doing so adapt and mutate as necessary, and thereby evolve.

Our proto-organism adopted a twofold strategy: a short life cycle and mass reproduction. This allowed for evolution on an exponentially increasing front, improving the chances of surviving the high rates of extinction in early Earth.

[\(Back to TOC\)](#)

Rise of the Prokaryotes

The Earth was formed 4.56 billion years ago, and we have found the first evidence of evolution dating back to 3.8 billion years ago in the Archaean. The oceans had substantially formed, but the Earth's surface was still made up of continental chunks drifting about under the influence of magmatic currents heated from the core.

It is believed life started in the ocean, near a hydrothermal vent. Neither the oceans nor the atmosphere at that time contained the levels of oxygen necessary to support life as we know it.

The Anaerobic Chemotropic Prokaryotic phase (3.8 to 2.9 billion years ago)

Our first life was therefore an anaerobic prokaryote, a single-cell microorganism or entity.

Its first requirement was to obtain energy. Our proto-organism had initially to kick-start things with energy from an inorganic source, such as the surrounding rocks or minerals, by a process called chemolithotrophy. When this source was triggered by lightning or an electrical charge or heat, our prokaryote had its first "activation energy".

After much mucking around for hours, days, years, perhaps thousands of years, our proto-organism discovered "redox" Applying activation energy, this is the chemical reaction that knocked off an ion or electron from a (donor) substance (oxidation) coupling it with a further transfer of the same on to another (acceptor) substance (reduction).

Our prokaryote then proceeded to develop an Electron Transfer Chain (ETC) applying the redox principle to transfer the electron (and its energy) via a series of intermediaries to a terminal acceptor. By a series of "reductions", this process created a "proton gradient" (of potential energy) at the latter. The terminal acceptor was then passed through a "molecular machine" or enzyme called "ATP Synthase"³, which synthesised the energy to form ATP (adenosine triphosphate) molecules (energy carriers). Voila, our prokaryote was in business.

Prokaryotes perform cellular respiration and ATP production across their cell membrane and in the cytoplasm. This is assisted by a structure called mesosome which are the infoldings of the cell membrane.

Donors were usually inorganic, the intermediates were organic, and the terminal acceptors either, usually inorganic compounds.

The next urgent task was to build a cell and make it function as a living entity (definition: it could reproduce). It established three sets of functionalities: (1) to breakdown and extract from the existing organic (and inorganic) compounds the nutrients and energy necessary to sustain life and tap more energy, (2) to build its different requirements, and (3) to operationalise the metabolic system. Then, our prokaryote went on to create a whole corpus of enzymes and biological tools to execute these functionalities.

Our prokaryote's primary requirement was for organic compounds. After further mucking around, it established four categories of organic compounds as its nutritional sources, namely (1) proteins for building, (2) carbohydrates (glucose) for food, and (3) lipids (fats for storage) and (4) nucleic acids. Additional requirements included minerals, water and vitamins, with which we not be concerned here.

³ ATPs are energy carriers, also the the unit of measurement of biological energy. When ATP releases a phosphate group to power cellular activities, ADP (adenosine diphosphate), is formed. It is then converted back to ATP through processes like cellular respiration, essentially acting as the "rechargeable battery" of the cell.

Our prokaryotes initially got their organic nutrients from the external environment by absorption through the cell wall-membrane. Where the molecules were too large, they flushed out enzymes to break them down first. In time, they began to store supplies in excess to needs. Ultimately, this would be the basic practice of future generations, with the ingestion of food as the standard source.

Ongoing research suggests that prokaryotes very early started using chemosynthesis to fix carbon compounds from inorganic compounds, in particular carbon dioxide and hydrogen in the air – in fact establishing the pathway for carbon fixation in the future. (There is the suggestion the latter function may well have been a standard process in nature before the emergence of life, perhaps another preparatory step to enable it.) Carbon fixation has remained the ultimate source of food, in the absence of everything else.

I could get no firm source, but it is likely the early cyanobacteria had evolved pathways enabling the (future) Calvin Cycle as a third independent source of energy production, although at that stage they had no dire need to manufacture organic compounds additional to what was already available.

Among the earliest metabolic systems put in place was the anaerobic universal pathway glycolysis. It critically converted glucose to extract ATP (but imperfectly), while releasing its payload of other raw materials. Other organic compounds were processed by other enzyme-tools to other intermediate stages for their purposes and/or fed into glycolysis to extract their payloads. This was the primordial “consumption” (of food) function.

Central to all of the above was the metabolic system. This is the working system of an entity that keeps all its operations functioning in sync and coordinated towards the objectives of the entity. In the case of a biological entity this would be: to be alive, grow, repair, be in homeostasis, reproduce, adapt, and evolve. Even at that stage, the prokaryote had built up a considerable operational management load.

Finally, our proto-organism also needed a management information system to store data and organise, select and set its directions of advance. Our prokaryote created and installed two related systems⁴ which also serve a second major function, the microorganism's building, repair and development system:

. (1) The first was the DNA system, housed in a nucleus. It stored all the genetic codes for an organism to develop, survive, and reproduce, in other words the blueprints for building and operating the organism. DNA also accurately copied itself on reproduction so this genetic information can be passed from one generation to the next.

. (2) The second system was the RNA. A copy of the DNA instructions is made into a messenger molecule called RNA, which takes the message out of the cell's nucleus into the molecular machine ribosomes (of which there are many in a cell). Ribosomes read the RNA message and link amino acids together in the correct order to build a protein.

Our evidence is that our prokaryote took a billion years to evolve all of the above, and all that bio-engineering took place in a single cell of less than a micron. By then, our prokaryote would also have multiplied into the zillions and occupied much of the land as well as the water, over an almost infinite number of mutations.

Modern evidence shows that our prokaryotes split early into their presently recognised domains of Archaea and Eubacteria (Bacteria). The timelines of species divergence suggest that archaea diverged earlier: between 3.7 and 3.1 billion years ago, while bacteria diverged from common ancestral species between 3.2 and 2.5 billion years ago.

Archaean prokaryotes became specialised to extreme conditions, while bacterial prokaryotes represented the main line of the prokaryote. Therefore, in this study, we have focussed on the latter, and our descriptions relate to them.

⁴ - Nucleic acids, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), carry genetic information which is read in cells to make the RNA and proteins by which living things function. The well-known structure of the DNA double helix allows this information to be copied and passed on to the next generation.

The (bacterial) prokaryote was typically a single cell microorganism, measuring from 0.1 to 5 microns (one millionth of a metre). The limited energy available set the limits on their evolution. They stayed small to maximise efficiency and replication, sacrificing speed of movement and size.

Typically, our micro-organism was enclosed by a cell wall on the outside and a plasma membrane on the inside. Together, they functioned as a two-way filter to intake external nutrients and in reverse to dispose of waste products. Some prokaryotes had flagella on the outer membrane for movement and linking up with others, eg. typically in colonies

Inside the plasma membrane was the cytoplasm, which consisted of a gelatinous liquid known as the cytosol. It was a mixture of colloidal protein and other molecules which included: enzymes, carbohydrates, small protein molecules, ribosomes and ribonucleic acid (RNA).

Prokaryotic cells had no internal membrane-bound organelles. The absence of a nucleus and other membrane-bound organelles differentiates prokaryotes from eukaryotes.

Prokaryotes reproduce by binary fission. There was no central brain. We may note some of their processes:

- . (a) The sourcing, production and application of energy.
- . (b) The breaking down and re-synthesising of organic compounds
- . (c) The fixation of carbon and storage of food
- . (d) The management of the reproductive processes
- . (e) The maintenance, homeostasis and movement processes.

We must make the point here that as we move forward with each new mutation and species, the old ones continue, usually with specialisations and improvements. Thus, the original anaerobic prokaryote and their successors are still very much around today. Scientists say however that 99% of all past species have gone extinct.

The Non-Oxygenic Photosynthetic Prokaryote Period (3.4 to 2.3 billion years ago)

The first dramatic **turning point** began when our prokaryote came within range of sunlight, probably on the ocean shores. The atmosphere continued to be devoid of oxygen. The world was still anaerobic.

With their biochemistry set, one day they came up with a pigment which captured a photon of sunlight (albeit in the infra-red range), which has since been named "bacteriochlorophyll". Not long after, they incorporated it into a new Photo System 1 to produce energy on a regular basis. Marrying this with redox and the ETC, they produced the first big turning point in evolution, the photosynthetic energy capture system. This resulted in a significant but still limited leap in the availability of energy, among other things limited to daylight and the performance of the terminal acceptor used.

Current evidence is that this event predated the split into the domains Archaea and Eubacteria, and before the latter developed the Cyanobacteria. The new system continued to use various hydrogenous inorganic compounds as electron donors and electron acceptors, but not (yet) water.

The energy breakthrough was the defining achievement. It enabled our prokaryote to fully build itself up. Critically, it enabled our prokaryote to create the enzymes, chemical pathways and routines which in the end enabled it to switch dependence from anaerobic photosynthesis to oxygenic photosynthesis and in time to its own organic compounds as the prime source of energy.

The Oxygenic-Photosynthetic Prokaryote Period (2.4 to 1.8 billion years ago)

We follow the evolution of the bacteria as it formed the main line of advance. Somewhere as early as around 2.9 billion years ago, the cyanobacteria became a lead species.

The next turning point, executed by the cyanobacteria, was oxygenic-photosynthesis. This began to happen around 2.4 billion years ago. It was in essence to adopt water (H₂O) as the electron donor. The underlying chemistry proved to be quite simple. When The water (H₂O) was oxidised by an appropriate reducing agent, it released an ion of hydrogen (H⁺) (an electron) as energy, and produced pure oxygen (O₂) and hydrogen oxide (H₂O) as end products. Hydrogen oxide remained as the oxidated residue, and oxygen was released into the atmosphere as a by-product. Needless to mention, water yields the highest release of energy. In this context, energy means electron (or ions thereof). This would change the world.

After much experimentation, our prokaryote settled on the enzyme NAD (nicotinamide adenine dinucleotide), or one of its variants, as the first electron acceptor. It designed the special enzyme NAD as a biological carrier of reducing equivalents, i.e. it could accept and deliver electrons. In that sense, it functioned as a coenzyme. NADP was the reducing version and NADPH the oxidising version. The latter is the only known oxidiser that can split water. If it had not invented this enzyme, the world would be without oxygen to this day!

To ramp up the supply of the energy, our prokaryote modified bacteriochlorophyll, finally making what we name today as “chlorophyll,” the same used by plants. It was capable in a number of variants of trapping sunlight across the full visual spectrum, and it was installed it in a newly designed Photo System II .

Light reactions occurred in two interdependent systems, primarily in Photosystem II but also via the earlier Photo System I. Light energy absorbed by Photosystem II caused the formation of high-energy electrons (H^{*}) which were transferred along a series of acceptor molecules (NADP) in an electron transport chain to Photosystem I, whence they ultimately flowed to their points of usage. Photosystem II simultaneously obtained replacement (reloads) electrons from oxidising water molecules using the oxidiser (NADPH), resulting in their split into hydrogen ions (H⁺) (electrons) and oxygen atoms. This happens at an oxygen-evolving complex (OEC) within Photo System II , also known as the water-splitting complex, a biochemical cluster.

The electrons are ultimately transferred to Photosystem I, which, after further light excitation, drove the reduction of NADP⁺ to NADPH, another crucial energy carrier.

Photosystem II produced the proton gradient that drove the synthesis of ATP by ATP Synthase, while Photosystem I delivered it the reducing power in the form of NADPH.

The increase in energy availability was quantum in scale. The immediate effects were twofold: (1) vast increase in prokaryotes and (2) vast increase in oxygen. The problem was the oxygen was poisonous to the anaerobic prokaryote.

It led to the Great Oxygen Event (GOE), at which stage, around 1.8 billions ago, the oxygen levels had risen to about 10% of Present Atmospheric Levels (PAL). Scientists estimate that about 90% of all prokaryotes died.

As a consequence, the oxygen diminished. By around 1.6 billion years ago, we had the Great Oxygen Crisis (GOC), when oxygen levels fell to around 1% PAL.

Boring Billion Years (1.6 to 0.5 billion years ago)

The ensuing million years became known as the “Boring Billion Years”. On the surface, nothing much happened evolutionarily. But it allowed our prokaryotic ancestors the time to struggle for survival and the emergence of the eukaryote

Recovery of the Prokaryotes

Firstly the prokaryotes created the enzyme defences against the harmful effects of oxygen, particularly a toxic by-product of oxygen called “reactive oxygen species”(ROS). This meant the survivors could and would continue to produce oxygen. This proved to be vital to re-supplying the atmosphere for the future.

Secondly the prokaryotes were able to adapt themselves to an oxygenic environment while remaining anaerobic. Realising that oxygen was one of the most versatile, energy-loaded and chemically-friendly (bonding) substances, they decided to incorporate it in their bio-engineering.

A cardinal change was oxidative phosphorylation, the upgraded energy production system in which **oxygen became the terminal acceptor**. It produced some 38 ATPs (per molecule of glucose) with the end product of water. This became the basis of aerobic respiration, which would become fundamental characteristic of all eukaryotes, animals and man. I have not seen it said so, but our prokaryote's invention of aerobic respiration must be accounted as vital a contribution (sine qua non) to evolution as DNA/RNA. What came after were mainly changes in the mechanisms.

It may be recalled that oxygen is produced by the prokaryote in the production of energy from sunlight by splitting water (ie anaerobic oxygenic-photosynthesis). Up to that point, the prokaryotes took the oxygen off the air. Scientist estimate, these prokaryotes used up 10% of their own oxygen production, and released the rest to the environment

It is thought that prokaryotes began experimenting with oxygenic-respiration (ie aerobic respiration) from an early stage, even as they were being decimated, with some success. The front-runners achieved "facultative capability" (able to switch), and the early eukaryotes inherited it from them. As the re-oxygenation began, the eukaryotic evolution could take place.

Cellular respiration, which breaks down organic compounds to produce ATP, may be anaerobic or aerobic. This process occurs in stages, including glycolysis in the cytoplasm, followed by the Krebs's Cycle (or citric cycle) followed by oxidative phosphorylation. The presence of oxygen as the final electron acceptor is what makes the process "aerobic". This was inherited by eukaryotes.

Likewise, prokaryotes developed the process of building organic compounds from carbon dioxide in the atmosphere, eventually known as Carbon Fixation, and this too was inherited by the early eukaryotes. This process is non-oxygenic.

[\(Back to TOC\)](#)

Emergence of the Eukaryotes

Single-cell Eukaryote

Scientists theorise that the first eukaryotes were formed through endosymbiosis, a process where a single-celled host, likely an ancient archaeon, engulfed another bacterium (inclusive of its various processes). This engulfed bacterium survived and evolved into the eukaryote's mitochondrion, (plural: mitochondria). Over time, this beneficial relationship led to a symbiotic partnership, resulting in the first complex eukaryotic cell. Later, some eukaryotic lineages acquired other symbiotic bacteria, such as cyanobacteria, which evolved into chloroplasts, allowing for photosynthesis. Carbon fixation was portably acquired in the same way.

The early eukaryotes were still single-celled. With their increased energy resources, they grew up to 10 to 100 microns, Besides a cell wall, cell membrane and cytoplasm, which they inherited from the prokaryotes, they became defined by a set of new and more sophisticated organs:

. (1) Mitochondria:

This is a double-membrane-bound organelle (mitochondrion, singular) that houses and performs cellular respiration. Eukaryotes will progressively develop the extraction of energy from stored organic compounds to become the main source of all their energy requirements, with the mitochondria becoming the "powerhouse of the cell".

Cellular respiration involves a series of reactions, including glycolysis, the citric acid (or Krebs's) cycle and oxidative phosphorylation, all of which take place in the mitochondria.

Mitochondria have their own DNA and play a role in other cellular processes like storing calcium. The number of mitochondria in a cell varies; some cells may have just one, while others may

contain hundreds. The acquisition of mitochondria was the critical step, allowing for a massive increase in the energy available to the cell.

.(2) Chloroplasts.

A chloroplast is a double-membraned organelle that hosts the oxygenic-photosynthesis function inherited from the prokaryote, converting light energy into chemical energy (ATP) to make food, etc. It contains the green pigment chlorophyll,

The chloroplast also hosts the Carbon Fixation process inherited from the prokaryote ancestor, which converts (fixes) carbon dioxide from the atmosphere in the form of organic compounds for respiration and storage, using the Calvin cycle. The enzyme that fixes carbon is Rubisco

In time, the above two functions will be combined together in plants, known simply as “photosynthesis” and forming the crucial component of the Carbon Cycle and base of the food chain.

.(3) Nucleus

It is the presence of a nucleus that distinguishes an eukaryote from a prokaryote, The nuclear envelope is a double-membraned structure that separates the nucleus from the cytoplasm The nucleus is the control centre of a single-celled organism. It coordinates the cell's activities by controlling gene expression, which determines the proteins that are made.

It contains the cell's genetic material (DNA). It protects the DNA chromosomes, regulates access, and is responsible for DNA replication, transcription into RNA, and RNA processing.

The nuclear envelope acts as regulated gateways for molecules to move in and out. It transcribes the DNA into various types of RNA, which then exit the nucleus through the nuclear pores to be used by the cell to make proteins.

.(4) Endoplasmic Reticulum (ER)

This is a network of membranes involved in protein and lipid synthesis, and includes the Golgi Apparatus, which modifies, sorts, and packages proteins and lipids for transport. It is contiguous with the outer membrane of the nucleus.

It is clear that the eukaryote made some very critical breakthroughs in evolution. First it established respiration as an alternative to sunlight as the source of energy supply, making this function diurnally independent and under its full control, Second, it installed its own organic compound manufactory, releasing the eukaryote from hunting around for food. Third, these factors extended the range of its mobility and multi-cellular specialisation. Fourth, the increase of energy at its command enabled it to grow and attain higher levels of life organisation and mobility, eventually intellectual capability.

For good measure, the eukaryote retained oxygenic-photosynthesis to provide the supply of oxygen, which had become indispensable. In fact the eukaryotes re-oxygenated the atmosphere after the Great Oxygen Crisis (GOC), continuing to maintain it at 21% with plant-life. By the period 700-541 million years ago, the planet began to experience the Neoproterozoic Oxidation Event (NOE).

The emergence of the eukaryote took place alongside the recovery of the prokaryotes during the “Boring Billion Years”. Fortunately, tectonic and atmospheric conditions were stable. The oldest unambiguous single-celled eukaryotes have been found in rocks from about 1.65 billion years ago

Multi-cell Eukaryotes

The next step was the multi-cellular organism, as organisms began to share functions.

The earliest evidence of multi-celled organisation actually comes from prokaryotic organisms, like cyanobacteria, that lived 3 to 3.5 billion years ago. These organisms formed colonies, but lacked the specialised, differentiated cells of true multicellular eukaryotes

The first organisms that were clearly multicellular were algae. The earliest has been found in Gabon, Africa around 2.1 billion years ago. . The first definitive evidence of multicellular eukaryotic life comes from fossils of photosynthetic algae dating back approximately 1.63 billion years. These ancient, multi-celled filaments were discovered in northern China in 2024 and are considered the oldest undisputed examples of multicellular eukaryotes. The earliest known sexually reproducing organism was a red alga found 1.2 billion years ago.

[\(Back to TOC\)](#)

The Home Stretch

Evolution of Animals and Plants

Timecope

4.567 billion years so (bya)

The Earth was formed

4.2 to 2.9 bya (1.3 bys)

The first generation prokaryotes
(archaea and eubacteria)

2.9 to 1.6 bya (1.3 bys)

The second generation prokaryotes (rise of cyanobacteria)
First generation unicellular eukaryotes

1.6 to 0.5 bya (1.1 bys)

Rise of multi-cellular eukaryotes
Facultative prokaryotes
Edicaran biota

541-538 bya (0.5 bya)

CAMBRIAN EXPLOSION

538 to present mya (0.5 bys)

HOME STRETCH

Environmental Conditions

The Cambrian Explosion marked the beginning of the Home. Stretch. The oceans covered 71% of the planet, very much like today. The supercontinent Gondwana had just broken up (500 bya) and would form Pangea (355 bya), which in turn would break up (175 bya) to form our present continents. All pre-Cambrian life was microscopic and lived in the oceans. The land was barren.

Generally, the planet was unstable. It was tectonically active, as it cooled. There continued to be magmatic flows and thermal eruptions. The atmosphere warmed and cooled (in fact depending the strength of photosynthesis in the ocean at the time), which in turn triggered glaciations. The latter then reduced the water levels of the oceans, and so on. There were also extraneous events, like a meteorite landing in Mexico.

Our eukaryotes had to fight against heavy odds, ferociously reviving, restarting, improving their specifications, and pushing in new directions each time after each five major extinction events

Proliferation of Life

After 3.7 billion years of prior development, with aerobic cellular respiration, oxygenic-photosynthesis and carbon fixation on board, our eukaryotes were poised on the starting line to proliferate life and take evolution to the next stage as represented by the emergence of man.

Our front-runners relied on multiple strategies, including adaption, diversification, mutationnd rapid growth, for quick response to changing environments, including toxic defence:

- .1 Self reliance in the production of energy (aerobic cellular respiration + photosynthesis)
- .2 Self-reliance in the supply-lines of food (including carbon fixation)
- .3 Multi-cellular specialisation, organisation of functions and central control (individualisation)
- .4 Increase in size, mobility, dexterity,
- .5 High replication, adaption and mutation (short-life-cycle and proliferation of families and species)

Our eukaryotes occupied the Earth in the zillions and were poised across a broad front, stacked with the necessary energy.

The single cell eukaryote continued to evolve. The new frontiers of evolution were the animal and plant kingdoms. The prokaryotes that had re-generated themselves continued to grow and develop. Altogether they have continued to multiply and fill the earth

Taxonomy

Taxonomy is the science of classifying living organisms into a hierarchical system based on shared characteristics. The result is that we have all living things today grouped under a Three Domain-Seven Kingdom System. The domains are (1) Archaea, (2) Bacteria and (3) Eukarya - animals, plants and all other eukaryotes, The classification system further breaks these down into seven ranks from broadest to most specific: Kingdom, Phylum, Class, Order, Family, Genus, and Species.

Our current Earth's population of living things is reflected in Table 1:

Table 1*
Three Domain- Seven Kingdom Classification⁵

Domain	Kingdom	Description	Phyla ⁶	Families	Genuses	Species
Archaea	Archaea-bacteria	Single-celled prokaryotes that often live in extreme environments	18-23	27		NA
Eubacteria	Bacteria	Single-celled prokaryotes that live in more common environments	10	300	3,433	NA
Eukarya	Protista	Earliest single-celled eukaryotes, including protozoa and algae	45	250	NA	36,400
	Chromista	Photosynthetic eukaryotic microorganisms (with chlorophyll), including many algae	8	180	NA	27,500
	Fungi	Heterotrophic (non-photosynthetic) eukaryotic microorganisms, including mushrooms, yeast, molds, etc.	8	550	10,468	611,100
	Planta	Multicellular eukaryotes that create their own food through photosynthesis (autotrophs)	14	400=750	28,724	296,1800
	Animalia	Multicellular eukaryotes that ingest other organisms for food (heterotrophs)	31	6,000	239.033	7.770.,000

*. Estimates of Archaea and Bacteria are only of known, with large proportions unknown. All figures should be taken as indicative. Sources vary widely.

⁵ - https://www.researchgate.net/figure/Estimated-total-number-of-species-on-Earth-in-the-seven-kingdoms-of-life-29-30_tbl1_363252151 (main source)

⁶ - The full standard taxonomic (or family-tree) classification of living things is: Domain, Kingdom, Phylum, Class, Order, Family, Genus, and Species.

In terms of both the number of species and the number of individual organisms, insects are the most numerous (ants). However, if considering all life, microscopic organisms like bacteria and tiny plankton may be more numerous.

The estimated total figure for all **species** for all the three domains is 10.1 million. Of this eukaryotes make up 8.8 million, while the two bacterial domains make up 1.3 million. There are many more species of eukaryotes than the bacterial group. Of the latter, bacteria proper are estimated to comprise 93% while archaea make up the small balance. No breakdown is given for the bacterial domains vis-a-vis their marine component.

So far, as at 2022, only some 2.16 million species of eukaryotes have been identified including 0.95 million animals, leaving 87% still unknown. Each year, about 13,000 more species are added to the list of known organisms. Figures for the bacterial domains are not available as yet. One research group suggests that 86% of the species on land and 91% in the ocean still await description.

The figures in the table above are intended to show that, with the Cambrian Explosion, evolution focused on developing Animalia as the front end. Plants evolved, supported by aerobic eukaryotes and bacteria, to maintain the oxygen environment and provide the food supply. Animalia evolved rapidly developing various functions and capabilities to combine into that superb free-ranging creature called Man, who in turn has transferred evolution onto the intellectual plane.

There have been many, many, many more species of animals than of plants or all the other eukaryotes put together. In an evolving situation, new species replace those that go extinct, with a net increase.

Ediacaran Biota (635 to 541 million years ago) (mya)

The Boring Billion Years terminated with two major “Snowball” glaciations which covered the whole globe with ice, the Silurian and the Mannion from 715-635 mya.

The Ediacaran period took place from 635–541 mya, over a spell of some 84 million years. This period saw the emergence for the first time of eukaryotic biota of larger, soft-bodied organisms that represent some of the first clearly multicellular life forms.

The biota were both animal and plant (or proto-forms of these). The former included sponges, cnidarians (jellyfish, anemones), worms and vendobionts. The latter included algae and lichens. They were typically enigmatic tubular and frond-shaped, mostly sessile organisms, lacking independent motive capability. This rapid diversification of multicellular life has been attributed to the increases in oxygen content. The oceans became better oxygenated after glaciation.

The Ediacaran biota flush was a global event. Oxygen-consuming multicellular eukaryotes became ubiquitous and widespread. Initially they were restricted to deeper, colder waters that possessed the most dissolved oxygen. Metazoan (animal) life gradually expanded into warmer zones of the ocean as global oxygen levels rose. Plant life came after animal life because they mainly reached sunlight later when they neared the shore-lines. The Ediacaran biota was largely swamped by and went extinct in the Cambrian Explosion.

Cambrian Explosion (541- 525 mya) (20 mys)

The “Cambrian Explosion” was the event that began the Home Stretch, the upscaling of Earth’s biopopulation to its present levels of diversity, complexity and development. It was a global event that took place from 541 to 525 mya, lasting a mere 20 million years.

It was primarily a massive diversification of animal life, with many new species and forms evolving rapidly compared to the periods before and after. It resulted in the appearance of most major animal phyla, including arthropods, molluscs, and chordates, and the evolution of hard body parts.

One of the earliest groups of arthropods, trilobites were among the most successful of all early animals existing in the oceans, also brachiopods (animals in shells)..

The period saw the appearance of many features common in modern animals, such as exoskeletons, segmented bodies, and complex body plans. The Cambrian saw the development of a complex food web with the emergence of predation as a way of life.

The Cambrian biota was primarily confined to the shallow sea margins. The land and the ocean depths were largely devoid of life, although some early land bacteria may have existed in moist sediments .

Plant life had not yet evolved. The Cambrian flora was little different from the Ediacaran. The principal taxa were the marine macro-algae Photosynthesis was carried out by bacteria and algae-protists, which populated the shallow seas

Up to the Cambrian Explosion, all plant and animal life was **microscopic** and invisible to the naked eye, neither on land nor in the oceans.

The Cambrian period ended in the Andean-Saharan Himantian glaciations around 485-445 mya, with significant but not total impact on the burgeoning life.

Phanerozoic era (538 - 120 mya) (418 mys)

The Phanerozoic Era which followed means the “Visible era”, marking the transition to visibility of life on Earth, starting with the Ordovician.

Ordovician Period (485-442 mya) (41mys)

The Ordovician was a time, lasting about 41 million years, in which many groups still prevalent today evolved or diversified. This process is known as the **Great Ordovician Biodiversification Event (GOBE)**.

The Ordovician is known for its diverse marine invertebrates, including graptolites, trilobites, brachiopods, and the conodonts (early vertebrates) . A typical marine community consisted of these animals, plus red and green algae, primitive fish, cephalopods, corals, crinoids, and gastropods. The trilobites were gradually replaced by arthropods.

A group of freshwater green algae, the streptophytes, began to colonise the flood plains and riverine zones giving rise to primitive land plants.

By the end of the Ordovician, Gondwana had moved from the equator to the South Pole. The glaciation of Gondwana resulted in a major drop in sea levels, killing off all life that had established along the coasts. The glaciation caused an “icehouse⁷ Earth” leading to **the Ordovician-Silurian Extinctions (@ OS)**, Some 60% of marine invertebrates and 25% of families became extinct.

Silurian period (443.8 to 419.2 million years ago) (22 mys)

Devonian period (419.2 to 359 million years ago) (61 mys)

One important event in this period was the initial establishment of terrestrial life, in what is known as the **Silurian-Devonian Terrestrial Revolution**.

It was a period of rapid colonisation and radiation of land plants and fungi on dry land. Diversity of plants increased greatly, comparable in scale and effect to the explosion of animal life during the

⁷ “icehouse” means ice caps at both poles

Cambrian. The appearance of vascular plants allowed plants to gain a foothold on land. The first trees and seeds evolved

Arthropods were the apex predators. Fully terrestrial life evolved, including early arachnids, fungi, and centipedes. The first amphibians appeared and fish diversified and occupied the top of the food chain.

Vertical growth of vascular plants allowed for expansive canopies to develop, forever altering the plant evolution that followed. The Devonian witnessed the widespread greening of the Earth.

Earth's second Phanerozoic mass extinction event (a group of several smaller extinction events), occurred in the late Devonian, ended 70% of existing species. The **Late Devonian Extinction Event** primarily refers to a major extinction occurred around 372 mya. Overall, 19% of all families and 50% of all genera became extinct. A second mass extinction occurred 359 mya, bringing an end to the Devonian. Some consider the extinction to be as many as seven distinct events, spread over about 25 million years, with massive loss of biodiversity.

Carboniferous period (359 to 299 mya (60 mys))

The Carboniferous is the period during which both animal and plant life were well established on land. The early half is sometimes referred to as the **Carboniferous Explosion**. The average global temperatures were exceedingly high; and oxygen levels were as high as 30% of the atmosphere, the highest ever.

Tropical swamps dominated the Earth, and the trees grew to greater heights and number. Their remains were left buried, which created much of the carbon that became the coal deposits of today.

The most important evolutionary development of the time was the amniotic egg, which allowed amphibians to move farther inland and remain the dominant vertebrates for the duration of this period. The period is sometimes called the Age of Amphibians.

The first synapsids (proto-mammalians) and sauropods (which include modern reptiles and birds) evolved in the swamps.

Throughout the Carboniferous, there was a cooling trend, which led to the **Perm-Carboniferous glaciation** and the **Carboniferous Rainforest Collapse**. Gondwana was glaciated as much of it was situated around the south pole. The late half of the period experienced glaciations, low sea level, and mountain building as the continents collided to form Pangaea.

Permian period (299-252) (47mys)

At the beginning of this period, all continents joined together to form the supercontinent Pangaea.

The land mass was very dry during this time, with harsh seasons. The Carboniferous Rainforest Collapse left behind vast regions of desert within the continental interior.

Amniotes rose to dominance in place of their amphibian ancestors. The Permian witnessed the diversification of two groups, the synapsids and the sauropsids (reptiles). The first conifers evolved, and dominated the terrestrial landscape.

The Permian ended with the **Permian-Triassic Extinction Event** (251 mya). It lasted under one hundred thousand years. It was the largest mass extinction in Earth's history and was the last of the three (or four) crises that occurred in the Permian.

It was the Earth's most severe known extinction event, with the extinction of 57% of all biological families, 83% of genera, 81% of marine species and 70% of terrestrial vertebrate species. It was also the greatest known mass extinction of insects. Eventually, some 95% of all life on Earth disappeared.

The scientific consensus is that a major cause was the flood volcanic eruptions of basalt that created the Siberian Traps, which released sulfur di oxide and carbon di oxide, resulting in acidifying the oceans, and causing high global temperatures.

It took well into the Triassic for life to recover from this catastrophe, and on land, the ecosystems took 30 million years to recover. The extinction event saw most lineages of primitive synapsids becoming replaced by more advanced therapsids.

Mesozoic era (252 – 66 mya)

This era is known as the **Age of the Dinosaurs**, spanning most of the Triassic, Jurassic and the Cretaceous, some 186 years in all.

Triassic period (252 to 201 million years ago) (51 mys)

At the dawn of the Triassic, ocean plankton communities transitioned from ones dominated by green archaeal-plastidans (prokaryotic) to ones dominated by endosymbiotic algae with red-algal-derived plastids (eukaryotic).

On land, groups of insects flourished, like mosquitoes and fruit flies, and the first crocodylians evolved. Dinosaurs first appeared in the Mid-Triassic, and became the dominant terrestrial vertebrates, occupying this position for about 150 or 135 million years, until their demise at the end of the Cretaceous. The first mammals also appeared but would remain small—less than 15 kg (33 lb)—until the Cenozoic

Climatic change however resulted in a large die-out known as the **Triassic–Jurassic Extinction** event. Many archosaurs (excluding pterosaurs, dinosaurs and crocodymorphs), and almost all large amphibians became extinct, as well as 34% of marine life, in the Earth's fourth mass extinction event.

Jurassic period (201 to 145 million years ago) (56 mys)

The Jurassic lasted 56 million years. The Jurassic climate was tropical and much more humid than the Triassic, as a result of the large seas appearing between the landmasses.

On land, dinosaurs and other archosaurs staked their claim as the dominant race, with theropods at the top of the food chain. Archosaurs rose to rule the world. The first true crocodiles evolved, pushing the large amphibians to near extinction. The first true mammals evolved, remaining relatively small, but spreading widely.

Conifer forests made up a large portion of the forests. In the oceans, plesiosaurs were quite common, and ichthyosaurs flourished. This epoch was the peak period of the reptiles. The Late Jurassic saw the first avians, evolved from small dinosaurs.

The increase in sea levels opened up the Atlantic seaway, which has grown continually larger until today. The further separation of the continents gave opportunity for the diversification of new dinosaurs.

There was a relatively minor **Jurassic-Cretaceous extinction** event at the end, killing off some 34% of biological life.

Cretaceous period (145 to 66 million years ago) (79 mys)

The Late Cretaceous spanned 34 million years, and saw an expansion of seaways. It featured a cooling trend that would continue in the Cenozoic. Seasons came back into effect and the poles got seasonally colder. Eventually, the tropics were restricted to the equator and areas beyond the tropic lines experienced extreme seasonal changes in weather.

The Early Cretaceous saw a decline in diversity of sauropods, stegosaurs, and other high-browsing groups. Dinosaurs still thrived, as new taxa such as Tyrannosaurs, Ankylosaurs, Triceratops and Hadrosaurs dominated the food web. Mammals continued to expand their range.

Flowering plants, possibly appearing as far back as the Triassic, became truly dominant for the first time. Birds became increasingly common and diversified.

At the end of the Cretaceous, the Deccan Traps and other volcanic eruptions were poisoning the atmosphere.

It is thought that a massive **asteroid** (10-15 km in size) smashed into Earth some 66 million years ago, creating the Chicxulub Crater, in an event known as the **Cretaceous–Paleogene (K – Pg) extinction** event, the fifth and most recent mass extinction event. Some 75% of the plant and animal species of the Earth were life became extinct, including all non-avian dinosaurs. The destruction was caused mainly through the lingering impact winter which halted photosynthesis in plants and plankton.

Cenozoic era

(66 to now mya) (66mys)

-**Paleogene period** (including the Palaeocene, Eocene & Oligocene epochs)

(66 to 23mya),

- **Neogene period** (including the Miocene and Pliocene ages)

(23 to 2.58 mya), and

-**The Quaternary period** (including the Pleistocene and Holocene ages)

(2.6 million years ago to now.)

In the short 66 million years following the K-P Extinction event, the Cenozoic saw the emergence of man. I tried to find a clear front runner among the survivors of the K-Pg Extinction who became man, but found no inputs. It seems they all started from scratch depending on their environment and opportunities.

Palaeogene period

(66 to 23mya)

The Palaeogene is the period when the continents moved into their current positions. India collided with Asia 55 to 45 mya creating the Himalayas, and Arabia collided with Eurasia closing the Tethys Ocean and creating the Zagros Mountains around 35 mya..

In the Palaeocene epoch, the climate was hot and humid with lush forests at the poles. There was no permanent ice and sea levels were around 300 metres higher than today. This continued until the **Palaeocene-Eocene Thermal Maximum** around 55 mya.

Around 50 mya, Earth entered a period of long term cooling. This was mainly due to the rise of the Himalayas. Around 35 mya, permanent ice began to build up on Antarctica. The cooling trend continued in the Miocene, with relatively short warmer periods.

The Late Eocene epoch saw the rebirth of seasons, which caused the expansion of savanna-like areas, along with the evolution of grasses.

The end of the Eocene was marked by the **Eocene-Oligocene Extinction Event** occurring between 34 and 33 mya. It was marked by large-scale extinction and floral and faunal turnover, although it was relatively minor in comparison to the large earlier mass extinctions.

The Oligocene epoch lasted 11 million years and featured the further expansion of grasslands which had led to many new species to evolve, including the first elephants, cats, dogs, marsupials and many other species still prevalent today.

Neogene period

(23 -2.58 million years ago)

In the Miocene, kelp forests evolved, encouraging the evolution of new species, such as sea otters. **Apes evolved into 30 species**. Many new plants evolved: 95% of modern seed plant families were present by the end of the Miocene.

The Pliocene saw dramatic physiographic-climatic changes. The Mediterranean Sea dried up for several million years, because ice ages reduced sea levels, The isthmus of Panama was formed and the Arctic region cooled leading to the glaciations of the Quaternary Ice Age. Climatic changes accentuated the savannas, the Indian monsoons, deserts in central Asia - and the beginnings of the Sahara desert. Grasslands shaped the evolution of birds and the mammals that fed on them.

By the Pliocene, mammals came to occupy almost every available niche, and some grew very large, attaining sizes not seen in most of today's terrestrial mammals. The **Australopithecus** evolved about 8 to 9 million years ago in Africa, beginning the human branch.

This epoch was full of mammals both strange and familiar, from mastodons, mammoths, three-toed horses and sabre-tooth tigers to marsupials, whales and primates.

Quaternary period

(2.58 million years ago to now)

Pleistocene epoch

(2.58 mya to 11,700 year ago)

Holocene epoch

(11,700 years ago to now)

The Pleistocene lasted from 2.58 million years This epoch was marked by ice ages as a result of the cooling trend that started in the Mid-Eocene. There were at least four separate glaciation periods marked by the advance of ice caps as far south as 40° N in mountainous areas.

Africa experienced further desertification which resulted in the creation of the Sahara, the Namibian and the Kalahari deserts.

Many animals evolved including mammoths, giant ground sloths, wolves and sabre-toothed cats. The genus **Homo** evolved about 2.8 million years ago, and **Homo Sapiens** therefrom about 50,000 years ago.

The Holocene epoch is the present, starting from 11,700 years ago. We are in an inter-glacial period. The first cradle of civilisation began about 8,000 years ago..

[\(Back to TOC\)](#)

PART THREE

Evolution of Man

Is Definitions

Unless the context otherwise requires,

“moral” means that which is right or good (as against wrong or bad) in relation to the individual's well-being, the collective welfare and/or the safety of the species.

“moral code” describes the set of behavioural precepts and norms sanctioned by society, while “ethics” relate to approved behaviour in specific areas, eg. the professions.

“religious domain”, appertains to the teachings and practices of a religion, generally including the worshipful and spiritual activities of its followers, while “spiritual” refers to any human interaction with the paranormal or unknown.

“reality”, that which exists, physical and non-corporeal, but excludes the unknown and the speculated

“Non-corporeal”, that part of evolved **reality** which is **not physical, but is known about reality** such as information, knowledge, systems, data, history.

“non-material”, a word I use for “spiritual”, to avoid possibly confusing connotations of the latter.

“beyond materiality”, beyond (known) reality both physical and non-corporeal

“Identity”, the sum total of a human being, a non-corporeal reality, an entity sometimes referred to as the “soul”.

“reason”, embraces the total range of man's abstract thinking abilities in application

“knowledge”, what is known of a reality, or the sum total of all relevant information about a reality appropriately organised, stored and retrievable.

“information” relevant human constructs of knowledge (facts) derived from processing data

“information gap”, the knowledge gap beyond reality and the unknown or the speculated that lies beyond man's ability to perceive or find out

Human Ancestry

On the physical side, the practice of bi-pedalism (walking upright) when in “terrestrial mode” marked the beginning of our evolution (as apes). From their earliest evolution most if not all animals have had a “brain “ of some sort, eg. the planarian flatworm. An increasing brain size marked the progressive evolution of our bi-peddalling brethren. They were also distinguished by two other features, namely they used objects (stones) as tools, and they began to live increasingly as a social group.

Humans are descended from apes (super-family Hominoidea) who first evolved 25-30 million years ago in the Miocene, within which was the ancestral line of the great apes (Hominoidea). Along the way, several branches split out from the latter, first the gibbons (Hylobatidae) about 14 to 18 million years ago, then the orang-utan (Pongo) in the same period, then the gorillas (Gorilla) 8-10 million years ago, and finally the chimpanzees and bonobos (Pan) around 7–4 million years ago. The time-modified ancestral line (Hominin) went on to evolve man.

Following their split with chimpanzees and bonobos, the hominins diversified into many species and at least two distinct genera. All but one of these lineages are now extinct, except *Homo sapiens* – representing the genus *Homo*.

The earliest members of *Homo* share several key traits with *Australopithecus* who evolved in Africa in the Pliocene. The earliest record of the genus *Homo* is the 2.8 million-year-old specimen from Ethiopia and the earliest named species are *Homo habilis* and *Homo rudolfensis* which evolved by 2.3 million years ago.

Homo erectus evolved 2 million years ago and was the first archaic human species to leave Africa and disperse across Eurasia. *Homo erectus* also was the first to evolve a characteristically human body plan, and is our direct ancestor.

Homo sapiens emerged in Africa around 315,000 years ago from the descendants of *Homo erectus* that remained in Africa. *Homo sapiens* migrated out of that continent, gradually replacing or interbreeding with local populations of archaic humans. They began exhibiting behavioural modernity about 160,000–170,000 years ago.

Early modern human (EMH), or Anatomically modern human (AMH), are terms used to distinguish *Homo sapiens* species that were anatomically consistent with the range of phenotypes seen in contemporary humans today.

A parallel group, also extinct, were the *Homo Neanderthalensis* who emerged in Europe and West Asia around 430,000 years ago, and included the *Homo Denisovans* (around 285,000 years ago). The two (together with related tribes) are called “archaic humans”. They overlapped with the *Homo Sapiens* and there was significant inter-breeding with the latter.

The Cro-Magnon refer to Early Modern Humans who lived in our world at the end of the last ice age (ca. 40,000–10,000 years ago). They lived alongside Neanderthals for about 10,000 of those years. They are now also extinct.

Homo sapiens evolved from the genus *Homo habilis*, very broadly between 50,000 and 12,000 years ago (the beginning of the Holocene), ushering in the Upper Palaeolithic Revolution

Transition to Modern Man

The Palaeolithic age, or Old Stone Age, began approximately 3.3 million years ago (before the genus *Homo*) with the first use of stone tools, and continued with *Homo sapiens* until about 10,000 to 12,000 years ago, the end of the last ice age. At first, the latter were hunters and gatherers.

The Upper Palaeolithic Revolution which occurred around 40,000 to 10,000 years ago was a period of rapid cultural and technological change. This era saw the development of advanced tool-making, the creation of sophisticated art and symbolic objects, and the establishment of complex social structures and long-distance trade networks. While some see it as an abrupt “creative explosion,” others debate whether the changes were a gradual evolution, influenced by a combination of biological, cultural, and environmental factors.

The Mesolithic or Middle Stone age, was the period roughly from 10,000 to 4,000 years ago which marked the shift from the purely nomadic hunter-gatherer to the settled agricultural communities of the Neolithic. Towards the end of the period, some cultures began the initial stages of domesticating plants and animals, leading eventually to settled farming. Some began forming more permanent settlements, which would develop into villages and eventually cities in the Neolithic. This era saw the first evidence of systematic burial practices, the use of decorative adornments made from shells and bones, and early forms of large-scale stone construction.

The Neolithic, the final phase of the Stone age, was marked by the development of farming, which allowed for permanent settlements and a shift from a nomadic hunter-gatherer lifestyle to one of agriculture and animal husbandry. This period saw major innovations such as the domestication of plants and animals, polished stone tools, and the creation of pottery.

The invention of farming was a central development, leading to the cultivation of crops like wheat and barley, leading to the construction of more permanent structures like longhouses and surplus-to-need economics.

The Neolithic period began at different times in different parts of the world. It is believed to have started in the Fertile Crescent around 8000 years ago, where agriculture, writing, and organized religion were first developed .

The end of the Neolithic period also varies significantly by region. It was marked by the introduction of metalworking, and is often considered to have occurred around 4500–2000 years ago. Man moved into the Copper and then the Iron age, by which time they were largely civilised communities.

Cradles of Civilisation

The earliest humans communities grew into complex societies from around 7000-5000 years ago and were defined by the emergence of urban centres, organised governance, surplus food production, and specialised labour.

Key characteristics included writing systems, monumental architecture, social hierarchies, and religion playing a crucial role in unifying populations and legitimising power. These societies arose in areas with geography favourable to intensive agriculture, leading to population growth and economic stability . They grew from states, to countries, to empires, and to civilisations.

The earliest was Sumer in Mesopotamia. The other cradles of civilisation included Egypt, China, India, and (less known) the Olmec civilisation in Mesoamerica and the Norte Chico civilisation of Peru.

[\(Back to TOC\)](#)

Modern Man

Behavioural modernity is a suite of behavioural and cognitive features that distinguish modern man from other EMHs, hominins and primates.

Frontiers of Modernity

I see modern man emerging in three dimensions: (1) facultative (or intellectual) development, (2) societal development and (3) moral development.

Most scholars agree that modern human behaviour can be characterised by a number of “human universals” in facultative development. These include abstract thinking, planning depth, symbolic behaviour (art, ornamentation), music, and dance, scale in exploitation of resources, and the development and application of technology, These attainments pre-suppose the acquisition of language and writing.

Collectively, man has built up and shares a massive structure of comprehension of the world he lives in. This incorporates two streams: (i) empirical or scientific knowledge and (ii) deductive or metaphysical thought. Besides his own reservoir of the preceding, man is also equipped with his own bank of experiential inputs, and his own emotions and passions.

At the societal level, there has emerged the social and legal framework evolving towards statehood, division of labour and craftsmanship evolving towards social hierarchy, and trade and economics evolving towards urbanisation. The family has remained the unit of the community and society.

At the morality level, there has been increasing order and personal and collective responsibility for the family, the community and the state. This has been accompanied by increasing education as well as self-awareness of the individual’s responsibilities in his choices and decisions in the exercise of free will.

But, moralists also generally agree that man is both self-gratifying and caring. There is a sense that while evolving his desirable societal attributes, man has not yet completely lost some of his primitive

instincts of survival. While on balance, his overall moral performance has been good, man needs to watch this front.

Civilisation

At some point, man is deemed to have become civilised. Among other things, this is measured by the increasing unification of peoples as one society, sharing their Intellectual heritage and technology, and living (as peacefully as possible) within a common set of ideals, standards and aspirations.

I tend to think man's future evolution lies in his civilisation, in his further development in the above dimensions, perhaps critically in the moral sphere.

[\(Back to TOC\)](#)

Evolutionary Status of Man

Turning Point

Whereas evolution has up to now been self-piloted, whether by chance or on a pre-programme, with intelligent man and free will, evolution adopted a new formula. It has placed the future in man's hands. This is a turning point, and possibly a terminal point.

The preceding represent a quantum leap for which there was no prior preparation. It raises the question whether man is the intended terminal objective of evolution (period), or whether evolution's intention is that hereon he discover and determine his own further evolution and destiny.

The Homo sapiens stands at the apex of the evolution that began on Earth. Some 19 species of the genus Homo came down the line with him but have all gone extinct, leaving him the dominant species on the planet. He exercises de facto hegemony over all other life forms, and is at the top of the food chain.

With the largest brain so far of any animal (1,300 cm), he has total mastery not only of himself but of his physical environment. He has an extraordinary set of intellectual and qualitative faculties. Among other things, he can self-drive himself through different emotional states from self-gratification to desire for the common good. And lastly, he is endowed with the free will to do so.

Man is today in a position to change the course of evolution. It is in fact thought of as mankind's responsibility.

Man, the Person

With intelligence and free will, man is an individual person, an independent being in his own right. Each person will have different behavioural responses to the real world. He shares mankind's responsibility through his decisions as an individual, in that they collectively determine the course of events

At the same time, it is thought that he is individually responsible and accountable for his decisions and actions. If they fail moral scrutiny, he can square out and make amends over a life-time. If he does not, we have a metaphysical issue whether his accountability extends into an after-life, or whether he can just get away with anything.

Each individual person is defined by **his own identity**. Identity is a reality that exists in a combination of his mind in his body. It manifests itself in his decisions, and commands the body through the brain. It resides in the mind. It encapsulates the sum of his past history, his present thoughts, his emotional suite, and his future aspirations. It shoulders his responsibilities, exults in his achievements, and shares his guilt. Man's identity is the living entity (some say "soul") of his being.

By incorporating identity into man's being, evolution has brought into existence a non-corporeal component in human nature. It is this view of identity that provokes the issues of life after death, reincarnation, etc. When the body dies, what happens to the non-corporeal being? An alternate view

is that this is all fiddle-faddle. He has an identity while alive as a sociological reality, but once he dies, that is it. He was just another intermediate. This is another aspect of the metaphysical enquiries going on.

It just may be that evolution will carry on whether the man-experiment succeeds or fails, and it will stand ready to test another formula – if indeed man has left sufficient of the planet Earth for it to do so

Purpose of Man

The answer to the question why man exists at all must await further metaphysical work – on which we comment further on.

For the present, in so far as man is concerned, his mission and purpose is and must be to progress (evolve further) as far as he can go using his intellectual capabilities, at the same time safeguarding the species, the planet and its other life-forms. Evolution hereon means civilisation.

Every human action has three levels of application and fulfilment: (1) personal objectives, (2) societal objectives, and (3) the safeguarding of the species. The underlying requirement is that this must not compromise the vitality of the planet and its other living creatures.

The best human actions are those in which all three levels are in sync. The best human person assumes responsibility and adopts the most favourable norms of attainment and behaviour for each, and acts accordingly, and further influences the collective to do the same. Where the majority of the latter do, the species is saved, while the person is said to have achieved the most desirable personal moral behaviour.

Achievements So Far

To appraise where we could be heading, it is meaningful to look at what man has achieved so far.

In the Knowledge sphere

We have united and institutionalised our efforts, achieving a collective mountain of knowledge

- In the physical sciences, we understand matter from the sub atomic to the cosmos.
 - In the biological sciences, we understand evolution and living organisms, from microbes up
 - In the psychological and sociological sciences, we have studied individual and social behaviour,
 - In the “earth sciences”, we have studied the complete Earth history and anthropology of man
 - In the philosophical disciplines, we have studied existence and identity, mortality and immortality.
 - In the metaphysical domain, we have studied existence, reality, knowing and casualty, including our intellectual faculties themselves,
 - In the theological domain, we have studied the existence and nature of a creator, including human accountability, and
- In the religious sphere, we have studied belief systems, myths and revelation,

Man has inter alia developed our moral and ethical codes, and accumulated much **wisdom** in the process, ie. how to live well.

In the Technology sphere

- With the computer, the internet and telecommunications, we have transformed mankind into an integrated society, functioning globally as one.
- We have substantially mastered our living environment (except the climate)
- We have conquered the air, the sea and space
- We have mechanised, automated and robotised our work process and food production
- Our medical and educational services are all high-tech.

On the obverse side

- We have not (yet) conquered death (if we do, we shall have other problems.)

In the Information sphere

.Man is today an information-based or knowledge-based species. The cutting edge of evolution is no longer biological but information

Our brain capability will increase rapidly by hitherto unimagined scales by technological inventions such as the quantum computer.

In the Social and Political sphere

.- We have taken concrete steps towards and institutionalised world consultation, cooperation, international law and world government,

.- And, for the first time, we have global, if not sector, peace.

On the obverse side,

.- We also have Incredible weapons of mass destruction.

In the Metaphysical front

Man's domain is our world and our reality, which for convenience I refer to as materiality. Beyond materiality lies the unknown

Yet there are some things external to his present world that rational man sooner or later circles round wanting to know, in particular who made the cosmos and the universe, including man (by evolution) and in the case of the latter what is his purpose. I call these the "metaphysical issues. Man has developed a whole set of disciplines exploring these issues; As yet there is no break-through. It is generally recognised that enlightenment will greatly strengthen man's life focus and organisation, and stabilise his moral development.

Shortcomings

Mortality

The first limit of the human is that he is mortal, with a lifespan of more or less a century.

Death is incorporated in his biology, a functional part of reproduction, speciation, and evolution. Every individual man is a sackful of cells (10 trillions to be exact). While he commands the totality, the individual cells are aging and dying, and new ones being born. At some point the man dies.

It is said that a short life-span for an individual is inconsistent with his being a person with a creative and cumulatively expandable intellect, and one whose personal "wisdom" and enjoyment of life is achieved with age and experience. It becomes increasingly incongruous as the evolutionary environment transfers increasingly to a man-made world through technology and mental application. Not surprisingly, man is constantly exploring the extension of life. Mortality remains a major frontier of evolution for man to break.

Morality

Moral means good for society, good for the species and or good for the man. Moralists have found that individuals in this world are from time driven by a common set of emotional failings, the most prominent of which are pride or vainglory, envy, wrath, sloth, avarice, greed, and inordinate sexual desire or concupiscence. Where they dominate, they become passions, overriding good sense and caution.

As against the preceding, moralists point out that the larger part of humanity do control these passions by the practice of the virtues, namely prudence, temperance, fortitude, diligence and justice. Combined with other positive emotions, like love, kindness, generosity, etc, they foster the high character, attained by much of humanity.

It is recognised that one of the reasons for the open-endedness of individual moral behaviour is that humanity as a species lacks of knowledge of what the individual's role and responsibilities are. This vacuance drives the metaphysical enquiries of man.

Fortunately, man has been developing along democratic lines, allowing for collective sanity to apply in social governance. By and large, man's responsibilities, relationships, rewards and resources remain in balance. Improving the moral behaviour (perfectibility) of man remains a major area constant attention and tweaking.

Other Dangers

The evidence so far suggests that our human destiny will be tied in with three factors:

- .- (i) How far we go in science and technology (physical and biological) without crossing human limits or creating uncontrollable means of our own destruction
- .- (2) How well we structure and manage our civil society, including enforcement of our laws and ethics, without resorting to wars.
- .- (3) The standards of behaviour of the people, which is closely related to their espousing and practising some kind of moral code, if not perfecting the individual.

[\(Back to TOC\)](#)

Our Record - Good

Societal Development.

Humans began to recognise the full extent and oneness of their species after the explorations and colonisations that followed Christopher Columbus in 1492. And the front-end soon began to function as a global community sharing their culture, including their languages and religion. The period was characterised by the struggles of the colonial powers for territory and raw materials. At home, they faced social revolution due to the widening gap between the rich and poor.

The scientific revolution which began in the 17th century transformed man's capabilities intellectually, in terms of his mastery of the environment, and in unifying the peoples of the Earth as a single community. It also more clearly separated the known from the unknown and unknowable.

Mankind has since developed an essentially unified civil society or civilisation while respecting and fostering national and cultural differences. We are an educated species and are able to access the different streams of knowledge and their institutions, whether scientific, philosophical, religious or traditional, with equal openness. Mercifully most people can communicate in common languages that have become international.

Fortunately, the world is now networked by a growing number of co-operating international institutions and associations, whether for education, research, professional development and surveillance. or managing our technological and supplies infrastructure. The multinational industries also cement our countries, where they were once primarily exploitative.

Finally, after two world wars, we have a declaration of human rights which enshrines the sanctity and freedom of the individual, and we have a UN system that governs us in common domains, sets the necessary ethics in relevant areas, and even arbitrates in an international court of justice.

The UN has done great things in health, education, trade and economic development, the foundations of our civil society. It is sufficient to look at the outstanding role the World Health Organisation (WHO) played during the recent Covid-19 pandemic, to appreciate the critical role of the UN system in our future survival.

However, an even closer look will reveal how inadequate the present system still is. Given the scale of our advances in (and the increased dangers of) our sciences and technologies, the whole UN is overdue for a complete revamp. They do not have authority within national boundaries. They have no enforcement powers, only limited "peace-keeping" roles with voluntary forces. They would be powerless to stop a nuclear war if one erupts between two super powers today.

If evolution has cast its lot with the individual human for its future, then the individual human must be able to exercise his choices within a framework of civic freedom. Of the two global systems tried out, democracy permits the better exercise of choice. On a hopeful note, the world collectively is leaning towards democracy as the standard political format for countries. According to the World Forum on Democracy, electoral democracies now represent 120 of the 192 existing countries and constitute 58.2% of the world's population.⁸ However, the practice of democracy is still flawed in many countries. Of the seven countries with the largest populations in the world, totalling 51.3%, only China, 17.39%, is not a democracy.⁹

Finally, the distribution of income is another indicator of progress towards universal equality. The World Bank data for 2022 gives only 39 countries out of a total of 177 countries (22.0%) with a per capita GDP of \$25,000 or above, the criterion of a developed country. Some 53 had less than USD 3,000. The distribution of Income and wealth within countries is another matter. Income inequality is at the heart of aberrant human behaviour. The hopeful note is that countries are increasingly tempering the extremes of capitalism with socialist policies, and vice versa.

The Technological Front

The European Space Agency (ESA) 's astrometry spacecraft (satellite) Gaia has already mapped and catalogued 1,7 billion stars in and around the Milky Way, The James Webb Space Telescope is currently looking at the universe some 200 light years from the big bang.

Man has been to the Moon. We have remotely been surveying Mars for some years, and our prototype starship has made its first successful (reuseable) take-off and landing on Earth. All we need is to re-invent quantum physics to get round the time barrier, and we shall be poised for the first step to long range space.

Today, a scanning transmission electron (STED) microscope has reached resolutions down to 0.5 nm (50 picometres) level and can provide magnifications of up to 10,000,000. Today, we can magnify our original prokaryote (of 1 micron) one 100 times.. At the quantum level, we are studying the boson, the gravity carrier, the last unknown frontier of space, and quasiparticles that are transparent in photons.

We have gone into the second quantum revolution with nanotechnology. We are now employing quantum mechanics to alter the quantum face of our physical world. We can create states of quantum coherence or entangled matter and energy that are not likely to exist anywhere else in the universe. These new man-made quantum states have novel properties of sensitivity and non-local correlation which defy our logic.

An equal revolution has taken place in biology and biotechnology. We know the complete architecture of a virus. We can trace our heredity through DNA to our first common ancestors. We have unravelled the complete genetic code of the human being. Technically, we are near to be able to clone ourselves. In biotechnology, scientists are talking of nanomedicine, ie diagnosing and delivering medication at nano levels even possibly using nano robot doctors.

We have replicated the nuclear fission of the Sun. We have 620 nuclear reactors supplying energy all round the world. We are on the point of launching fusion reactors, replicating the even more powerful process of nucleosynthesis that fuelled the primeval expansion of the cosmos and provides the energy of the stars.

⁸ - <https://www.coe.int/en/web/world-forum-democracy>

⁹ - <https://www.worldometers.info/world-population/population-by-country>

The Information Age

The development of the Information Technology (IT) is perhaps the most profound directional change to evolution brought about by technology. Homo Sapiens have evolved into an information-based species.

As the decisions he makes have more and more to do with the world of his own construct, the more he is dependent more and more on processed information, and less and less on the physical inputs of his senses. The latter is increasingly technically sensed.

A typical human today is a knowledge-worker. He is highly “instrumentalised” even in his daily life, checking his smartphone or computer for stock prices or talking (giving instructions) to a robot or his car to carry out a function. All automated functions are information based.

We have now multiplied our data processing and computing powers and our memory banks zillionfold. The world’s libraries and transactional records are substantially digitised, enlarging our span of the understandable. All the information is stored or accessible somewhere and can be downloaded by anyone with a smartphone. This enables us, collectively and individually, to think with wider spans of information and in further depth in the abstract, to take better decisions and manage our civilisation more efficiently.

With Artificial Intelligence (AI) programming of our existing computer capabilities (for example the top 500 supercomputers today in tandem) we can interrogate our data resources, simulate, and programme extensive and intensive information analysis beyond the wildest imagination.

We are already proto-typing the quantum computer, which is geometrically more powerful, with IBM’s Osprey with 433 qubits in the lead. The technology is still shaky. With Artificial Intelligence (AI) married to a quantum computer we shall be able to re-write quantum mechanics and GPS the Milky Way (at least), and when we get there we shall also have our favourite books and operas with us.

Human Well-being

Mankind goes forward with the expectation that with increasing civilisation man improves as a moral creature. By giving man free will, evolution is banking on this.

And the features of civilisation that apply here include education, health, improved standards of living, and equal enjoyment of resources and opportunity. These promote greater understanding and peace. They develop responsibility. Finally, they enable people to adopt philosophies of life based on inter-human compassion (caring), and the transfer of life’s satisfactions to the practice of the virtues rather than personal passions.

The mis-exercise of free, on the other hand, is managed and secured against by controls within social development, inter alia the ethical and legal frameworks.

In this sector we have a long way to go. Taking education, the most fundamental requirement, as at 2023, while the world literacy figure is 87.4%, the figure of the average years schooling of adults (+25 years) is only 8.8 years and the expected only 13 years. In high-income countries, nearly 84% of young people complete upper secondary education over their lifetime. In contrast, in low-income countries, approximately 61% of youth are completely **out** of upper secondary school. Gloriously, basic education is compulsory, and most children have primary education.

The bottom is our life-span. In 1950, the average global life expectancy was around 46 years, a significant jump from earlier periods. By 2023-2024, it had risen dramatically to roughly 73 years, with projections for 2025 hovering around 73-73.5 years. This increase in longevity has been due to health and living standard improvements.

[\(Back to TOC\)](#)

Our Record - Not So Good

Wars and Conflicts

In our time, peoples have come together with nationalist or ideological aspirations to wage war or cause societal subversion on a global scale. Perhaps our greatest achievement is that we survived the 20th century.

Driven first by territorial aggrandisement and then by race superiority ideology, one country launched two world wars and exterminated six million people. World War II was the largest and most violent military conflict in human history. It was a technological war, dominated by new generation aircraft, battleships, submarines and radar, and ended with the world's first "WMDs" (weapons of mass destruction). Official casualty sources estimate battle deaths at nearly 15 million military personnel and civilian deaths at over 38 million.

Driven by dialectic materialism (an evolutionary ideologic travesty) and led by megalomaniac political leadership, the communist revolutions near crippled the world. Any attempt to estimate a total number of killings under communist regimes depends greatly on definitions, ranging from a low of 10–20 million to as high as 110 million if one includes all nine countries and deaths from famines, gulags, deportations, etc. China alone top scored with 66 millions and the USSR with some 20 million¹⁰.

In the last three quarters of a century there has not been another world war. This is not to say we have been living peacefully.

The Cold War lasted from 1945 to 1989, and has left a legacy of nuclear missiles. Even today, believe it or not, there are some 12,100 nuclear warheads, mostly shared by US (5,748) and Russia (5,580). They in turn have some 1,479 and 1,509 respectively strategically deployed at any one time on nuclear submarines, intercontinental ballistic missiles, heavy bombers and forward bases. The other countries with nuclear warheads include China (500), France (290), UK (225) India (172), Pakistan (170), Israel (90) and North Korea ((90)).¹¹ Despite valiant efforts to disarm, the nuclear threat remains the greatest danger to the survival of mankind.

There has always been some war or conflict going on. Data collected by the Uppsala University in Sweden¹² identifies 285 distinct armed conflicts having taken place since 1946.

One research group, the Global Peace Index (GPI), estimates that some 13.5% of the world's GDP is going into armament and war, 92 countries are currently involved in conflicts beyond their borders, and 110 million people are either refugees or internally displaced due to violent conflict.¹³ Not to be outdone, we have inter alia the Russian invasion of Ukraine, and Israel doing battle with Palestine.

It takes great faith to believe that human nature will improve as we grow more civilised, as would appear to be the position taken by evolution if it believes we shall survive. The philosophic stream however points out that man is inherently capable of and does exercise the necessary virtues to do the right thing

Destruction of the Planet

The highly developed human species uses proportionately much more energy (including the brain), requires much more territorial space, and therefore consumes far more natural resources per individual than other species.

¹⁰ - https://en.wikipedia.org/wiki/The_Black_Book_of_Communism

¹¹ - <https://www.armscontrol.org/factsheets/nuclear-weapons-who-has-what-glance>

¹² - <https://ucdp.uu.se/downloads/index.html#armedconflict>

¹³ - <https://www.visionofhumanity.org/highest-number-of-countries-engaged-in-conflict-since-world-war-ii/>

A growing group of scientists argue that the current age of man should be described as the Anthropocene Epoch, and began in the year 1950, which is when human activity started to have a significant impact on the planet's climate and ecosystems.

Around 10,000 years ago, some 57% of the world's habitable land was covered by forest. We have lost one-third since, half in the last century. Scientists estimate that only about 5% of the environment remains unaffected by humans, in floral and faunal terms.

The current rate of extinction of species is estimated at 100 to 1,000 times higher than the natural background extinction rate. We could be losing from 1,500 to 10,000 species a year, from microorganisms up. Biodiversity loss and species extinction have accelerated to the point that human activity is either on the cusp of or has already produced a 6th mass extinction

This has been accentuated by the rise in pollution, in carbon dioxide (57%), methane (10%) and other “greenhouse” gases. Unless checked, the world's temperature will cross the critical threshold of 2 ° Celsius above pre-industrial levels, in 10-15 years. The ice-caps are already melting, despite the fact that we are supposed geologically to be in the Holocene ice age.

There are signs of biological instability. The human body is becoming susceptible to increasing stress and aberrations. We have cancers and mental disorders. Most alarming, we have the emergence of viruses, by nature predatorial, that diversify rapidly and multiply almost infinitely in human hosts, who are almost indefensible against them.

Mankind has developed close to limits to the point of adversely affecting the planet and evolution. This has to be taken into account in considering the future of the human race.

[\(Back to TOC\)](#)

The Quest

It is in man's nature that he must know, if possible to the point of proof (as per scientific principles) whether there is a supreme being and his intentions in creating man; or to the same points of proof that there is nothing; or that there is no way of knowing either through our reason alone.

We may or may not recognise that, there is an orientation within man's intellect which finds it necessary to ask the questions, as though nature needs and intends that he should look for if not find the answers.

It is clear that the answer, some answer, would be fundamental to man's ultimate understanding of his purpose, whether now or in future. We have further to remind ourselves that, here, man is looking beyond this cosmos, beyond his own reality.

It seems contrary to “common sense” that, after establishing man with abstract thinking to master the universe, it does not matter (to evolution) whether man pushes himself further or destroys the Earth and himself. The very same abstract thinking tells us that man's purpose is to take evolution forward, whether to the stars, beyond space-time, and even to discover the unknown, even beyond materiality.

There is a sense that life this our temporal existence is not a perfect paradise. It is too short and imperfect, too wrapped in obligations and restrictions, and riddled with morality, to be the end-all of everything.

There could be somewhere beyond a higher plane, a more perfect existence, non-corporeal, possibly in an afterlife where mortality would have no meaning. And, this could well be the quest of evolution from the start, or the idea would not have been implant in us.

Evolution has worked to a series of overall algorithms, with the widest possible choices at each point, using the opportunities presented along the route. They allowed for corrections, adaption and mutations, and seizing new advantages as they arose. It is an open question at which stage man, in the form of ourselves, emerged as a possible final prototype, possibly after the split of the genus Pan.

The future lies with us. Evolution has passed the baton on to us. Our primary temporal objectives are three-fold and pretty clear: (1) well-being of the individual, (2) welfare of the our society, and (3) perpetuation of our species. We could add two others: namely (4) live longer and (5) preserve the planet.

There is a sense that in relation to our capabilities, our known objectives are incomplete. Therefore, we lean towards our promptings to ask the metaphysical questions, and seek to qualify for a more perfect life in the hereafter.

At this stage of evolution, the destiny of the individual is the destiny of the species Homo sapiens. This has not been so up to now. We are the turning point. If man goes immortal, the species will go immortal – for the first time, and probably finally in evolutionary history. It is not unreasonable for us to perceive this as the probable ultimate terminal objective of evolution, and that we have been designed with that end in view.

[\(Back to TOC\)](#)

The Temporal Pathway

By way of explanation, I use the term "temporal" to refer to the here and the now. All life will terminate when this universe terminates, and therefore nothing in this temporal time is immortal. Only existence beyond materiality is immortal;

My focus here is on how man, the individual, evolves further in our temporal time, both on Earth and in possibly In space.

Further on, I look at whether there is an alternative or parallel path for him beyond materiality (after death) in addition to his temporal function of safeguarding the species.

In The Short-Term Stay on Earth

For the time being, this is the only option. Long-distance travel into space must realistically await until we have re-configured our science. Purely for conceptual purposes, we might give ourselves a time-frame of say about 500 years or so still substantially here. The break-through could however come earlier, or take longer.

The technological advances will apply, but overcoming our shortcomings will be our priorities. We may state these as our macro-objectives to ensure our long-term survival.

.(1) A unified global society with a shared information and knowledge base, culture and moral values, coupled with tight international control over individual aberrant behaviour, will be the best assurance of survival.

.(2) The best investments will go into improving the standards of health, education, and well-being, in conditions of growing equality of incomes and shared affluence, freedom of choice, better distribution of wealth and equal opportunity, and.

.(3) As house-keepers, we must cater equitably for the needs of (a) the human population and (b) the other living creatures, while (c) we manage and preserve the resources of this planet..

Human Population

Fertility

The world's population is now about 8.2 billions, and will peak at 10.3 billions in the 2080s. It looks like we will be declining rather than increasing after that.

What we shall definitely have to do, after taking into account all other needs and concerns, is to project, plan for and **manage** a desirable level of population over our chosen time-frame. We shall

have to achieve that by behavioural and cultural management, the bottom line of which will be by control of the net reproduction rate.

Fertility will be the Achilles' heel of mankind. China went in for an enforced one child family at one stage. But, enforcing the reverse has been quite another matter; instead they are now paying extensive bouses for more chidden.. Life enhancement and extension, and longevity, will introduce further layers of complication.

Structural Imbalance

The vast majority of the world's population lives in the developing countries, some 6.7 billions, totalling 84%. Yet developed countries, totalling 1.1 billion people, hold about 69% of the global wealth. The developed world accordingly earns much more per capita. The gap between rich and poor is continuing to widen.

Disparity in wealth and income are the fundamental causes of global discontent, instability and conflict. The poor communities also rely more on natural resources, exploiting these without conservation, to the point of destruction.

Led by international institutions, the world has seen an enormous flow of financial and technical assistance to support developing countries. And the latter countries have struggled on their own to close the technological and income gaps. The transfer of China, India and Indonesia to the middle income groups has significantly tipped the balance forward.

It has to be added that the principles of socialism, expensively won in human lives, have had a significant role to play in tempering the excesses of capitalistic maldistribution. The structural imbalance can be expected to reduce, progressively removing a serious threat to survival. But maldistribution of resources remains a time-bomb that can trigger a war of mass destruction.

Life-Style

As man increasingly depends on technology, this will reduce the call per capita on natural resources, at the same time consuming the latter more efficiently and more sparingly. Man will increasingly have to forgo the natural product for the manufactured one on the supermarket shelf.

Man could also develop new habits and tastes, Already a paperless society saves a lot of forests, crab-meat saves a lot of sharks and artificial crab-meat saves a lot of crabs.

Human habits can be trained. In Singapore, a meal in a food court would be incomplete without sugar-cane juice. In Mauritius, which is covered with sugar-cane plantations, one could not find a single glass of it anywhere. The population has been drilled that it is almost sacrilegious to cut it, as sugar-cane (sugar) is the backbone of their national economy.

Conserving the Environment

Mankind has developed close to limits to the point of severely adversely affecting the planet's ability to support the human species. We have a human-induced triple planetary crisis of climate change, ecological threat and biodiversity loss, caused by pollution and waste. Serious behavioural corrections are needed.

Climate Change

The Earth's average temperature has risen steadily. Unless checked, the world's temperature will cross the critical threshold of 2° Celsius above pre-industrial levels before the end of this decade. In 2024-25, it was 1.47° C above baseline.

The above has primarily due to atmospheric pollution, in carbon dioxide (CO₂), methane and other "greenhouse" gases (GHGs). This rise reflects the increased energy generation by burning fossil fuel - in transport (cars, aircraft), electricity generation, and industrialisation. Estimates from the Energy Institute and Statista placed fossil fuels' share still at around 82% of the global energy mix in 2023.

The world has been addressing these issues since 1995, under the UN Framework Convention on Climate Change (UNFCCC), which meets annually (COP). At its latest meeting at Belem, Brazil in November 2025, the COP30 notably failed to secure a binding commitment to phase out fossil fuels.

The agreed-upon target established at Paris (2015) is to limit the global temperature rise this century to **well below 2° Celsius** above pre-industrial levels, while **actively pursuing efforts to limit it to 1.5°C**. This latter goal requires deep emissions cuts to reach net-zero CO₂ by mid-century, which the world is currently also on track to overshoot.

The UN Environmental Programme (UNEP) reported that the world has so far failed to meet the lower climate change target. Governments' latest pledges to cut emissions in the future, if met, would still see the world face 2.3° to 2.5° C rise in warming.

The principle issue is that the developing countries disagree to meet the costs involved on a proportionate basis, arguing that the developed countries have been largely responsible for the pollution and should bear the burden of restoring the environment.

The carbon footprint is an index of the total amount of greenhouse gases (GHGs) etc, released by an individual, organisation, event, or product, directly and indirectly, measured in CO₂ equivalents. The global average is 4 to 5 metric tons. To achieve the Paris global warming target, it must drop to under 2 tons by 2050. The current US average is 16 to 17 metric tons. Mankind remains in danger.

Conserving the Eco-Systems

Oxygen makes up 21% of the atmosphere. Any serious disruption to breathable air could be fatal to all life. Most of Earth's oxygen (50-80%) comes from ocean photosynthetic organisms like phytoplankton, algae, and cyanobacteria, with land plants contributing the rest (around 20-28%).

Mankind must conserve the oceans and all marine life. The latter is also our greatest reservoir of fresh food, as well as the major physical factor influencing our climate and water supply. Currently, stable, the main threats will be pollution (plastics!) and overfishing of popular and endangered species.

On the other hand, the forests (all plant habitats in fact) require serious continued attention. Scientists say that only 5% of our terrain remains unaffected by man and we have lost one-third of our forest cover since industrialisation. They also represent the remaining living space available for our wild life and fauna

Too little carbon dioxide and other greenhouse gases in the atmosphere and the Earth would be frozen. Too much would turn the atmosphere into a furnace. The carbon cycle is Earth's natural system for recycling carbon atoms, moving them between the atmosphere, oceans, land (living organisms and soil), and rocks. The processes include photosynthesis and respiration, as well as rock weathering. Besides regulating climate, it is crucial for sustaining life. Plants and insects play crucial roles in the carbon cycle.

Most of the Earth's atmosphere is made up of the inert gas, nitrogen (78%). Nitrogen compounds are essential for all living things. The nitrogen cycle converts nitrogen into multiple chemical forms. Human activities such as fossil fuel combustion, use of artificial nitrogen fertilizers and the release of nitrogen in wastewater have dramatically altered the global nitrogen cycle, negatively affecting the natural environment system and also human health. The nitrogen cycle is another critical parameter of human evolution.

Biodiversity

Generative AI gives me this alarming report on biodiversity loss. " We are losing living organisms at an accelerated rate, estimated to be **1,000 to 10,000 times higher** than the natural background extinction rate, with some scientists calling it the Sixth Mass Extinction driven primarily by human activities like habitat loss, pollution, and overharvesting... We could already be losing from 1,500 to 10,000 species a year from microorganisms up."

In the animal kingdom, there are about 10 million other species, besides man. There are over one million species of insects alone.

Scientists estimate Earth hosts around one trillion microbial species, but only a tiny fraction (perhaps thousands to a few million) have been formally identified. These include our bacteria, archaea, fungi, and viruses,

Viruses are the most numerous, adapt and multiply with ferocious speed, and are the only ones who are both indestructible and immortal¹⁴. By evolutionary design, they must replicate in another biological organism and are therefore biological predators. Man will no doubt bear in mind he could be overpowered by viruses alone, at any time. And I would not vouch for his immortality if he should take them into space with him at some time in the future.

On the other hand, microorganisms (cyanobacteria) are our oxygen suppliers. Ultimately, man will have to operate a viable and responsible biodiversity policy.

Since he is in charge, he may decide to eliminate certain species altogether, ie. tailor-make his universe, perhaps kill off his rivals as does with weeds in his garden.

All in all, man has a reasonable prospect of surviving on this planet, provided he disciplines himself and masters climate change.

In The Long-term Extraterrestrial Habitation

If our population stabilises and we manage Earth properly, we may not need to migrate to an extraterrestrial habitation. But we shall still want to take in the universe as part of our living space.

We have been to the Moon. We are currently exploring Mars. It is likely we shall have at least temporary habitations there by the end of this decade, and begin to build up our space know-how and technology.

Space Travel

The problem is long distance space travel. Firstly, space is big and distance is measured by light-years. Secondly, nothing within it can travel faster than the speed of light, ie 300,000 km/sec; and any matter attaining that speed becomes light. The radius of the observable universe, on the other hand, is said to be 46.5 billion light years.

Astronomers estimate there are possibly 2 trillion galaxies in the universe. We are part of the nearest galaxy, the Milky Way. There could be as many as 300 million Earth-sized habitable exoplanets within just the Milky Way. The nearest is 4.2 light-years away, orbiting the red dwarf Proxima Centauri.

Man's ability to visit space is severely limited by first by the speed he can attain, and ultimately by the speed of light. Voyager 2, which entered the interstellar medium on November 5, 2018, would take about 75,000 years to get there, travelling as it does at 17 km/sec. Our own galaxy centre is 26,000 light-years away.

On our present science, **even if we attained half the speed of lightning** (150,000 km/sec), we would need 8.4 light years to get to Proxima Centauri, probably 12 years to allow for the long acceleration needed and the equally long deceleration at the end. On the same basis, we would take 60,000 earth-years to get to the Milky Way centre, and about 7 million earth-years to get to Andromeda the next nearest galaxy.

¹⁴ - See my e-book "Virus* Biological Predator" (2021) SBN 978-981-18-3046-4 (PDF) at <https://geraldpillay.com/>

Even if we achieve half-light speed, we shall be going nowhere outside our Solar System. Realistically, space travel is meaningless unless we can travel **upteen times faster than light**. It means a new science and a new technology. The break-through could happen all at once, or it could take thousands of years, if ever.

Living in Space

There are zillions of third-generation exoplanets, even if we limit ourselves to the Milky Way. In the long-term, if we can get there, it does not matter if they do not have the atmosphere or food we need. With the right portable energy and resources, we can make or bring our own requirements. At this point, it appears man will be able to sustain himself extra terrestrially by technological means. Man is already essentially non-corporeal, living on the mental plane in an information-based environment of his own making.

And there will still be the question of life-span. A century or so would hardly be enough to just raise a human to maturity in his new world. Man would strive for as much longevity as possible, in this temporal time, to enjoy his enhanced life-estate. It would be great if over 500 years, he lived to an expectancy of the same.

Living in space would still require that man fulfil his first obligation, to perpetuate the species by reproduction. He would undoubtedly retain his sexual proclivities, and in the best environments and circumstances he should be able to reproduce naturally. However, he may continue to have difficulties with maintaining the net reproduction rate, judging by the growing disinclination of women to have children. As we all live into longevity, the burden of reproduction will fall on a narrowing band of the younger.

The burden of reproduction can be further narrowed by cloning, using surrogate mothers. Cloning produces identical genetical twins, but not the person. The clone is a new born baby, and will grow up to be a new person (like a son). It is also possible man will in the very very long run seek to reproduce by artificial (technological) gestation. That would terminate one cardinal function of evolution, namely natural reproduction.

As a declining proportion actually die, the number of children needed will be less, unless to populate new planets. We shall then have just a bunch of old fogies and grumpy old ladies, and few children. Man may of course by then have learnt to re-pair, re-style, renew and rejuvenate themselves, and remain looking perpetually young. Thus, whether on Earth or in space, we shall become a “designer people”.

There is no question but that we shall have created our physical utopia, possibly travelling around in space with ease, returning to mother Earth for the holidays and visiting relatives (If we still have them), and skiing on the slopes of a planet in Andromeda.

Human capabilities technologies can make significant improvements to the quality of life, if focussed on improvement of the “normal” central human capabilities referred as the “normative framework”. The aim must be better human individuals and a better society. It can help equalise society. In the long-term, when everybody is clone corrected and engineered from the start, this will be less of a problem

Whatever the reproduction system, it is to be hoped that by then man would have lost or mastered his primeval emotions and passions, and instead have fully developed his incipient virtuous qualities, such loyalty, fairness, caring, and love. Perhaps, these qualities could be bio-engineered in or out as enhancements independently of, before, during or even after cloning. In terms of human management, perhaps these sets of qualities could be added to the menu for cloning, and as criteria for deciding on the early demise (euthanasia) of the unsuitable or the longevity of the future elite. Currently we are close to identifying all the specific genes that control various traits, and may well be able to do these things as normal therapy.

The problem will be who controls the menu for cloning, and who lays down the criteria of essentials to qualify the output as man. Extreme changes may affect overall normality to the point of the person

being (still) Homo Sapiens. Needless to say, we could create monstrosities who could endanger the world (and other planets), worse still if someone made them immortal. .

The prospects of creating a biological or bionic “superman” also seem utterly remote. But, by life extension, an individual could achieve considerable longevity.

There is one other way, so far only conjectured, for perpetuation, and that is to “download” the personality of a man (ie his brain and everything in its memory banks) on to a computer, and for him to function therefrom in a suitably robotised environment. Such a transfer to a technological “body” would spell the last severance from evolutionary biology, and might be the only case of achieving immortality in this temporal time – for as long as the technological environment exists. Sex would however be a memory.

[\(Back to TOC\)](#)

The Parallel Pathway Evolution Beyond Materiality?

Our rational endowments operate in two modes (1) the empirical, the basis of the sciences and (2) the enquirial and deductive, the basis of the metaphysical. There is a (3) third faculty, awareness of the unknown, which is accompanied by other arcane faculties (not present every one). It is extra-rational, is expressed generally in the religious domain, and is the subject of separate attention further on. In our first mode, man has streak away and is today master of the Earth, with a significant presence in space.

The Metaphysical Frontier

In our second mode, man has probed and queried whether there exists a beyond, beyond the universe. Hence we have the various disciplines of metaphysics, and their crystallisation in philosophies and religion.

The Metaphysical Issues

Ultimately, all enquiry beyond materiality boils down to what I have described as the “metaphysic issues”. These are (1) is there a supreme being, transcendental or external to the cosmos; (2) who, if anyone, created the universe (evolution); and why; (3) the purpose, responsibilities, and the fate of man, and (4) life-beyond death.

A positive answer to the first admits of the second. A negative answer leaves the second open to another round of speculation – since we exist, a negative answer to the latter would be irrational.

The third issue underlies personal behaviour. Since man is in the end individually responsible for the well-being and perpetuation of himself and the species, he must strive to achieve moral perfectibility. The problem is the human, who is notoriously “imperfect” and still enwrapped by his instincts, emotions and passions. We still rely on rewards and punishments in our social systems.

On the fourth issue, life is said to be too short for full accountability or expiation of our conduct. A set of “moral laws” from “above” coupled with rewards and punishments extended into after-life would provide for this, as well as eternally rewarding the good. It would help keep a lot of people in line.

There is a growing incongruity between a fully intelligent creature with free will, capable of conquering space, purely to exist as an evolutionary intermediate, and then subjecting him to senescence and death. The fulfilment of earlier creatures was the evolution and reproduction of the next generation. In this case, man is himself a terminal (albeit intermediate) objective, made responsible for continuation of his species. Having the responsibility means he stands to be judged.

The fulfilment of man must be in terms of his intellectual and moral attainments. The shortness of the present life span is thought of as inconsistent with all he can and needs to do or achieve. This impels man to extend his life, seek longevity and if possible conquer death, ie seek immortality.

The Temporal Conundrum

in the long-term (say 1,000 years from now), when every need, pleasure and wish had been satisfied, when he could hit a hole-in-one every time, and every cause was attended to, unless the metaphysical issues are cleared up, we shall still have a bunch of old fogies no wiser, and asking the same questions. Like the crows on the tree in Disney's Jungle Book, they would be sitting around and asking: "what shall we do next?"

They will ask why do we exist, what is the point of being eternally good, is there a better form of longevity, something more or more worthwhile to do, a higher quality of life, what comes after temporal time, and what exactly is our ultimate destiny. Finally they will ask is this happiness?

They will still be looking for the next template for evolution, since this is no longer left to chance but is their responsibility. But then, they will also ask who they are responsible to, and if none why bother. They could become very bored.

Unless evolution (we) bio-engineer some kind of superman, a long life will not be so great if we were to be forever stuck in some artificial machine-body. To enjoy immortality, man will want to be fully incorporeal (free of his body) and transfer beyond materiality.

Metaphysics has been able to explore the subject rationally and formulate the issues in depth but cannot produce the answers, as it has come up against the natural limits of the knowable as against the unknowable.

The Religious Frontier

Up to now, man's answers to the metaphysical questions have come mainly from the third set of his faculties, namely his awareness of the unknown, incorporating his arcane abilities, and expressed historically and societally as religious development.

Man has so far relied on the teachings of religion to fill the gap and has carried civilisation forward, (successfully we may add) bridging the knowledge and psychological gap by what has been called reasonable belief.

The initial stirrings about the metaphysical emerged from the clouds of unknowing about his environment surrounding early man. Responding to an innate need for some answers, man proceeded to believe in and ascribe the unexplainable variously to higher beings (spirits and deities) and began to worship them. This was the start of religion.

As science cleared up much of the unknown, the metaphysical issues remain. The major religions themselves proceeded to develop considerable corpus(es) of metaphysical understandings.

Review of Religion

Every cradle of civilisation developed its own religion. I have proceeded to review the major religious and philosophic developments. Their history, metaphysics and philosophy are generally closely intertwined. My review has therefore been basically historical,

The report will appear in the next volume: Cosmos III*** - Evolution, Beyond Materiality? Here I only allude to those features bearing on our present discussion.

The Abrahamic religions subscribe to a supreme godhead, of varying attributes: omniscient, omnipotent, immortal, morally perfect, creator of the universe and man, and arbiter of the latter according to his moral code, in other words divine. The Dharmatic religions on the other hand conceive of Being as transcendent and immanent in the universe, of which man is a part through re-incarnation according to the morality of his life. Central to their teachings is the doctrine that man's life on Earth is some kind of trial, and if he gets it right his rewards and destiny lie in some kind of immortality.

Traditional Chinese culture recognises Shangdi, their godhead, the Mandate of Heaven to govern the peoples, and an afterlife with ancestor worship. In a world crowded with folk-deities, their philosophic focus has been less on the metaphysical and more on social order and a proper way of life. Currently, they have adopted dialectic materialism (communism) “with Chinese characteristics”: as their political ideology.

One set of religious teachings incorporate revelation. The others have developed from the enlightenment of holy individuals, mystics and philosophers. They all prescribe a way of life, which generally include a moral code for the individual which may be extended comprehensively for the management of society. Revelation and enlightenment serve as sufficient proofs, and religious adherents reside in their belief and faith of their truth.

Modern Western philosophy emerged from the Greco-Roman and Christian cultures. It is the mainstream within which metaphysics has taken shape, among the other current secular disciplines of philosophy. One main line of thought seems to be that man can by the use of his intellect establish a credible probability in the existence of a prime mover or supreme being, and that it is reasonable to believe in him. But the knowledge gap is there and it requires faith and belief to do so. One further line of thought is that the latter must be given (or revealed) from above. The term commonly used for the supreme being or prime mover is God. Western civilisation has given us two political modes of societal development: the democratic with freedom of religion, and atheistic communism.

Western democratic civilisation took an important turning point when it went separated religion from politics. As a result, religion today, although institutionalised, is essentially an individual matter. However, religion’s contributions to man’s civilisational ideals and his moral and ethical development have been substantial, some would say pivotal. In the communist world, religion generally struggles but continues.

The belief in a higher order of being remains a basic anchor to a majority of the peoples of the Earth. A 2020 survey showed that world-wide 75.8% of the world’s people believed in God with about 24.2% identifying as unaffiliated to a religion. While it probably reflects some less developed peoples, the overall proportions cannot be ignored.

Religion has been taken advantage of by leaders, even abused by tyrants, to control the population, based on fear of the unknown and punishment for misdeeds. As the mysterious and misinformation got cleared away, this domain has contributed many important qualities to the matrix of human life. Besides the moral code, they include the right to life, equality, justice, and fairness. They have made significant contributions to the moral and behavioural development of man, in fact opening the routes for man to progress to the next qualitative higher plane of behaviour, namely virtuous conduct. In human terms, we have qualities like kindness, charity and love. Afterlife, a feature of some theologies, also adds continuity, depth and meaning to man’s otherwise short existence.

Historically it was thought that religion would fade away with scientific and philosophic development, but this has not happened. This study finds religion to be a sector of emerging rather than decreasing importance.

[\(Back to TOC\)](#)

The Way Forward

Metaphysics in in the large Space-Time

If evolution has been heading man towards a non-corporeal and immortal existence, as there is much evidence to suggest, then our next immediate (metaphysical) step is acquiring extra-rational muscularity and extra information

Our disciplines have gone a long way, crossed-backed by the sociological, neurological and psychological sciences. Our ability to prognosticate and speculate will widen as we revise and re-write our sciences, as we discover new information about our (hitherto) arcane abilities, and as mainstream metaphysics assimilates with the metaphysics and theologies (including revelation) of the various religions, and vice-versa. We should increase our perspicuity in all domains over time.

My own feeling is that once we get out into space, our perspectives of the universe will change dramatically and the unknown will look quite different. We are likely to have an enlarged understanding of the cosmos, maybe “get nearer” to the origin of things. Belief may then be more automatic, with knowledge. People may decide to opt for immortality rather than longevity.

The recent visit of comet 3i/Atlas, in June-December 2025, prompted a number of scientists to speculate that we were being robotically observed by a more highly developed alien species, possibly an emissary of a guardian federation of alien civilisations. I have no doubt they exist, possibly evolved in the same way, earlier. Our first questions, when we meet, will undoubtedly be whether they know the answers to our metaphysical issues and what they did do following that.

Systematic Exploration of Human “Spiritual” Experience.

I have avoided use of the word “spiritual” because of its association of ideas. I use it here specifically to mean the contact, communication, mediation and state of awareness (holiness) with the world beyond materiality. These are usually experienced by people with arcane faculties, such as mystics, sadhus, contemplates, visionaries, re-incarnates, saints, and even people in prayer or with a sixth sense. The phenomena may include oracles, appearances and events as well as states of mind. This field has not been systematically recorded, but includes a long history, their context and content mainly associated with religion.

The subject area is subjective, experiential and generally behaviour beyond rationality. To the extent it is factual, (ie it happens,) it should at this point be comprehensively studied to understand if nothing else the faculties and skills involved. These could perhaps become standardised human skills, like yoga, etc. practised in time by everyone in space and at home.

This field must be explored. It is widely assorted and largely unclassifiable. The best approach is a convergence of scientific and religious intellectuals, working with agreed lists of information sought, definitions and criteria for selection of subjects. With goodwill, co-operation and collaboration there will be much to obtain in the way of empirical output. These will serve to provide the next platform for further stages of study.

It would be a breakthrough if we could isolate the **gene** that triggered this faculty, in fact any gene that could double our metaphysical range. We could then apply it in gene therapy, and our descendants could add it to the options on the menu for cloning. We shall have made progress if we broke new ground, sharpened our common vision of the unknown and enlarged the basis of man’s beliefs.

The Last Divide

Presently, societal development is proceeding in two political formats, the democratic system, and the communist planned society. It is likely we shall coalesce and emerge as a single global society with a common bill of human rights and sharing an increasingly common technology-based culture, including freedom of religion. Religion will then be the last divide.

At that point, the “evangelical” role of the religions may be reversed. Instead of, as necessary in the beginning, combating each other to increase their flock, they may find greater fulfilment in coming together to enlighten the people on the common elements of their teachings in relation to the metaphysical issues. They would still have separate roles offering and guiding their flock as to their respective teachings and different paths to immortality.

The final step would be a voluntary convergence among the religions themselves, and then conjointly with the scientific and metaphysical disciplines, to study both the arcane faculties of man and the sum total of man’s spiritual experiences within religion.

If we can extract (and share) from man’s spiritual experience commonly agreed information, I would say we could be edging more than a few steps towards strengthening our reason base, and closing the information gap.

Whatever the information package we extract from the above, the mere fact that it will represent added or new or refined collective information previously unavailable and now commonly agreed

means that we shall be better placed to postulate our questions and focus nearer the truth, ie ask better questions. It does not mean we will be able to answer ourselves. To the extent the results debunk earlier misinformation and mistaken views, the exercise will have improved the total understanding of things. There will still be a gap, albeit a more focussed one. Man will ultimately have to believe something, even that there is nothing to believe.

In the happiest of situations, it will be left to the religions in the end mainly to offer their respective ways of life and serve a humanity increasingly enlightened as to its destiny.

[\(Back to TOC\)](#)

Evolutionary Strategy

From this study, I find that there is a unifying direction and purpose combining the pre-biotic and the biotic stages of our evolution. Evolution has been a single programme in two parts which brought about the existence of man as we have him.

The overwhelming evidence is that man was and is the culmination of physical evolution. All parallel proto-types have been phased out. The infusion of intelligence marked a quantum leap and a turning point. It is equally clear that the next stage of evolution has been placed in the hands of man, through civilisation. With individual free will, man must achieve the objectives of evolution collectively for the species and individually for himself. He has been given total hegemony over the planet Earth.

Evolution has passed the baton on to us. Again from all the evidence, we are in an intermediate phase of an on-going relay, on our way to finding the terminal post. Our immediate objectives are three-fold: (1) well-being of the individual, (2) welfare of the our society, and (3) perpetuation of our species. We could add two others: namely (4) live longer and (5) preserve the planet. As far as we can perceive, the ultimate terminal objective of evolution is apparently something for man to identify, set course for and achieve.

There is a sense that in relation to our capabilities, our immediate objectives are incomplete. There is a sense that, despite our increasing well-being, life in this our temporal existence is not a perfect paradise. It is too short and imperfect, too wrapped in obligations, restrictions and moral issues, and riddled with morality, to be the end-all of everything.

There could be somewhere beyond a higher plane, a more perfect existence, non-corporeal, possibly in an afterlife where mortality would have no meaning. Therefore, we lean towards our promptings to ask the metaphysical questions, and seek a more perfect life in the hereafter. And, this could well be the quest of evolution from the start, or the idea would not have been implant in us.

Judging by the strong continuing belief that a or some kind of supreme being exists and is the source of all life, we must conclude that the metaphysical issues remain our paramount intellectual quest. But, as certain knowledge lies beyond our physical reality, we can only go so far as to conclude that such a belief is reasonable or unreasonable. Because of free will, man is divided.

The study perceives that inculcation of man's abilities to ask the metaphysical questions as significant of an objective within evolution for him to reach out beyond materiality, to pose the question if not obtain the answers rationally. This latter leaves the implanted awareness of the unknown in him and his arcane faculties, the foundations of man's religious development, as the source of his metaphysical understandings so far, including revelation. If this is indeed man's passage of knowledge to the unknown, then evolution requires that, having established the metaphysical reasonableness thereof, man must believe in the metaphysical answers by the routes available to him, in essence in a supreme being and an immortal afterlife. Belief becomes fulcral to evolution's own terminal objective of gaining immortality through man.

One would have thought that belief was the vital step, and all should be plain sailing after that. In fact, man's overall understanding is that he is also required to successfully manage his passions in a moral life to qualify for the aspired afterlife,. These passions he inherited as part of his evolution; and it seems their control has become a second qualification, and the decisive one, for immortality. In effect, evolution has put man a "double spin" -metaphysics is not enough.

Two Stream Temporal Evolution

Our prognosis is that man is on course to achieving the continuation of the species in temporal time. Mankind will continue as a series of generations who live to a ripe old age (say 500 years each), in an increasingly technological environment here and in space.

Overall, it seems that if evolution is working toward another quantum leap, it would most likely be in the direction of immortality, which means the afterlife.

It would appear that it is the design or intention of evolution that the alternate path (to an afterlife in association with the supreme being) is left open-ended, for individual discovery and choice

Given the above scenario, we could express evolution's strategies to achieve its current objectives as follows:

. (1) That individual man continues to self-evolve as a technological creature, living progressively longer from generation to the next, perpetuating *Homo sapiens* as such, on Earth and in space. If he finds no other path, each man dies satisfied with what he has done. The species ends when the last man dies. In this scenario, the species is carried on, but each man is an intermediate.

.(2) That if man collectively answers the metaphysical issues in the positive, particularly that there is an accountable afterlife, then more (if not all) individuals will orientate their values and lives accordingly, with significant changes in societal arrangements. The ideal is everyone transfers to immortality. Man begins an immortal stream, and so does the species. In the short-term, this is unlikely; perhaps it will become more so as man grows older (500 years) in age and "wiser", perhaps in space in a thousand years.

.(3) And there is the status quo: that the majority of the peoples of the Earth, through religion, believe in various answers to the metaphysical issues, predominantly the existence of a supreme being and an afterlife. As a great evolutionary achievement of its own, mankind has secularised societal development, allowing for individual freedom of belief. In this scenario man is both a terminal objective if he chooses to go for the afterlife, and an intermediate otherwise. The species survives on both planes, while it continues the quest in temporal time.

(4) When the last man dies, the species remains immortal.

In future man may achieve a sharper insight into things-beings beyond materiality. Everyone will then understand better what they do not believe in and what they do believe in, and in the case of the latter make their transition to the afterlife. Perhaps all paths will converge, and man will then represent the species wholly and solely in immortality

It is hard to tell what will happen to the atheist stream; in this scenario, the non-believers will go extinct. The only unresolved point then is that the "bad guys" on Earth may think that they will "get away" with their misdeeds if they simply do not believe in a supreme being. On the face of it they will vanish forever. Evolution may, however, have other plans for them. and for those believers who do not qualify for eternal bliss: re-incarnation would be one.

Where Are We

Let us not beat about the bush. If we have two positions or options, and free choice, then, we shall have two streams of human evolution: (1) life here and now only, in temporal time, mortal, and (2) life after death, in association with the supreme being, immortal. We might note that, until he actually dies, man has a choice which way to go. It almost seems evolution is hedging its bets. Perhaps we are still in an intermediate stage, and current man is still a developing prototype, to see how far he can go; when he gets his metaphysical answers, all will be revealed

We may take that those who adhere to a religion implicitly or explicitly think it reasonable to believe, and order their lives accordingly.

On the other hand, atheists are people who have concluded that such belief is unreasonable, and order their lives accordingly. So far no one can or has proved that a supreme being cannot exist, and so their faith is in their unbelief. An agnostic is like an ostrich with his head in the sand.

In the interim two stream scenario, all unbelievers, with their personalities and identities, will die and vanish forever. They will become the discards that did not make it. The believers shall enjoy immortal life after death for their good, but may be punished eternally if their evil outweighs their good and they remain unrepentant..

In the two stream scenario, however, each generation will grow “wiser” with increased longevity, and they will progressively eradicate their troublesome passions. Their knowledge-base will also grow. Overall, their moral conduct is likely to improve, and they will register a higher proportion of believers and as immortals. Perhaps by then, religion will play more of a facilitative role, while people naturally incline towards immortality after death. They may play a part in guiding the believer which version of immortality to go for.

It is my expectation that man’s evolution will continue intellectually and technological, as his societal development stabilises through increasing civilisation. I see his intellectual evolution specifically in these directions: (1) to re-configure science to break the time barrier,(2) to gain further control of both the non-biological and biological nano-worlds - the latter including his body, and (3) to answer the metaphysical issues more cogently and help resolve the loose-ends

[\(Back to TOC\)](#)

Concluding Remarks

It seems contrary to “common sense” that, after establishing man with abstract thinking to master the universe, it does not matter (to evolution) whether man pushes himself further or destroys the Earth and himself. The very same abstract thinking tells us that man’s purpose is to take evolution forward, whether to the stars, beyond time-space, and even to discover the unknown, even beyond materiality.

There is a sense that life this our temporal existence is not a perfect paradise. It is too short and imperfect, too wrapped in obligations and restrictions, and riddled with morality, to be the end-all of everything.

There could be somewhere beyond a higher plane, a more perfect existence, non-corporeal, possibly in an afterlife where mortality would have no meaning. And, this could well be the quest of evolution from the start, or the idea would not have been implant in us.

My feeling is that we shall progressively acquire enhanced, perhaps additional, intellectual faculties. We shall then know and believe what we need. We should be there by the time we move into space. We should have a clearer picture of things by then.

Meanwhile, let us move on technologically. And manage our collective morality as best we can to stay in business and not go extinct.

I close the study with a high sense of optimism about further study of the arcane and the religious domain. On the one hand, on the religious side, I found in Teilhard de Chardin¹⁵, the distinguished scientist-priest, the kind of convergent visionary we need, who caused a stir among his fellow Jesuits by identifying his Omega Point as both the ultimate objective of human evolution and the apex of his religion. At the same, on the secular side, there are many advances on many fronts at different levels, and I can do no better than reproduce the following Google AI generated summary as an indication:

“Main advances in metaphysics include new approaches to established questions such as the mind-body problem, causation, and personal identity, and a renewed focus on topics like physical cosmology, the nature of physical laws, and the metaphysics of modality (possibility and necessity). Other advances include shifting

¹⁵ - https://en.wikipedia.org/wiki/Pierre_Teilhard_de_Chardin

from purely unchanging concepts to understanding the reality of changing things , a process sometimes called the "new metaphysics".

As I see it, we have awesome information technology to deploy. And the already well-laid metaphysical platforms look like the best common ground for solid forward footholds. The key is quantum-level AI programming, with their potential of multi-layered assembly and interrogation on cross informational and cross-religious fronts.

My own feeling is that if evolution is working toward another quantum leap, it would most likely be in the direction of the non-corporeal, until we are embroiled in beyond materiality.. My feeling is that we shall progressively acquire enhanced, perhaps additional, intellectual faculties. We shall then know and believe what we need. We should be there by the time we move into space. We should have a clearer picture of things by then.

Meanwhile, let us move on technologically. And manage our collective morality as best we can to stay in business and not go extinct.

As I see it, we have awesome information technology to deploy. And the already well-laid metaphysical platforms look like the best common ground for solid forward footholds. The key is quantum-level AI programming, with their potential of multi-layered assembly and interrogation on cross informational and cross-religious fronts.

We should remember that with a convergence of effort, we could get breakthroughs from both sides. Thus, a major religious leader recently issued an encyclical stressing the safeguarding of the environment as a moral responsibility. And there is this delightful 1953 story of Arthur C Clarke, entitled "The Nine Billion Names of God". The traditional Tibetan wisdom believed that once all the nine billion names of God had been discovered, the purpose of existence would be fulfilled, and the universe would end. Some monks decided to hire two programmers to programme the newly invented computer to do just that. One day, not long after, it was found that everything had disappeared.

Some people say that evolution can make serious mistakes. Mammalian reproduction for instance is thought to be among the most sophisticated bio-engineering systems developed by evolution. When imported into the human, we had woman, designed as the ultimate in caring motherhood to raise its most precious creature, man. And then, it went on to endow her with the same (some say better) brains as man, and free will – with a touch of vanity. As a result, women today operate on the basis of equality with men and see it as their duty to manage the world before reproducing babies. In consequence, the human reproduction rate has dropped abysmally low and the race will be shrinking by the turn of this millennium, when all the women in the underdeveloped countries join their front-end sisters, Reproduction is the fundamental tool of evolution. It is hard to see how evolution can reverse this mistake, if it is a mistake. As usual, it will be left to the men to sort things out. On the other hand, evolution may be hedging its bets, with women as the more viable alternative to lead mankind, while men worked out the technological alternatives.

We need new thinking, new vision, and like the eukaryotes of old, new synthesis and new courage. Somewhere in the Late Jurassic, there were dinosaurs (archosauria) . When one of them was told his descendants would one day fly, he said : "That would be a quantum leap". We are in the same position.

[\(Back to TOC\)](#)

END

About Gerald F Pillay

(Extracted from Academia, at <https://geraldpillay.academia.edu/>)

Biography

Gerald Francis Pillay was born in Melaka on 2 Dec 1934. The family migrated to Singapore in 1949. He graduated with the B.A. Honours Upper II in Geography (1957) from the University of Malaya (then in Singapore).

Mr. Pillay served 33 years in the Singapore public service. In 1957, he joined the Administrative Service, rising to Deputy Secretary. In 1974 he was transferred to the newly-created Industrial Training Board as Secretary. In 1989, he retired as Deputy Director (Dy CEO) from the board, which has since become the Institute of Technical Education (ITE).

In 1989, he formed GFP Consultancy. He practised as a policy consultant in Technical Education (TVET), serving international agencies such as the World Bank, UNESCO and ILO, employers and employers' organisations. In 1992-3, Mr. Pillay served on Botswana's Presidential National Commission on Education, nominated by the Singapore Government. He retired from practice in 2006.

HIS RECENT RESEARCH INTERESTS have been in the major frontiers of science and technology, probing the origin of things. He hopes next to explore the material-spiritual duality of human nature.

He releases these technical self-briefs on [Academia.com](https://geraldpillay.com), so far on "Quantum Mechanics" (2021), "Virus -The Biological Predator" (2022), and the "Cosmos - An Historical Survey and Exploration of the Future" (2023).

He has also e-published "the Chitty Melaka Story" (second edition) (2013) and "Japanese Conquest of Malaya and Singapore, 1941-2" (2019).(check Google).

Full CV available at "About Me" ,at the WordPress publications site.at <https://geraldpillay.wordpress.com>

[Back to TOC\)](#)
