# iPerspectives

AIAS Fellows' Magazine

Issue 1 . SPRING 2020

## LIFE

ORIGIN . MEANING . FUTURE

AIAS
AARHUS INSTITUTE
OF ADVANCED STUDIES

iPerspectives
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# CONTENTS




# FOREWORD

The Aarhus Institute of Advanced Studies (AIAS) is proud to introduce this first edition of *iPerspectives*. *iPerspectives* is a magazine issued by the fellows at AIAS, following one of the interdisciplinary workshops at the institute. These workshops are one of the key instruments in stimulating interdisciplinary thinking, and they are often the breeding ground for new scientific initiatives and ideas. The ambitious title of the workshop behind the first *iPerspectives* is *The Origin and Destiny of Life*, and it took place in the winter of 2019.

Science, and in particular the advancement of science for the benefit of us all, has always been driven by the delicate balance between two seemingly opposing research strategies: The *inside-out* strategy that relies on the advances made possible by the undisturbed and uninterrupted investigations on the theoretical foundations of our present knowledge. A good example is the discovery of the chemical element no 72, *Hafnium*. The work of Dmitrij Mendelejev in 1869 had shown that an element remained undiscovered in the periodic system, and that place no 72 was empty. Later in 1922, Niels Bohr could predict the properties on the missing element, based on his electron theory for the atoms. Soon thereafter in 1924, it was discovered and named *Hafnium* after the city of Copenhagen where it was identified. At that time, no one needed or asked for *Hafnium*, but had it not been there, we would have been forced to adjust or rewrite our models for the world around us.

The other strategy, the *outside-in*, drives science forward through the pressing need we as individuals or as a society have. The deep and profound knowledge we have today of our immune system, and how it is interacting with intruding viral agents, originates partly in the need to solve the challenge of the outbreak of the AIDS/HIV epidemic in the 1980s.

The *inside-out* and the *outside-in* strategies are entangled, and often the solution of a specific problem will lead to new fundamental knowledge, as well as the development of new theories and models that will lead to new and unforeseen applications. The literature on modern research strategies is vast, and the simplistic picture given here is present in the numerous concepts introduced to understand how science advances to benefit us all: *push-pull, mission-oriented, blue-sky, grand challenge, SDGs, Innovation, Pasteur's Quadrant*…

However, less developed is perhaps our understanding of how disciplines work together, and how we create the "nurseries" and provide the *protected space* where basic ideas and theories can "meet". Interdisciplinarity is well described in an *outside-in* context, where a specific challenge is addressed by a team of experts from different fields of research. However, do we also provide an *inside-out* setting for interdisciplinary research, where scientists meet and share their basic field-specific ideas and theories on a specific topic with the sole purpose of insight and inspiration?  Yes, there are many good examples of this approach, but at AIAS we think more could be done - by for instance encouraging the AIAS fellows to engage in arranging conferences and workshops devoted to exactly this. In an effort to make these workshops more visible and share their insights and ideas, we thus issue the *iPerpectives* magazine.

We hope you'll enjoy reading it, and welcome you to visit the AIAS homepage for more information on upcoming events at AIAS, subscribe to our Newsletter or maybe follow us on Twitter.

Photo: Ida Marie Jensen

Søren Rud Keiding
*AIAS Executive Director, Professor*


Photo: Melissa Bach Yildirim

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# EDITORS' NOTE

Photo: Anders Trærup

Photo: Søren Kjeldgaard

Photo: Melissa Bach Yildirim

Photo: Søren Kjeldgaard

Welcome to the first issue of *iPerspectives*, an interdisciplinary magazine by Research Fellows at the Aarhus Institute of Advanced Studies (AIAS), Aarhus University, Denmark. We, the editors of this issue, came together when Thomas sent an open invitation to all AIAS Fellows last September to co-organise an internal workshop (*details on page 45*) on the *Origin and Destiny of Life*. The idea for an e-magazine came up at one of our planning meetings, and was presented at the workshop on November 29, 2019. *iPerspectives* was initially meant to be a magazine by and for current and former AIAS Fellows. The interesting presentations at the workshop, and later the interest from former Fellows, motivated us to get them published, at least on our website.

We'd like to thank: Søren Rud Keiding, our Director, who kindly agreed to write the foreword to the first issue, and supported the workshop, Morten Kyndrup, our former Director, who supported the idea of the workshop when it was first presented to him, and colleagues and former Fellows who generously gave their time to make *iPerspectives* a reality. We are all temporarily at AIAS, and we hope that the workshop and e-magazine series will continue through the current, incoming and future Fellows. We hope you will enjoy reading the contributions in this issue, as much as we did.

*Cici Alexander*

*Jennifer Galloway*

*Sâmia Joca*

*Thomas Tauris*

# Life in Space

One of the leading hypotheses for the origin of life involves panspermia, that life came to Earth from space and that life exists throughout the Universe. Evidence to support this idea comes from several meteorites found on Earth.

*By* **Thomas Tauris**


Photo: Søren Kjeldgaard

Image credit: NASA/JPL-Caltech

When discussing the origin of life, it is often useful to consider the timeline for major events in the 13.8 billion year history of the Universe. Our Solar System, and thus the Earth, formed 4.5 billion years ago and, interestingly enough, the more advanced organisms, as well as the first animals, only formed during the *Cambrian explosion*, about half a billion years ago. Actually, it is merely 50,000 years ago (at 99.9996% of the present age of the Universe) Neanderthals and Homo sapiens lived in Europe side by side. Hence, life as we know it - not to mention civilised life - evolved very slowly on a long timescale.

It is an interesting question how long time civilised life on our planet can exist? The answer is crucial for the probability estimates of finding civilised life elsewhere in our Galaxy, the Milky Way. From modern knowledge of stellar evolution, we can set an absolute upper limit on the end date, namely 5 billion years. At that time, the Sun will become a giant star and expand in size by a factor of several hundred, possibly even engulfing the Earth. Engulfed or not, the enormous temperature rise on Earth will in any case kill all existing forms of life.

It is most likely, however, that our civilization will come to an end on a much shorter timescale. First of all, it is difficult (even for an optimist) to envision a peaceful future on a timescale of more than a few hundred years. The dangers lurk everywhere: overpopulation, lack of resources, clashes of religions and cultures, nuclear warfare, economic inequality, epidemics, pollution etc. (Global warming is unpleasant and may spark further crisis, but is not a major concern, in my point of view). Mankind may be able to spread into space and colonize e.g. Mars and a few other places (moons) within the Solar System - although what a poor and simple indoor life without access to oceans and wooded mountains. The distances to even the nearest exosolar systems leaves little hope for being reachable. Current technology with interstellar travelling at about 60,000 km/h would require 20,000 years even to reach the nearest neighbour star.

Even if mankind manages to overcome the abovementioned serious issues, we also face the possibility of mass extinction from impacts of asteroids and comets. By looking at the Lunar surface full of crater holes, and remembering that the Earth's surface area is 16 times larger than that of the Moon, we can estimate the average time intervals between catastrophic impacts. Several times in history, life on Earth suffered from mass extinction due to such events, where up to 95% of all living species went extinct. For example, 66 million years ago when a 10-15 km asteroid or comet hit the Earth in the Gulf of Mexico, eradicating many species including the dinosaurs.

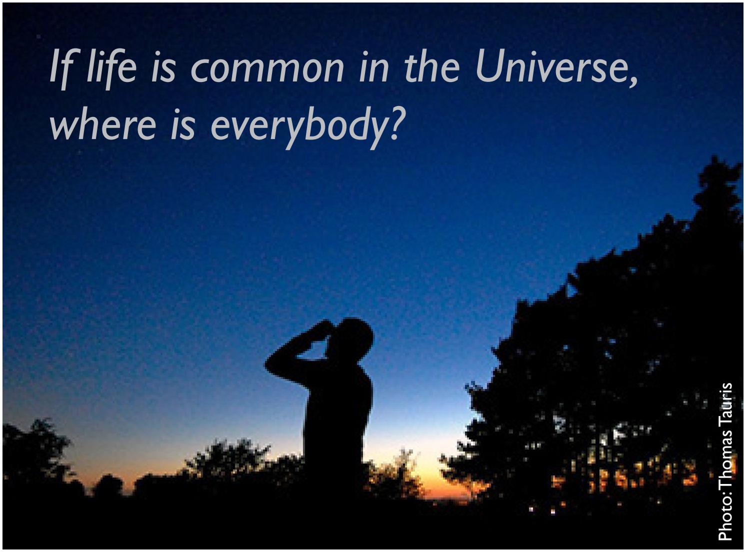
**At that time, the Sun will become a giant star and expand in size by a factor of several hundred, possibly even engulfing the Earth.**

One of the leading hypotheses for the origin of life involves *panspermia*, i.e. that life came to Earth from space and that life exists throughout the Universe. Evidence to support this idea comes from several meteorites found on Earth, including ALH84001 and the Murchison meteorite. Electron microscopy of the former (which originally came from Mars) revealed chain structures resembling living organisms - although this interpretation is highly controversial, whereas in the latter meteorite 86 amino acids have been identified, including several amino acids essential for life (glycine, alanine, glutamic acid), as well as polyols (sugar alcohols). But if life came to Earth from space, how on Earth did it originate in space? Panspermia is no shortcut for an explanation of the origin of life.

To investigate whether life could originate in a rather primitive chemical environment (mimicking the early atmosphere of the Earth), Miller and Urey conducted a famous experiment (the *Miller-Urey* experiment) at the University of Chicago in 1952. They simply heated some water (ocean) and added the gasses: ammonia, methane and hydrogen, before electrical sparks (lightning) were fired between electrodes within the water vapour and gaseous mixture, and then the simulated atmosphere was cooled again. The resulting condensed water mixture now contained a chemical compound of more than 20 different amino acids - the building blocks for proteins that are essential for development of life. This is not the final proof that life originated on Earth. However, it demonstrates that it is *possible*. In any case, many complex organic molecules and amino acids have also been identified in space in interstellar dust clouds located in our Galaxy. Finally, it is interesting to notice the presence of *extremophiles* on Earth, which are organisms with optimal growth in environmental conditions considered extreme in comparison to the usual Earth environment (not only with respect to temperature and pressure, but also in ability to survive cosmic radiation and hibernation for at least hundreds of years). One example of such animals is the so-called water bear (tardigrade) of size 0.5 mm. Such organisms may well survive interplanetary travel, but interstellar distances are still much larger.

**The Miller-Urey experiment is not the final proof that life originated on Earth. However, it demonstrates that it is possible.**

The *Drake equation* from 1962 is a probabilistic argument used to estimate the number (*N*) of active, communicative extraterrestrial civilizations in the Milky Way galaxy. It consists of a number of factors: the average rate of star formation in our Galaxy, the fraction of those stars that have planets, the average number of planets that can potentially support life per star that has planets, the fraction of planets that could support life that actually develop life at some point, the fraction of planets with life that actually go on to develop intelligent life (civilizations), the fraction of civilizations that develop a technology that releases signals into space, the length of time




for which such civilizations release detectable signals into space. The number *N* can take values between $10^{-12}$ and $10^{7}$, depending on estimated values of the various input factors. In particular, the last factor on the survival time for civilizations is uncertain. Is it just a few hundred years, or could it be billions of years?

If life is common in the Universe, where is everybody? This is known as the *Fermi paradox*, after the Italian-American physicist Enrico Fermi (1901-1954). It is a universal trait of living things that they tend to fill up all available territory, so the Earth should already have been colonized, or at least visited, but no evidence of this exists. Possibly, the answer is that few civilizations ever arise. Or perhaps it is the nature of intelligent life to destroy itself or to destroy others.

The *anthropic principle* was introduced by Carter (1973) and Barrow & Tipler (1986) in reaction to the apparent fine-tuning of many fundamental physical constants (needed for life to develop) and the Copernicus principle which marginalized the position of mankind. The *strong* anthropic principle states that the Universe is compelled to eventually develop intelligent life. Or the Universe is as it is *because* we are here. (Critics say that this is a tautology.) The *weak* version of the anthropic principle states that the fine-tuning is the result of a selection bias, i.e. what we can observe is limited by conditions leading to our existence.

To conclude, it seems that three leading hypotheses remain for explaining the origin of life: extreme luck, a *multiverse* (i.e. numerous parallel universes - we just live in one of them), or creation via God (intelligent design). Regarding the latter, let me end by quoting Albert Einstein: "*What really interests me is whether God had any choice in the creation of the world*".

**About the author:**

*Thomas Tauris is an AIAS-COFUND Fellow (2019-2020) and Professor in astrophysics at Aarhus University. Thomas is a theoretical astrophysicist working on a broad range of topics, including: formation and evolution of compact objects (black holes, neutron stars and white dwarfs), pulsars, binary star interactions, gravitational waves, supernovae and hypervelocity stars.*

# The Destiny of Humankind

## In my opinion, there are only two main questions that really matter for humankind:
## a) Are we alone in the Universe?
## b) Does God exist?

*By* **Christos Tsirogiannis**

Photo: Ida Marie Jensen

On November 29, 2019 I was honoured to give a presentation at the conference entitled 'The Origin and Destiny of Life', at the Aarhus Institute of Advanced Studies (AIAS), invited by the organizers, Professor Thomas Tauris and Associate Professors Cici Alexander, Jennifer Galloway and Samia Joca. The idea regarding the creation of this event was for AIAS fellows to share their thoughts about the creation and (mainly) the future of humankind; It was the first time I was asked to present on a subject in which I am not an expert, a task that I found challenging and exciting.

Image: Bibliothèque Nationale de France [Public domain]

**As an academic and, especially, as a forensic archaeologist, I am seeking the truth by discovering and publishing evidence.**

My presentation was entitled 'Is the truth out there? References in ancient texts and some thoughts on our future'. As an archaeologist, I referred to published academic work of a NASA scientist on ancient Greek and Latin texts recording extraordinary phenomena, which are now - based on the scientific knowledge accumulated during the last 2,000 years - perfectly explicable as natural phenomena; there was one exception, but based on the trend, we might expect the case be explained with further knowledge in the future. I then expressed my own views, as all presenters were asked by the organizers to do so; in my opinion, there are only two main questions that really matter for humankind: a) Are we alone in the Universe? b) Does God exist?

I believe that our duty as intelligent human beings is to contribute with our daily work to the constant moral, scientific and technological advancement of humanity, in order to reach a point to answer these two questions, even if it takes us millions of years to do so - if ever. In my opinion, nothing else matters, in the grand scheme of things, than finding those two answers. It does not really matter which is our job, profession, specialism, hobby or passion in this life, so long as this is contributing, directly or indirectly, to this advancement.

It is, of course, unavoidable, that such advancement will be very gradual, as the history of the development of humankind demonstrates. However, certain events and inventions in history speeded up the process, although at the same time humanity still maintains all the elements that pause or significantly delay this process (wars, destruction of the planet, etc.) Therefore, what could have been a linear process of gradual development, in relatively recent times we turned it into a race against ourselves: we will soon have to leave this beautiful planet that gave birth to us, before we die with it, destroying it in every possible way.

As an academic and, especially, as a forensic archaeologist, I am seeking the truth by discovering and publishing evidence. This is the only safe approach to answer any questions arising in my discipline; I need evidence and proofs to contribute to the advancement of my field, as all academics usually do. At the same time, as a person, I am religious, although I have no actual proof for my beliefs; it is a matter of faith. Some see an obvious contradiction, others see an obvious compatibility between the two. But it seems that there is only one way to find out what really happens: by surviving our fights and keeping on working to discover more.

**About the author:**

*Christos Tsirogiannis is an AIAS-COFUND Fellow (2019-2022). He is a forensic archaeologist researching international illicit antiquities trafficking networks through the identification of illicit antiquities in auction houses, dealers' galleries, museums and private collections.*

# A brief history of Geological time

Black smokers and tube worm communities at Sully Vent in the Main Endeavour Vent Field in the northeast Pacific Ocean. Credit: NOAA

*By* **Jennifer Galloway**

Photo: Søren Kjeldgaard

Earth is 4.6 billion years old. Life may have first originated on Earth as long ago as 4.5 billion years. The oldest fossils are hematite tubes that may be the remnants of microscopic bacteria. These putative fossils are found in rocks in Quebec, Canada. The bacteria that made these tubes would have lived in hot vents in the oceans that covered the early planet. The setting for the origin of life on Earth may have been these deep marine hydrothermal vents. Early life may have harnessed the energy gradients that exist when alkaline vent waters mix with more acidic seawater.

The first photosynthetic life probably used reducing agents such as hydrogen or electrons rather than water. Early photosynthetic systems, such as those from green and purple sulfur and nonsulfur bacteria are thought to have been anoxygenic, using various molecules (H, S) as electron donors. The biochemical capacity to use water as the source for electrons in photosynthesis evolved in an ancestor of extant cyanobacteria. The geological record indicates that this planet-transforming event took place early in Earth's history, at least 2450-2320 million years ago, and possibly much earlier. Fossils of what may be filamentous photosynthetic organisms are dated as 3.4 billion years old. By the Archean Eon, at least 2.5 billion years ago, there was an already diverse biota of cyanobacteria. An oxygen revolution, termed the Great Oxygenation Event, transformed the Earth's atmosphere and the shallow ocean from weakly reducing to oxidizing. This event caused almost all of the life thus far on Earth of go extinct. Cyanobacteria are responsible for creating the conditions that enabled the subsequent development of multicellular life forms, and thus, life as we know it today. Consider this the next time you see green sludge in a pond.

A newly discovered group of 2.1 billion year old fossil organisms may be the earliest known example of complex life on Earth. These fossils are flat discs almost 5 inches across, with scalloped edges and radial slits. These were either complex colonies of single-celled organisms, or early animals. They have been discovered in Gabon, and dated to 2.0 billion years old.

This now brings us into the Proterozoic Eon (2.5 billion to 541 million years ago). Below I will highlight a few enigmatic life forms that lived during the

## Proterozoic Eon 2.5 billion to 541 million years ago


*Charnia masoni*
Animalia

Precambrian (Ediacaran)
England and elsewhere

Length: 15 cm

This enigmatic precambrian animal was long thought to be related to sea pens but a more recent opinion is that it is a representative of a group that has no relation to any currently existing or extinct clade. It is a fractal creature with up to four level of subdivisions visible in fossil impressions. The first specimen has been discovered in England. It apparently lived in deep water.


*Haootia quadriformis*
Cnidaria

Late Ediacaran

Length: 5 cm

Haootia, a cnidarian polyp, has been identified as the earliest animal discovered to show muscle fibers. Its exact affinities within the Cnidarians are however unknown.


*Dickinsonia costata*

Length: up to 1 m

One of the most famous fossils of the Ediacara biota is Dickinsonia, first described by Sprigg in 1947. Dickinsonia fossils were preserved as imprints of ovoid or ribbon- like creatures with bilateral symmetry. Their sizes range from a few millimeters to practically a meter in length. The animal also appeared to be segmented. The affinities of Dickinsonia were and is, still today, highly debated.

Ediacaran Period (ca. 635-542 million years ago). The art featured in the figures are by Nobu Tamura (http:spinops.blogspot.com). Many of the animals that existed during this time were soft-bodied and did not preserve as well as animals that had a skeleton in the fossil record. Consequently, comparatively little is known about these animals and the ecosystems that they were a part of.

The Phanerozoic Eon was the dawn of a brave new world. Below I highlight a few of the animals that existed during the Cambrian Period, which spanned from 541 to 485.4 million years ago. At this time, a rapid explosion of life occurred. Although many of the new life forms did not persist, all of the animal phyla that exist today have their roots in the Cambrian.

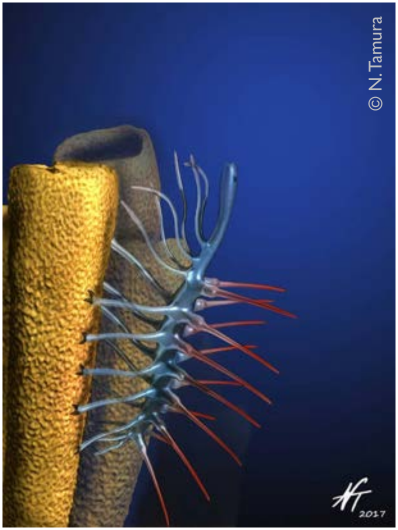
## Cambrian Earth Evolution's Big Bang 541 to 485.4 million years ago


*Anomalocaris saron*

Early Cambrian

Length: 1 m

The Chinese equivalent of the Burgess Shale Anomalocaris canadensis had a tail with two long and slender furca.




*Hallucigenia sparsa*

The lobopod animal Hallucigenia (size = 2 cm) and the armoured slug-like animal Wiwaxia (size = 3 cm). Hallucigenia possesses rows of spines on the back of its body while Wiwaxia developed a body armour of small, overlapping scales and blades. Both traits may have evolved as a defensive mechanism against predators.

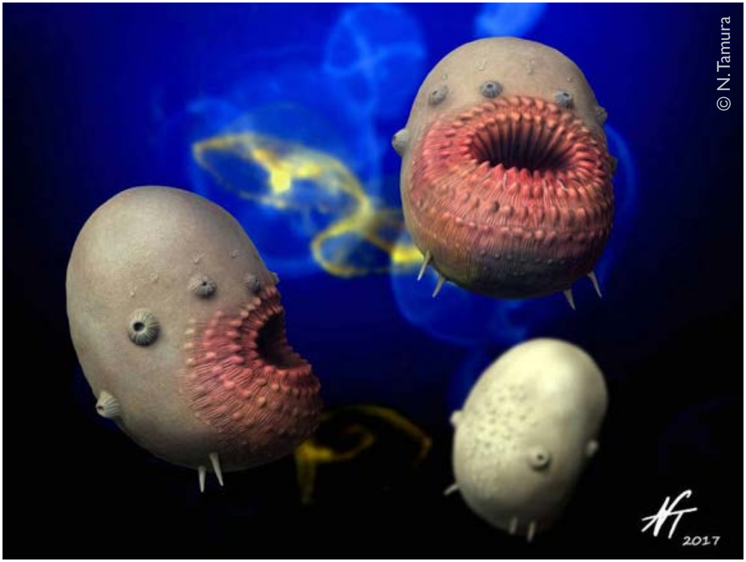

*Wiwaxia corrugata*


*Ottoia prolifica*

Middle Cambrian
Burgess Shale Fm
British Columbia, Canada

Length: 8 cm

This Cambrian worm from the Burgess Shale probably belong to the extent group known as priapulids. They were burrowers that probably spent most of its buried in the sand. Some 1000 specimens have been collected from the Burgess Shale.




*Saccorhytus coronarius*

Size: 1.3 mm

The size of a grain of rice, *Saccorhytus* from the Early Cambrian is the earliest known unequivocal deuterostome (Chordates, Echinoderms, etc.).

*Ctenoimbricata spinosa*
Echinodermata

Middle Cambrian

Length: 2 cm

Echinoderms (sea stars, sea urchins, sea lilies, etc...) are characterized by their fivefold radial symmetry in their adult form. However, they start their life as larvae with a bilateral symmetry, indicating that they must have evolved from bilateral ancestors. *Ctenoimbricata* is the first fossil of echinoderm to be described showing the original bilateral stage of the evolution of this stem group.


The illustrations in this article are by Nobumichi (Nobu) Tamura, and made available under a Creative Commons 3.0 Unported (CC BY-NC-ND 3.0) licence. Nobu is a Physicist at the Lawrence Berkeley National Laboratory in California. Paleoart is his hobby.

Significant events in the history of life on Earth followed the Cambrian Period. Land plants, dinosaurs, mammals, humans. But the Cambrian Period is significant because within several million years, rapid in a geological sense, the calm peaceful environments experienced by early life on Earth were transformed into a new world ruled by highly mobile animals. Modern anatomical features were established at this time. The Cambrian Explosion emerged out of a complex interplay between small environmental changes that triggered major evolutionary developments. Probably one of the most significant events in life's history was carnivory, made possible by oxygenation of the planet by the advent of photosynthesis that enabled the energy requirements for mobility and triggered an evolutionary arms race.

**About the author:**

*Jennifer Galloway is a Research Scientist at the Geological Survey of Canada and an AIAS-COFUND Senior Research Fellow (2019-2020). She is an Adjunct Research Professor at Carleton University and Adjunct Assistant Professor at the University of Calgary. Jennifer is a geologist, palynologist, and paleoecologist who is interested in the role of climate on ecosystems.*

# Being Human

## The care we received from others in the early stages of life, no matter how imperfect it may have been, gave each of our lives an initial sense of meaning.

*By* **Samuel McCormick**

What does it mean to be human? Thankfully, there are only three minimum requirements. In order to be human, one must first be embodied. Your body needn't look like mine, but we each need to have one. And like all human bodies, yours and mine alike must eventually perish. If embodiment is the first condition of human being, death is its final requirement.

What happens along the way, in the meantime between these first and final states? In keeping with this issue of *iPerspectives*, I'd like to characterize the meantime between our corporeal origins and terminal futures as a *time of meaning* – not in the heady German sense of *meinen*, from the ancient verbal root **men-*, meaning "to think" and "to remain" and, more precisely, as its offshoot *mono-* suggests, to remain "small" and "isolated" in one's thought; but in the lower, more pedestrian, yet no less Teutonic sense of *gemein*, a descendent of the compound adjectival root **ko-moin-i*, meaning "held in common," which itself derives from the Proto-Indo-European **mei-*, meaning "to exchange" and, in so doing, "to change." What do human beings hold in common, exchanging as they go and changing along the way, in the existential meantime between birth and death?

Consider what's happening right now. That you are still reading this little essay about what it means to be human is not only proof that you




have a body which has not yet perished (though I can't promise you won't die of boredom before you reach the end of this essay — or of laughter, for that matter). It's also a testament to the fact that you have somehow managed to live long enough, and with enough socioeconomic privilege, to become literate in English (and probably other languages, too, as the foregoing paragraph wagers). How, exactly, did this happen?

To be sure, you probably didn't learn English the way I learned English. (Or is it "learnt"?) But one thing is certain: Before either of us began to learn the language in which this essay is written, or any other language for that matter, we received copious amounts of physical care from other human beings, especially during the first few months of our individual lives — an all-too-human period of infancy aptly termed, as any bleary-eyed new parent can attest, "the fourth trimester." If our basic material needs had not been met by other human beings at the start of our individual lives, I would not have survived long enough to write this essay, and you would not have survived long enough to read it.

Whatever else the meaning of life might entail — that's right, I said it, *the meaning of life* — I'd like to suggest that it starts here, in the early stages of the mortal meantime which you and I both continue to inhabit, at a point in time when the care we received from others, no matter how imperfect it may have been, gave each of our lives an initial sense of meaning. And not just any initial sense of meaning, for in receiving care from other human beings at the start of our individual lives, we were also introduced to what is arguably the best part about being human in the first place: not the universal experience of mortality but the way this experience inclines us to hold each other in common, especially in times of need.

**About the author:**

*Samuel McCormick is Associate Professor of Communication Studies at San Francisco State University and was EURIAS & Marie-Curie Research Fellow at AIAS in 2017-2018. His latest book, The Chattering Mind: A Conceptual History of Everyday Talk, will be published by the University of Chicago Press in February 2020.*

# Maths Actually

## If you have a spare moment, see if you can find the mathematics in everyday life.

*By* **Doug Speed**

Not a Christmas passes in the Speed household without watching *Love Actually*. However, this year's viewing had a twist, as I had recently finished reading *Why do Buses Come in Threes?* (Rob Eastaway & Jeremy Wyndham), a book explaining some mathematical oddities that occur in daily life. Now, when I saw Harry buying a flower necklace for his secretary, I was reminded that the reason plants tend to have 5, 8 or 13 leaves is because these numbers (which you might recognise as part of the *Fibonacci sequence*) maximize the sunlight afforded to each leaf. When David was knocking at doors in the "dodgy end of Wandsworth" in the hope of finding Natalie, it seemed outrageous chance that he should first bump into Mia, one of the other characters in the film; however, the book pointed out that once you take in account how many events happen everyday, you appreciate that "one-in-a-million" coincidences actually occur on a regular basis. Finally, when I watched Jamie frantically trying to avoid getting soaked in a thunderstorm, I wished he had known that he would have stayed most dry by ensuring that his horizontal velocity matched that of the rain. By the time the credits arrived, accompanied by Billy singing "Christmas is all around", I realised the song would have been more accurate had he changed the lyrics to "Maths is all around" (which also would have improved the scansion of the chorus!).

**About the author:**

*Doug Speed is an AIAS-COFUND Fellow (2017-2020). He has a degree in Mathematics (University of Oxford) and a PhD in Statistical Genetics (University of Cambridge). Doug was a member of the Genetics Institute, University College London, and his focus is on developing statistical software for analysing genetic data.*


Why do Buses Come in Threes?
The hidden mathematics of everyday life
Rob Eastaway & Jeremy Wyndham
Why do Buses Come in Threes?

# The Origin or Destin
# what does it mean to

For me, the question leads to the following answer: to allow all emotions and feelings to come and go within us, knowing full well that whatever is happening will eventually pass.

*By* **Joshua Nash**

Having come from an intellectual family, questions of life, existence, God, and the rest always banged around at home and in my head. Strangely, though, this thinking more often than not got me into a knot. Overthinking. Metathinking. Thinking about thinking. I once heard it said that thinking is often merely rearranging prejudices. There's something in that.

I began working at AIAS on 1 February 2018. Of the several things I wrote during my almost two years there, I reckon the two short yet most important contributions to thinking and being alive were published in the 2017/2018 and

# y of Life, or be alive?

2018/2019 AIAS annual reports. 'AIAS-Research-Self' muses on the role of useless knowledge generation in research and how during the start of my AIAS tenure I plunged into an academic and existential dark night of the soul. That is, a kind of breakdown which hopefully led me and continues to lead me somewhere different and maybe to a more whole place. 'The Importance of Being Chosen' queries the possibility, reality, and even responsibility of being special, of almost having been given a gift when we enter a research institute such as AIAS. Do we fail if we have a personal breakdown? Are we failures if we don't give good returns and dividends on the gift of being chosen?

I left AIAS to move back to Australia more than three months ago. Life is different here and the origins and destiny of *my* life, not necessarily anyone else's, are ebbing and flowing. My time at AIAS and in Aarhus was a beautiful jaunt, a sojourn of emotion, thought, and experience to the other side of the planet for reasons still and most likely perpetually unknown to me. We come to this planet, we share a little time — together alone and alone together — as a little blip of consciousness and hopefully with good helpings of love and fun times, then we disappear. We invent theories and religions and delve into the mysteries of existence in the hope that there will be some kind of answer, some salve which can help us get up in the morning, be ourselves, whoever that is, and a way to make sense and meaning in the who, what, where, when, and how of our existence. All the while, time is ticking and we're getting older. All the while I ask myself: does any of this really matter?

We always have a choice. I have sometimes found it difficult not to play the victim in a world which seems so unjust. Self help books and therapy can take us some of the way; time in nature and gardening and any other number of healthy and less healthy activities can help us embrace what is there or keep us away from our pain and inevitable, eventual death.

While I have no idea and am not overly concerned about the origin and destiny of life, I am definitely doing my best to derive meaning from being alive. Today. And as a friend and co-astronaut of the depths intimated to me on the phone today, 'affect leads to meaning.' And whether that affect is so-called 'good' or 'bad', I prefer to feel all the breadths of emotions rather than be (comfortably) numb and distant from the latitudes of feeling. As the same friend said to me, 'going into therapy is as much about getting better emotionally and mentally as enabling and giving ourselves the almost bizarre parallel of being able to feel worse. And often, much worse.' Obliteration of truths and falsehoods of who we think we are and our senses of self lead to required private, intimate, and (inter)personal composting.

For me, the question — what does it mean to be alive? — leads to the following answer: to allow all emotions and feelings to come and go within us, knowing full well that whatever is happening will eventually pass. And knowing that there really are no mistakes in life, only (meandering) paths of learning. And hopefully through arriving at our own semblance of an answer, we can help other people come to their own conclusions about what a life of meaning might be for them.

**About the author:**

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Photo: Joshua Nash By Holly Bennett, Pitcairn Island, 2016

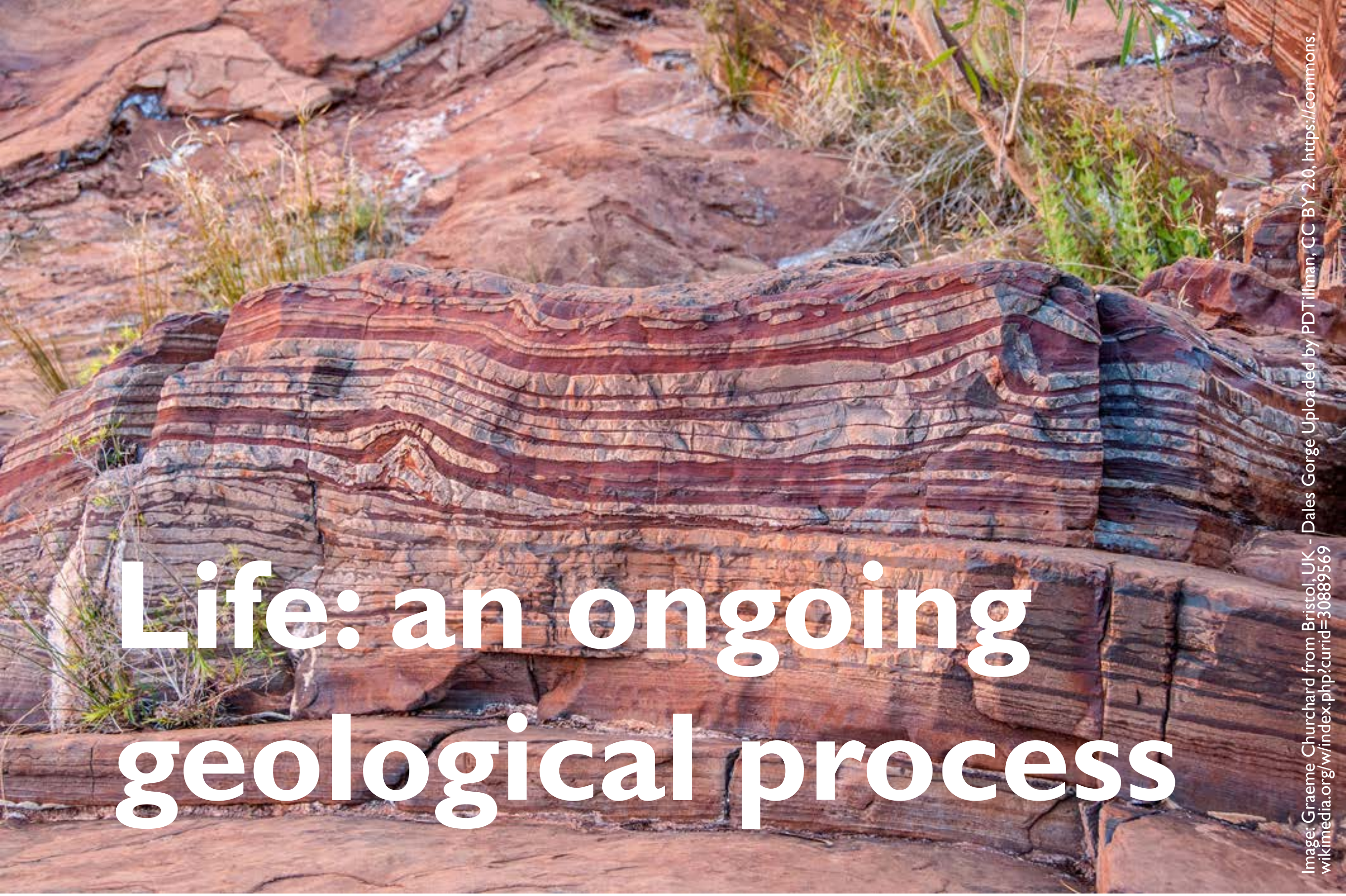

Image: Graeme Churchard from Bristol, UK - Dales Gorge Uploaded by PDTillman, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=30889569

# Life: an ongoing geological process

*By* **Alfonso Blázquez-Castro**

*"We are the representatives of the cosmos; we are an example of what hydrogen atoms can do, given 15 billion years of cosmic evolution."*

*"We're made of star stuff. We are a way for the cosmos to know itself."*

Carl Sagan

Many will raise an eyebrow after reading the title of this essay. Is life about rocks? If Geology deals with inanimate structures, then how can life be regarded as anything close to a geological process? I hope to provide some facts, examples and opinions that will prove that, indeed, life can be regarded as a

*Image on the previous page: Banded iron formation, Karijini National Park, Western Australia. Note the horizontal red and brown strata, the result of iron oxidation by oxygen and its deposition as sediments over millennia.*

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particularly complex geological process. However, one must not conclude from this that life is *just* an ongoing geological process. This is the devil in the details. Life, as said, is a very complex mix of different processes occurring at different levels. But, undoubtedly, it started as a geological process and proceeds, at some levels, as a geological process. In what follows, some ideas will be put forward briefly as to support this point of view about life.

**How did life start? Short answer: no one knows. What is true is that life started as the result of geo-chemical and geological processes.**

First things first: how did life start? Short answer: no one knows. What is true is that life started as the result of geo-chemical and geological processes. All the elements, except hydrogen and tiny amounts of lithium, making up living structures come from the stellar debris left after star explosions. Carbon, nitrogen, oxygen, phosphorus, sulfur, all are the result of nuclear alchemy that took place eons ago in long dead stars. The early Earth was made of these elements as were/are all living structures inhabiting the planet. The discussion of how life emerged on Earth is arduous and beyond the scope of this essay. Enough to say that a mixture of geological processes (lightning discharges, heating/cooling cycles, high-temperature chemistry taking place at underwater hotspots –black/white smokers-, etc.) were the prime movers for life to start and thrive (see image on Page --). The first living structures would hardly had been considered as living entities by most people: complex molecules leaning at the edge of life, carrying out endless chemical cycles and transformations, undergoing thermodynamical and chemical selection, driven by thermal, concentration and pH gradients. On time, indeed a long time, these molecules and structures arranged into more familiar “cellular” structures, proto-cells, that are our (great-great)$^n$ grandparents.

So, life started as a geological process. Then, evolved partially as a geological process. There is no indication, past or present, that some kind of dramatic process set life aside from geochemistry and geology. There was a continuity. Take, for example, the aqueous solution that fills every cellular organism. This solution is a reminder of how the primitive water bodies were when life emerged. Its salt composition and concentration were set some ~ 4,000 billion years ago. It has remained basically unchanged since then. The seas have kept getting more and more salty with the millions of years. Our cells, however, remember. Every one of us, every cell making us is a living reminder of the primordial waters. We carry billions of tiny fragments of a long-forgotten, long-gone ocean.

There are geological "structures" within our cells. DNA, for example, is a long string of phosphates and sugars from which the four bases are hanging. It can be considered a particular phosphate crystal, flexible and compactable, but at the same time regular and structured. A number of proteins require for their action the presence of different metals (iron in blood hemoglobin is a common example). These metals are arranged in coordination complexes, very similar to those we can observe providing color and chemical activity to some minerals, like sapphires, hematite or azurite. Even more incredible: there are semiconductors deep within mitochondria, the organelle providing energy to the eukaryotic cell. Everyone has heard about pyrite: fool´s gold due to its similarity to true gold in color and relatively high density. Well, how about having nanoscopic pyrite chunks inside your cells? This is the case for several types of proteins, iron-sulfur proteins, on charge of shuttling electrons to power the cells or to drive photosynthesis. These proteins display nanometric clusters made up of linked iron and sulfur atoms, almost in a crystalline arrangement (see image on Page --). In fact, there are proponents of an iron sulfide scenario for the origin of life, in which sulfide minerals provided the first templates and biochemical reactors from which organic life later evolved.

Then, it seems clear that we keep a lot of "geological micro-structures" as essential parts of our biology. But, how does it work the other way around? Does life affect geology on Earth? There are plenty examples of the impact of biological action on the planet. A dramatic one was the discovery of oxygenic photosynthesis and the release of oxygen to the oceans and the atmosphere. Starting around 2.4 billion years ago water splitting through photosynthesis led to the release of huge amounts of oxygen to the environment. This generated a massive extinction and adaptation period, probably an environmental pollution of a scale not ever seen in the planet, before or after. Oxygen was extremely toxic for organisms not adapted to

*White smokers, one kind of hydrothermal vent located deep in the oceans at crust hot spots. Likely places for the origin of life 4,000 billion years ago*

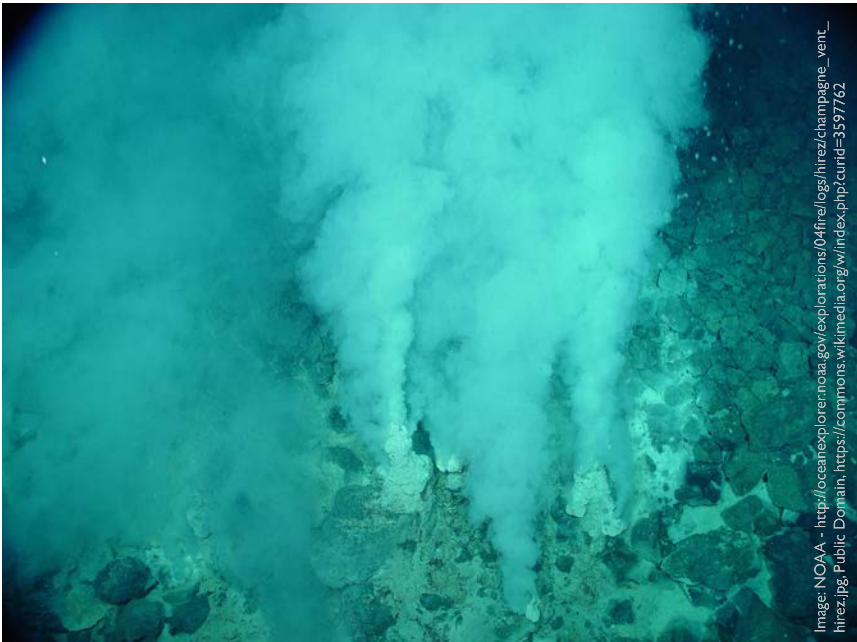
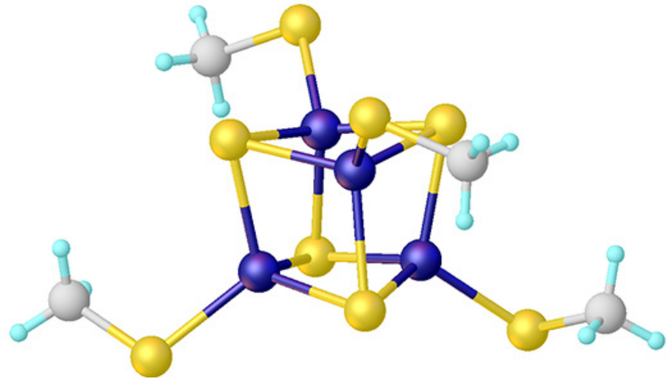


Image: NOAA - http://oceanexplorer.noaa.gov/explorations/04fire/logs/hirez/champagne_vent_hirez.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3597762



*Structure of $[Fe_4S_4(SMe)_4]^{2-}$, a synthetic analogue of 4Fe–4S cofactors found in several iron-sulfur proteins. Notice the crystalline structure, very similar to pyrite. Blue: iron atoms, yellow: sulfur atoms.*



it. Until some learnt how to survive it life was seriously threatened for extinction by its own chemical waste. A lesson to be remembered. Finally some organisms not only adapted to it, they harnessed oxygen to provide much more energy for their metabolisms than any other source before: the road for complex, multicellular, active organisms was paved. But this oxygen wave brought an oxidation on a planetary scale. Billions of tons of metals and minerals were oxidized, forever changing the composition and geochemistry of the surface of the planet. The banded iron formations are a testimony of those events which changed iron chemistry, for example (see image on Page --). Oxygen also changed the atmosphere. Among several effects an ozone (triatomic oxygen) layer was established in the stratosphere. Most people are aware of the protective role of this layer (life inadvertently protected itself from ultraviolet radiation with the help of oxygen, but also protected the geological structures of the planet by reducing the photochemical weathering of such radiation), and that life needs the ozone layer to thrive. What is not common knowledge is that the ozone layer also changed the vertical temperature profile of the atmosphere. With the ozone layer there is an atmospheric region (between ~20-50 km) where temperature in fact increases with height (the opposite to the usual). This leads to a thermal anomaly that changed the atmosphere, atmospheric circulation, climate patterns and the weather. Again, on a planetary scale.

Different geological processes, like plate tectonics, depend on the amount of carbon available, mainly as carbonate minerals. These carbonates are in equilibrium with the amount of $CO_2$ in the oceans and the atmosphere. But $CO_2$ levels in the air and water change due to the action of life. There is a planetary breathing: inspiration-expiration cycles driven by the photosynthetic activity and the aerobic respiration of countless organisms, which every year significantly reduce $CO_2$ levels during the Northern Spring and then rise in coincidence with the Northern Autumn. Thus, the

## It makes little sense to try to understand this planet on dichotomist terms. It is not only that everything is connected, everything influences everything else.

available carbonates for plate tectonics and other geological process change along the year following this “Earth breath”. A similar process, with changing levels of methane, has been detected in Mars. Whatever it is of biological or geochemical origin is yet unclear.

Living activity changes the levels of a plethora of other chemical compounds. There is a carbon cycle, a nitrogen cycle, a phosphorous cycle. All of these change the chemistry and geology microscopically, locally, regionally, and planetary. Life and rock and water and air are interlocked and feedback one in the others. Every Spring in the Northern hemisphere the whiteness due to snow and ice changes to the dark shades of green of billions leafs. This heralds the increase in photosynthesis and the reduction of $CO_2$ levels. But it also warms up the planet because life reduces the planetary albedo (amount of light reflected by a body) by making the Earth darker. This additional heat drives winds and sea currents. It increases erosion due to more powerful winds. The erosion breaks down rocks and grains, making chemicals and nutrients available for life to grow on.

As the reader has guessed by now, the examples of this Geology-Biology continuum are enormous. It has been my intention to call the attention upon the fact it makes little sense to try to understand this planet on dichotomist terms, to stir reflection on these matters. It is not only that everything is connected, everything influences everything else. I feel this is very important if we are to really understand all these processes going around and inside us. If we are to fix the current environmental situation. As stated above, life should not be viewed exclusively as a geological process. But it has a lot of Geology in it. With its impact on so many planetary processes, it makes sense to consider it an ongoing geological process.

**About the author:**

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# How clocks shape our lives

## How important are circadian rhythms? If they are disrupted, can they really be problematic for our daily life functioning? Can circadian rhythms affect the trajectory of our very lives?

*By* **Lisa M. Wu**

Have you ever noticed yourself experiencing jet lag after flying across the world? Do you ever find yourself sleepier at certain times of the day than others, such as right after lunch? Your answer is probably "yes", because of the important role that circadian rhythms play in our daily lives. What are circadian rhythms exactly? Circadian rhythms are cycles of rhythmicity in our behavior, physiology and biochemistry that occur approximately every 24 hours. For example, melatonin tends to rise at night

Image: Adapted by CA from Scenic View of Mountains During Dawn by Simon Matzinger @pexels.com, Moon And Stars by Min An @pexels.com, Human head Silhouette Face @PNGFuel and Person Touching Black Two-bell Alarm Clock by Stas Knop @pexels.com

and then decline in the early hours of the morning. Cortisol does the opposite. It tends to rise in the morning and then decline over the course of the day. We also have rhythms in mood and even memory. Our activity even follows a 24 hour rhythm generally; we tend to be more active during the day, and less active at night when we are sleeping.

Circadian rhythms provide an adaptive mechanism for organisms to coordinate cellular processes, physiological functions, and behaviors with the predictable 24-hour cycle of light and dark on Earth. In mammals, our master clock is housed in the suprachiasmatic nucleus (SCN) in the brain. Light is perhaps the most important input from the environment for regulating our circadian rhythms. Light strikes intrinsically photosensitive retinal ganglion cells in the eyes that stimulate the SCN to communicate time-of-day information to clocks in various parts of the brain, and peripheral organs such as the heart, lungs, liver, and endocrine glands. We also have clock genes that regulate their own transcription and translation over 24 hours, and are important for a wide variety of other genes important to many bodily functions. Essentially, circadian rhythms prepare our body for rest at some times of the day and activity at others.

It is well known from highly controlled laboratory studies that circadian rhythms are very important for behavioral and physiological rhythms. These near 24-hour rhythms can be synchronized and aligned with the 24-hour environment via light. The question is, how important are these rhythms? If they are disrupted, can they really be problematic for our daily life functioning? Can circadian rhythms affect the trajectory of our very lives? Given the important role circadian rhythms play in all of our bodily processes, it is not surprising that disruptions to circadian rhythms can have numerous negative health effects such as increasing the risk of cancer, diabetes, and cardiovascular disease. But, what are the kinds of individual differences, life span changes, and disruptions that can impact us across our lives?

**Individual chronotypes**

Early chronotypes ("morning larks") rise early and are most active in the morning, but feel tired late in the afternoon or early evening. Late chronotypes ("night owls") are tired during the morning, but feel awake in the evening. Big deal? Why does that matter? Well, the typical "9 to 5" structure of society tends to favor the morning larks. What it means is that night owls need to get up when they really would prefer to be sleeping. Unfortunately, this has negative effects on their bodily functions. Melatonin release, which cues when bedtime is coming, will not be released until much later. Even the release of insulin that usually occurs in the morning will not occur so readily in evening types, putting them at greater risk of metabolic problems such as diabetes. What can happen is that night owls will be sleep deprived all week long and then try to make up for it in the weekends. Sleep quality is impaired, and their circadian rhythm will be less robust. In addition, if a person keeps changing their sleep pattern, then they can become socially jetlagged. Being socially jetlagged is associated with poorer health, worse mood, and increased sleepiness and fatigue. Each hour of social jetlag is associated with an 11% increase in the likelihood of heart disease. This effect is over and above getting enough sleep!

## Being socially jetlagged is associated with poorer health, worse mood, and increased sleepiness and fatigue.

**Negative health outcomes associated with lifestyle**

A number of lifestyle factors can negatively affect circadian rhythms and, in turn, health outcomes. One well-known risk factor for circadian rhythm disruption is shift work, which has been linked with a greater risk of cancer in some epidemiological studies. You may be thinking, "I don´t do shift work. I´m in the clear!" However, there are everyday situations that can increase the risk of health-related problems due to circadian disruption for all of us. Daylight savings is one example. The practice of pushing the clocks forward one hour in the Spring and back one hour in the Fall can hurt your health. The reason is that daylight savings creates a battle between the sun clock, our social clock (time to go to work and school), and the body clock resulting in disrupted sleep schedules that can increase stress hormones, boost heart rate and blood pressure, increase inflammation, and can even increase the risk of car crashes and heart problems. Indeed, this problem can affect such large swathes of the population that leading researchers in the field of circadian medicine (Roenneberg et al., 2019) recently published a position statement advocating for the abolition of Daylight Savings Time. If you still do not believe that 1 or 2 time zones matter, then consider this. In a study undertaken at Northwestern University in the US that examined players in 40,000 Major League Baseball games in the US over 20 years (Song et al., 2017), jetlag from flying east had significant negative effects on player performance. Eastward jetlag was worse than Westward jetlag. For those of us at AIAS, jetlag is almost an occupational hazard, especially if we attend conferences numerous time zones away or if we visit our loves ones across the world. There are documented negative effects of jetlag on health exacerbated by the number of time zones crossed. Generally, jetlag is associated with daytime fatigue, feeling unwell, difficulty staying alert and gastrointestinal problems. Thankfully, it is usually temporary.

Image: London New York Tokyo and Moscow Clocks by Pixabay @pexels.com

**Circadian rhythms across the lifespan**

You may have read recently that there has been a movement across many school districts in the United States and other parts of the world to move school start times to later in the day. Why is this? It turns out that adolescents tend to have later chronotypes than fully-grown adults and research supports the notion that delaying school start times may benefit adolescents´ sleep and circadian alignment. Indeed, our circadian rhythms tend to change across the lifespan. For example, as we get older, our rhythms tend to become flatter and less flexible. Over the age of 60, there is also a shift in preference towards morningness (morning preference) over eveningness. As we age, adjusting to phase shifts (particularly going back in time) is also much more difficult, affecting our ability to engage in different shift work schedules. Researchers have posited that these age-related changes may be associated with changes to the eyes as we age. For example, progressive yellowing and thickening of the lenses, changes to pupil size, and reduced responsivity to blue light may affect the amount of circadian-stimulating light we receive.

In sum, circadian rhythms affect all aspects of our lives in both big and small ways. Understanding the nature of these different factors can help inform policy-making in the workplace, education, and health care. Perhaps most importantly, circadian rhythms are a fundamental part of our physiology and behavior that tell us a little something about who we are as a species.

**About the author:**

*Lisa Wu is an AIAS-COFUND Research Fellow, and received her PhD in Clinical Psychology from Columbia University. She is a licensed clinical psychologist and researcher. Her research has focused on quality of life and survivorship issues in cancer patients, and the development of interventions to treat such changes. She has examined cancer-related cognitive impairment, light therapy to treat cancer and treatment-related symptoms, and the underlying biological and chronobiological mechanisms of the cancer symptom cluster.*

# Temporal Entanglem

## How Pasts, Presents, and Fu

By **Adeline Masquelier**

While rummaging through my field notes a month or so ago, I came across a newsletter someone (probably a friend) gave me during one of my recent trips to Niger. Entitled *Echo des jeunes* ("Echo of youths"), the 10 page-publication features a number of short articles and reports as well as a brief history of postcolonial Niger. What caught my attention—and in all likelihood, what prompted the "friend" to give me a copy of the newsletter in the first place—was the short graphic vignette on page 3. The vignette features a Nigerien couple—rural dwellers, judging from the farmer's hat the man is wearing—who finds out that their young daughter Zara, who has been entrusted to a tutor in the city so she can attend school there, is mistreated. The couple just received a letter from Zara's teacher informing them that Zara is "treated like a slave" by her host family. Zara's father, who sold two cows to pay for Zara's room and board in town, is furious. He decides he must find another tutor for his daughter, one who will support and encourage her so she can do well in school and fulfil her aspirations. The vignette is entitled "Girls' education, the fight for development," suggesting that in Niger national development is contingent on girls' education. In other words, Niger can only advance as a nation if Nigerien girls are sent to school and become confident, resourceful, and goal-oriented women who contribute to the country's economy while helping raise the next generation of self-aware, entrepreneurial citizens.


Marcos Elias de

In recent years, I have started examining education, or rather the experience of schooling, in Niger through the lens of temporality. Now, modern schools are typically understood to be infrastructural "paths" to the future. In the Global South, in particular, schools

# ents:

## tures Interlock in Niger

Oliveira Júnior

are described as institutions that, by breaking with traditions, nurture aspirations and sustain hopes of prosperity yet to come (Stambach and Hall 2017). Rather than focusing on the shared past, they constitute incubators of a common, and importantly, preordained future. As we shall see, however, the mass possession (or, as physicians call it, the "mass hysteria") of Nigerien schoolgirls calls into question the notion that modern schooling entails a "complete break with the past" (Meyer 1998). When spirits suddenly irrupt in the classroom demanding redress for past injuries, the past is experienced as "imperfect" (Lambek 2002), in the sense that is it both incomplete and unruly. In what follows, I point to the limitations of models based on sequential, irreversible temporalities for describing how people in Niger inhabit time.

A number of social theorists have recently come to reject the conceptual primacy of "the future" (Berlant 2011; Edelman 2004; Goldstone and Obarrio 2016) while others have disrupted our models of linear time and progressive history (Chakrabarty 2000). Drawing on their insights, I suggest that rather than seeing schools in Niger as operating on a rigidly normative temporal trajectory, we consider them as instances of temporal entanglements. The "time of entanglements," Achille Mbembe (2001) argues, is not a linear series of events in which each moment annuls and replaces the moments that preceded it. Instead it is an "interlocking of presents, pasts, and futures that retain their depths of other presents, pasts, and futures, each age bearing, altering, and maintaining the previous ones" (Mbembe 2001: 16). Additionally, this time is made up of disturbances—what Mbembe (Ibid.) calls "a bundle of unforeseen events"—and is not irreversible.


*"I take my daughter to school, it's my duty. Do the same."*

In Niger, the least educated country on the planet, not all children attend school. Significantly, those children who will never see the inside of a classroom are more likely to be girls. Despite the government's commitment to gender equity and the array of legal instruments, strategies, and policies initiated by multilateral donors, there remains sizeable gender disparities with regards to educational opportunities and outcomes. While female primary school participation rests at just over 50 percent, the literacy rate for women between the ages of 15 and 25 is less than 25 percent. Predictably, the poorest girls are least likely to complete primary school. In the global effort to combat social inequality and narrow the gender gap, international organizations, such as the World Bank, have adopted a school-to-the-rescue model of development that casts girls' education as the pathway to individual empowerment and a critical tool of economic growth.

The catch-all term "girls' education," it is worth noting, refers to a knotty set of issues centred on the empowerment of girls and women. It encompasses questions of gender equality and access to education as well as broader problems, such as the alleviation of poverty. Like other pamphlets, posters, and sensitization messages I have come across in the past decade, the vignette about Zara's struggles is meant to inspire Nigerien parents to do everything they can to ensure their daughters receive adequate schooling. By presenting the case of an ordinary farmer who firmly believes his daughter "must succeed just like every other girl in the country," the vignette encourages other parents not to give up investing in their own daughters' education when obstacles surface.

Scholars have observed that schooling everywhere is associated with a specific set of hopes, dreams, and desires. The mission of the girls' school my three daughters attended in New Orleans, our hometown, is captured by a logo that reads: "Today's Girls, Tomorrow's Leaders." Schools are where futures are imagined and nurtured. In Niger girl's education is frequently presented by development agencies as an engine of progress. Educational campaigns financed by bilateral donors routinely extoll the benefits of sending girls to school. Parents are told that girl's education matters. In public spaces, posters show responsible fathers who drop off their daughters to school and encourage other parents to do the same. "Nothing has more impact on a nation than the education of girls," reads the adage printed in the right-hand corner of page 3 of *Echo des jeunes*. Education is touted as the solution to a number of societal problems, including poverty, underdevelopment, and gender inequality. The lesson to be learnt from the vignette, then, is that it is not only Zara's future, but also the future of the country, that is at stake.

This model of education is based on the assumption that hard work and commitment are the key to individual success. Accordingly, students who make school their priority are a step closer to achieving their dreams. Yet the myth of meritocracy obscures social and gender inequalities as well as other challenges students, especially girls, face. It takes more than diligence and determination to succeed in school, as Niger's education statistics reveal. Take retention rates, for instance. While more Nigerien children than ever are currently enrolled in primary school, thirty percent of these children will eventually drop out before they reach middle school. And more will drop out before they reach high school. The problem is particularly acute for girls. Only one out of ten girls ends up in high school. The large majority of girls who make it to middle school abandon their studies around the time they turn fifteen. Adolescent girls face enormous pressure to conform to pious models of Muslim femininity and domesticity and many of them leave school to marry and start families (roughly 50 percent of Nigerien girls are married by age fifteen). For those who are expected to contribute significant labour to the household, academic requirements often compete with domestic duties (as the case of Zara demonstrates, girls are easily exploited). For yet others, sexual harassment at school or on the way to school is the main obstacle to the continuation of their studies.

What these all too common scenarios suggest is that girls' educational trajectories are easily derailed. Girls may well dream of becoming teachers, lawyers or doctors, but in contexts where low retention rates remain unaddressed, the overall quality of education has worsened, and inequities have deepened, with the poorest and rural children least likely to attend school, such dreams often remain out of reach. In impoverished countries like Niger, the promise of education dangled by politicians, development workers, and rights activists often turns out to be "cruelly optimistic" (Berlant 2011).

There is a less visible yet nonetheless troubling sign that the future promised by education is severely compromised for some girls. In recent years significant numbers of adolescent schoolgirls have become possessed by violent, rash, and vindictive spirits who claim to have been wronged in the past. Possession is often contagious. Minutes after a girl shows signs of being overtaken by an invisible force, others in her vicinity will exhibit the same symptoms. These incidents have raised concerns about school safety and prompted questions about the place of secular education in an overwhelmingly Muslim society. Aside from disrupting school activities and, in some cases, leading to the momentary closure of schools, possession (or "spiritual attacks" as people call them) often forces the victims to abandon school—their affliction is simply too incapacitating.

During exorcisms performed to free the victims of their tormentors, the spirits reveal how they were displaced when the trees they inhabited were felled to make room for schools. They now grieve for their lost homes. By reappearing years later to broadcast grievances, they force people to confront a past that never ends. At another level, the spirits' tales of eviction point to a broader history of iconoclasm aimed at purifying Islam from unwarranted innovations. In the past century Niger witnessed several waves of religious fervour that resulted in the progressive erasure of spirit-centred practices. Spirit possession, once a central dimension of health-seeking practices and a popular form of entertainment as well as a wellspring of political resistance, became progressively vilified as a source of immorality and an index of backwardness.

In schools known to have been the site of spirit possession incidents, the presence of spirits (despite the effectiveness of purification rituals, one can never be sure the spirits have left) is generally understood through the lens of the past—a past that puts constraints on the present. People speak of schools as haunted. Teachers warn students not to visit spots suspected of being "infested" with spirits. In sum, the past is frequently evoked in the form of a looming menace that periodically invades the present. Of course, one never knows when the spirits will strike, but spirit attacks are nevertheless anticipated as the inevitable offshoots—the never-ending ripples—of a violent, iconoclastic past.

**In sum, the past is frequently evoked in the form of a looming menace that periodically invades the present.**

I once visited a middle school in July. It stood silent and empty, devoid of the laughter, babble and animation that would have filled the air during the school year. I was cautious to avoid the beans stalks that had been planted at regular intervals across the entire schoolyard (during the rainy season people grow food everywhere they can). My guide, the head of the school's parent association, was more worried about inadvertently disturbing a spirit. He proceeded guardedly, warning me to follow him and not go near the latrines (latrines are perceived as particularly dangerous since spirits are known to congregate in "dirty" places). I felt at times like I was walking in a minefield. In the end, we stopped by the water pump where, a year or so before, a girl had been attacked by a spirit, setting off wild pandemonium among the rest of the students (several additional girls were possessed) and forcing the authorities to momentarily close the school. Before we left, the man pointed to the wall surrounding the school, and in the distance, I noticed that a part of it had collapsed. He told me that the youths of today were brash, undisciplined, and often reckless: "They have no respect, these delinquents. They jump over the walls and they shit in the schoolyard. I used to go to this school. Back then it was a nice place. Kids would never dare do such a thing. This place is going to the dogs."

To do justice to the stories of hope and failure, nostalgia and haunting that I have collected over the years about schools, spirits, and adolescent girls, one must let go of the notion that time unfolds in a sequential, unidirectional fashion. When raging spirits take possession of schoolgirls to make it known they were displaced from their homes, a troubled past is uncovered that stubbornly refuses to go away. In her work on imperial formations, Ann Stoler (2008: 196) invokes the concept of ruination to register the "protracted quality" of damages to bodies, landscapes, and relationships. From this perspective, the spirits' expulsion may be described as a single event, but it is more accurately captured through its multiple, diffuse, enduring effects. After Mina, a seventeen-year-old girl I knew, became possessed by a spirit in the classroom, she was never the same. Her mother took her to a number of healers and spirit mediums, hoping they would make her better. Mina kept having terrifying visions. She slept poorly and did not eat much. She was afraid of leaving the house and refused to see visitors.  After a while, her friends stopped checking on her. She never stepped foot in school again.

By interrupting school life and the victims' educational trajectories, spiritual attacks uncover the imperfectness of the past—a past that refuses containment—while putting the accent on the tyranny of a projected futurity over the here-and-now—the kind of ideology of progress that is at work in Zara's story. The oppressive logic that governs the promise of a better tomorrow is what Elizabeth Povinelli (2011) calls the "future perfect." As an aspirational mode that frames current hardship as the necessary precursor to futurity, the future perfect demands sacrifice, such as the investment poor Nigerien parents make in their daughters' education to secure a redeeming future—recall the two cows that Zara's father sold so she could go to school. In a very real sense, Nigerien schools can be said to be haunted by both the violence of the past and the promises of the future.

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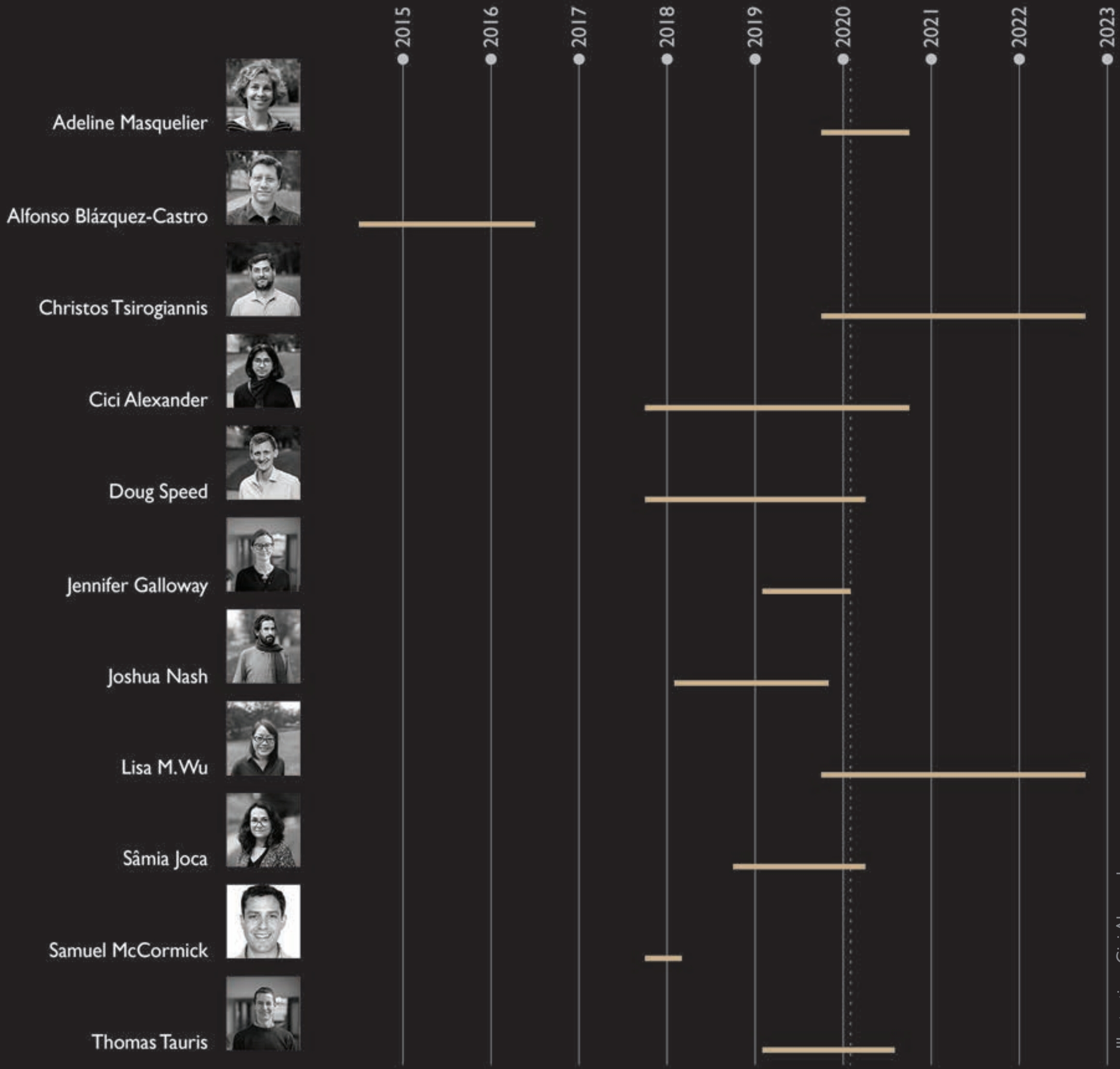


Illustration: Cici Alexander

# The Origin and Destiny of LIFE

## PROGRAMME

### Presentations

**Thomas Tauris** | Life in Space

**Jennifer Galloway** | Earliest known life forms and what happened thereafter

**Søren Rud Keiding** | Water and Life

**Kei Hiruta** | The Meaning(lessness) of Life: Suicide, Death and Non-existence

**Jennifer Galloway, Cici Alexander** | Six blind women and an elephant

**Ton Otto** | Asking big questions by curating exhibitions: The time travelers at Moesgaard Museum

**Christos Tsirogiannis** | Is the truth out there? References in ancient texts and some thoughts on our future

**Lisa M. Wu** | Circadian Rhythms and the Life Span

**Hale Güney** | Can different religions live together in harmony?

### Discussion Topics

I. Prospects for future life on Earth
*Human population growth, resources, pollution, religion, war, ...*

II. Information overflow and the human brain
*Can we cope with the enormous data flow? Is a hybrid brain/computer the future?*

III. How should mankind respond if contacted by extraterrestrials?
*Assume an encoded light signal is received, should we answer back?*

IV. Will life develop automatically, or is God needed?
*Is it simply a matter of a supply of the right chemical elements and conditions?*

?

What is Life?
How did it originate?
Life on other planets
God
Population Explosion
Nuclear Weapons
Technology

**Date**
29 November 2019

**Venue**
Aarhus Institute of Advanced Studies (AIAS)

**Organisers**
*Thomas Tauris*
*Samia Joca*
*Cici Alexander*
*Jennifer Galloway*


*A word cloud generated from the articles in this issue of iPerspectives at https://wordart.com/*

*Images*

*Front Cover: White flocculent mats in and around the extremely gassy, high-temperature (>100°C, 212°F) white smokers at Champagne Vent Source: NOAA - http://oceanexplorer.noaa.gov/explorations/04fire/logs/hirez/champagne_vent_hirez.jpg*

*Back Cover: Miniature représentant l'Ascension du Christ dans le sacramentaire de Drogon between circa 845 and circa 855 Ascension, sacramentaire de Drogon.jpg Source: Bibliothèque Nationale de France*

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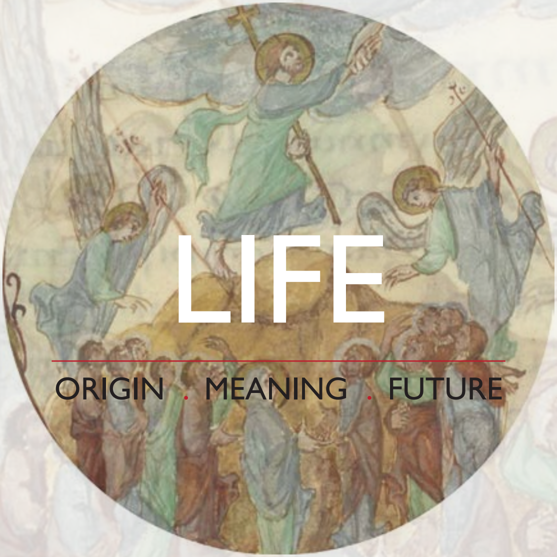

# LIFE

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