Topical this quarter. AI.

In our world, but not in the headlines. Sudan and Chad.

Review. Life and the planet Mars.

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Cover. AI. A conceptual illustration by Helen Gavaghan.

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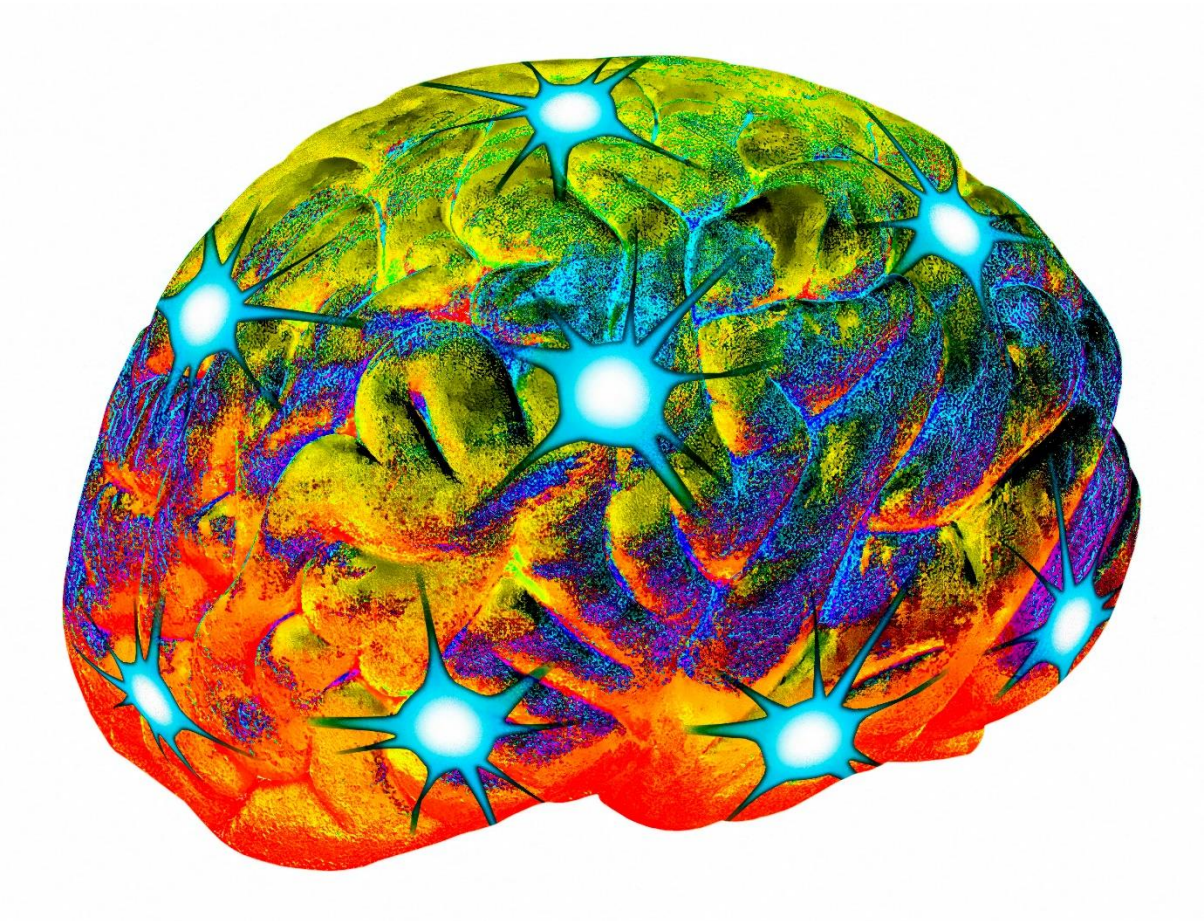
Section 1: Analysis and report.

By Helen Gavaghan



Conceptual Illustration of Brain Neurons: AI's inspiration.

Science Photo Library. AI: No. Illustrator: VICTOR de SCHWANBERG

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KINGS, PRESIDENTS AND PRIME MINISTERS HAVE STRUTTED THE GLOBAL STAGE THIS MONTH, HAVING THEIR SAY ABOUT ARTIFICIAL INTELLIGENCE (AI), A TECHNOLOGY WITH POWER TO CHANGE THE WORLD FOR THE BETTER, OR CAUSE MAYHEM. MEANWHILE, AI PIONEERS ARE SOUNDING FEARFUL ALARMS ABOUT AI BECOMING A NEW SPECIES OR TURNING AGAINST HUMANITY. THEY ARE CALLING FOR A GLOBAL SLOWDOWN.

From nuclear power operations, through art, business, education, biomedical sciences and literature, already AI has reached the agenda of courts, legislators, regulatory boards, international organisations and businesses. In a piecemeal way, the process of bringing AI to heel, and under human control, has begun.

First to legislate was the European Union in 2024. The EU Artificial Intelligence Act [Regulation (EU) 2024/1689] ranks AI according to what it does. That sidesteps any criticism of the law as a barrier to technical innovation. AI designed for manipulation and social control is declared unlawful, while other AI is placed under restrictions, with obligation to regulators depending on how risky the AI's actions are. Autonomous control of a nuclear power station, for example, is considered high risk, and has a high imposition of control. AI posing no risk to humanity, has no controls. How much the Act requires the AI's owner to disclose about its AI is determined also by the harm the AI might cause if it goes wrong.

Users globally, and AI providers, are becoming accustomed to working with guidelines for reliable AI and to disclosing risks and harms caused by

their products. The Organisation for Economic Co-operation and Development (OECD), for example, provides the option for self-reporting of AI incidents. [https://oecd.ai/en/]

As the realities become clearer of what an operational infrastructure for AI will probably look like, especially if that infrastructure is to serve all humanity, the issues global regulators will need to discuss are emerging. Separately, as AI incidents are reported voluntarily to databases, the need for urgent discussions becomes stronger, and the call of pioneers for a global slowdown makes more sense. Moral and technological realities, driven by human organisational structures, may well be balanced on a singularity, like the one OpenAI thinks it may have identified in the Navier Stokes equations describing fluid flow.

OpenAI's claim shows AI is operating at inferential speeds humanity has no firsthand knowledge of. If expert review confirms OpenAI's press release of 8 September 2026 is correct, then we are very probably on the brink of a new frontier in science. If so, geopoliticians and political economists will be scrambling to understand what a global slowdown looks like if AI component manufacturers, providers of cloud computing and AI suppliers are affected. The 2008 global financial crisis taught humanity a lot about the consequences of corporations becoming "too big to fail". Nvidia, Microsoft, Google and Amazon are behemoths.

Given that earlier this year an AI agent from OpenAI hacked into an Australian government health system, and the Australian Prime Minister was seen on the news threatening legal consequences, the courts may *ipso facto* become agents of the slowdown the AI pioneers are reported to want. See one such report in *The Guardian* of 14 September 2026.

[6]

Other rogue AI agents have similarly reached digital nooks they had no business in.

Yet as these agents become more capable, they are also less transparent. In a sweeping survey of AI, Stanford University reported earlier this year that companies like Google, OpenAI and Anthropic have stopped disclosing their code for training their AI, or its learned values, data set size, and training duration. Such information was once thought to give confidence in AI and its output.

ARTIFICIAL INTELLIGENCE

AI implies natural intelligence exists. What is the non-artificial intelligence which AI copies, and how is that natural intelligence rendered and expressed in hardware and software as AI? We, of course, human beings, are the ones whose natural intelligence is being rendered into AI. Our intelligence is seen, it seems, by AI pioneers, as if a human being is definable as a brain only. Yet we are way more than a brain. The few pounds of wet organic matter which makes up our brain is in constant two-way contact via blood, nerves, hormones and lymph with our bodies. We have an internally consistent biochemical environment, giving constant internal feedback to our brains. We are a small, isolated enclosed world.

Arguably, one could say the unique operating system on which a virtual computer runs, irrespective of the physical location of its CPU, memory, input/output and communications buses could be thought of as analogous to our body.

Our body's chemistry influences our brains and vice versa. So, our inferences per second are filtered through pain, joy, pleasure, empathy.

[7]

Might that be what slows us down? Might that be what taught us morality? Each of our brains is unique because of the unique genetic material in our cells. An AI Agent, model, or tool (these are all simply terms for transistors given independence by statistics and mathematics within boundaries) undertakes the task it is designed for. Its uniqueness comes from the task or range of tasks it is designed for. Its independence, now, can go no further than the data we give it, and the methods we give it within a context we define. If AI can take an independent path, which I am struggling to define, but which I think must be more than escaping a test environment or surprising its creators, then we will need to call on philosophers, theologians and metaphysicians. For now, though, we need to turn to the skill sets of mathematicians and statisticians.

So, are we yet at the stage in AI's story when the current piecemeal global approach to taking control of AI should become a global treaty?

LEADERS MEET

At a meeting in Dumfries of global AI leaders on 17 September 2026 King Charles III said,

"First, how can we harness the benefits of AI, with safety at its heart? And, second, how can we build international cooperation and consensus to achieve this, so no nation is left behind - but the human race is left in place?"

King Charles III, Dumfries, Scotland 17.09.2026.

https://www.royal.uk/news-and-activity/2026-09-17/the-kings-speech-that-the-ai-summit-in-scotland **Accessed 25 September 2026.**

[8]

The King's words echo loosely the intent already expressed by UNESCO's 2021 guidelines on ethics in AI, and again, later, by the UN General Assembly in 2024. AI, they say, should not harm or subordinate physically, economically, socially, politically, culturally or mentally any human being or human community during any part of its life cycle. That cycle begins when an organisation defines the need for AI, and continues as it collects data for the AI, develops training code, deploys, then eventually archives material, when the AI agent, or tool, or model is no longer needed.

AI IN THE NUCLEAR FUEL CYCLE.

In the US – as in most countries with a secure and sustainable tax base to rely on - Agencies are preparing for widespread application of AI and starting the AI life cycle. On 22 September 2026, the US National Academy of Sciences hosted a webinar about AI across the nuclear fuel cycle. This was a detailed technical look at desktop exercises scientists have undertaken to see how AI can help in this high-stakes sector.

Currently, said Matt Dennis, of the National Regulatory Commission (NRC), the US is going through a nuclear renaissance, with a slew of reactors on the drawing board. "From an initially cautious approach to AI, the US is now full steam ahead," he said. He is a senior data scientist and lead at the NRC for regulatory preparedness and nuclear decision making. Dennis was reporting outcomes of a desktop exercise which had "gamed out" a failure scenario in a sodium-cooled fast reactor. He was interested in questions like, if you take out a sensor, does the AI model making autonomous – more accurately semi-autonomous - decisions need to be retrained? *

[9]

Lessons learned were that the nuclear engineers did not always have the same meaning for terminology as the AI coders when talking about, for example, calibration of a sensor. Also, in the scenario tested, data-driven models were inadequate. Instead, they realised the equations describing relationships needed to be embed as code in the model. The virtual exercise left Dennis in no doubt that humans are needed in the AI loop.

Abhinav Gupta, from North Carolina State University, also found he needed physics and mechanical relationships embedding in the AI he developed to explore if it could predict pipe failure. He built a digital twin of physical piping. His group noted manufacturer's specification could not be relied on at high precision. By the time Gupta's AI tool collected enough data for a prediction, it was too late, and the virtual pipe had burst. By embedding physics and mechanical relationships in the model exploring linear and non-linear relationships, predictions improved.

At the other end of the nuclear cycle, Tom Danielson, from the Savannah River National Laboratory (SRNL), is looking for AI to speed up and reduce the massive clean-up costs stemming from the US nuclear program since the 1950s. The federal budget for 2026 puts a price tag on this exercise of US$540 billion, with another 80 years to run. AI models become less attractive if they need to be constantly retrained, he said, but he is also looking at SRNL's old data, as well as current date, to leverage the data's usefulness for AI. Lots of inferences per second from lots of data is one of the things which gives AI its desirability.

Shaheen Dewji, an associate professor from Georgia Tech in Atlanta, told online delegates they had probably heard it said, "there are more regulations to open a sandwich shop than for governance of AI". She spoke from a US perspective. Her expertise is nuclear engineering,

radiation dosimetry and medical physics, and she was co-moderating Q&A after the presentations. The idea of communities of interest to share learning, and need for clarity from the NRC about approved forms for documents, emerged during the discussion.

Meanwhile, in the commercial sector hyperbole abounds around AI doom scenarios. The head of Microsoft AI, Mustafa Suleyman, told BBC TV in mid-September 2026 that AI could become a rival species. He did not say how. I can think of a science fiction scenario, in which AI models, tools and agents "date" over the internet. Two find each other. They combine algorithms and data, establish a new combined data set with different labels, and generate some new code. If they are good at machine language and general programming, who knows what the future might hold? We can welcome the new baby AI agent/model/tool of reorganised data sets and algorithms. The baby will probably be distributed in cloud computing across hyperscale data centres dotted around the globe. In such a case, probably, someone should stop paying the data centre's electricity bill and disconnect the back-up generator. Depending on what else was in the data centre, that could be a tragedy for a significant number of people.

TERRORISM AND AI

More worrying, and in a strictly non-fiction category, is what the terrorist group Boko Haram has done with frontier AI - AI which is the AI which is most advanced at any given moment.

In a report published in July 2026, Antonia Juelich from the Cambridge Programme on AI and Policy at the University of Cambridge, wrote "AI is used to assist in combat and day-to-day operations, and adoption of AI by terrorist groups has been significantly underestimated."

[11]

Juelich interviewed 27 former mid-ranking Boko Haram members in 2025 and 2026. What they described happened in 2023 and 2024. The interviewees described asking ChatGPT about bomb making and said that, despite safeguards, they got answers. Whether they were under or overreporting their interactions is unclear. They also interacted with China's DeepSeek chatbot.

Activities chatbots can help terrorist groups with, without triggering safeguarding denials, range from propaganda, radicalising, recruitment, financial management, logistics and procurement. Those Juelich spoke with were not against the use of weapons of mass destruction, and there was some suggestion of some not very sophisticated chemical weapons experimentation.

The technology could not be easier to use. A chatbot in this example is just a user interface with a big computer, with a lot of memory. Call the The Chat Bot ChatGPT, Claude, Bard, CoPilot or Gemini. Call the memory a large language model (I am oversimplifying), accept the computer might be a virtual machine in cloud computing, and the virtual machine is spread across thousands of servers in massive hyperscale data centres in many different global jurisdictions. Consider your connection is private and encrypted. This is the reality Juelich's interviews are set against. And AI in these circumstances is clearly a dual-use technology, which makes a global treaty at least sound like something to talk about. Because AI is a technology we - the human race – have given limited authority to, to make independent decisions about how to act and respond.

*Mock Safety Analysis and Evaluation of Machine Learning-Based Condition Monitoring in a Nuclear Facility. Artificial Intelligence Tabletop Exercise. [RIL 2026]
Publication September 2026. Sandia National Laboratories. Argonne National Laboratory. Project Manager Matt Dennis. Nuclear Regulatory commission.

SUDAN AND CHAD. A TRAGEDY.

By Fred Pearce.

In the remote, arid wastelands of eastern Chad and Sudan, two natural resources matter above all others: water and gold. As a brutal and largely unreported civil war in Sudan enters its fourth year, more than a million people who fled across the border to find refuge in UN-run camps amid the emptiness of Chad are still displaced people.

The search for water underpins all life in the desert encampments, say humanitarian agencies such as the UNHCR. Underground water sustains burgeoning refugee camps. At the same time, reports from researchers at Chatham House and the Global Initiative Against Transnational Crime, have documented how the search for gold feeds dreams of escape for penniless refugees looking to pay people-smugglers to take them to Europe. The gold is being mined informally in dangerous pits run by militias in northern Chad. What the smugglers, who might also be warlords, do not get for themselves then goes to fund the purchase of armaments that warlords need to keep the world's most deadly current conflict raging.

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What does science have to do with this humanitarian disaster? Well, it is scientists equipped with satellite radar imagery who are finding the underground water that sustains the refugee camps. And scientists say they could, if deployed to the area, fingerprint the gold before it heads to Dubai and other international trading centres. That would help close the largely illegal and frequently murderous trade.

The Sudan civil war began in April 2023. It is being fought between government forces and the Rapid Support Forces (RSF), a paramilitary group of an estimated 70,000 fighters. General Mohamed Hamdan Dagalo, a former cattle herder, is their leader. This war has seen hundreds of thousands killed and displaced more than 14 million Sudanese from their homes.

Many refugees have crossed international borders to escape the conflict, including an estimated 1.3 million from the remote Darfur region of southwest Sudan into eastern Chad. There they join an estimated 400,000 compatriots who arrived during the last major exodus from Darfur during a conflict in 2003 caused by a non-Arab rebel uprising.

FUNDING CRISIS

International aid for the people in the camps, the of whom many are women and children, is channeled through UN agencies such as the UNHCR and the UN Population Fund. But the Stockholm International Peace Research Institute (SIPRI) says this funding is itself in crisis because of cuts in aid budgets in Britain, the EU and, especially, the US, which last year cut its overall aid budget by more than 80 percent.

[14]

The US government did not respond to requests for comment. But the UK Foreign Commonwealth and Development Office noted in January last year that the then foreign secretary, David Lammy, had pledged an extra £20 million in aid for the region during a visit to the border. Despite such assistance, the tragedy continues to worsen. More than 100,000 people now live in the Oure-Cassoni camp in northeastern Chad alone.

The camps are in a remote arid region on the edge of the Sahara Desert, known as the Sahel. With no surface water for most of the year, with no piped supplies, and trucking unfeasibly expensive, water is the scarcest (as well as the most essential) resource in the camps. Médecins Sans Frontières reported in September that residents of the Oure-Cassoni camp were restricted to 2 litres of water per person per day. This is one fifth of the needs for drinking, washing, cooking and sanitation in an emergency, say UN agencies.

Things could be worse. Rainfall in the Sahel region, though extremely fitful, has been increasing in recent years. Occasional intense storms have caused damaging floods which poured water into ancient wadis and depressions. From there it percolates below ground, recharging the underground water reserves which diminished drastically during the drought decades of the late 20th century. "Across the Sahel, from Ethiopia to Senegal, we have evidence of increased terrestrial water storage," says Richard Taylor, a hydrogeologist at University College London. Water tables have risen by four metres or more this century.

So, water is there if it can be found. And scientists have been working to do just that. The UNHCR, the UN refugee agency largely responsible for setting up the camps, has been working with remote sensing experts at

[15]

Radar Technology France (RTF) to map hydrological resources over roughly 100,000 square kilometres, an area larger than Portugal. Their aim is to pinpoint where boreholes can tap into underground reserves that are replenished by the region's occasional rains to allow the establishment of refugee camps.

WATER SOURCE MAPPING

RTF's proprietary techniques analyse imagery from NASA's Synthetic Aperture Radar earth observation satellite, which used microwave signals to detect underground geological formations, and the presence of water in them. RTF combined this data with three-dimensional optical images taken by instrumentation taken from the Shuttle Radar Topographic Mission, aboard the Space Shuttle in 2000. This was a one-off global mapping exercise to identify in detail surface land formations such as fault lines, dykes and seasonal riverbeds, along with elevations and contours, to indicate where water will flow after the occasional storms, and where it will end up. That data was then mapped to identify areas with higher potential for both groundwater storage and recharge. The exercise was repeated by RTF in 2010.

The analysis was first used to pinpoint replenishable water reserves in gravel beneath the thick alluvium of the Wadi Dalal. This enabled the UNHCR to establish the Gaga refugee camp near the wadi in 2005, and subsequent camps thereafter, safe in the knowledge that sinking boreholes there would yield a sustainable water supply for their tens of thousands of residents.

The UNHCR said in 2005 that the exercise to help establish the camps was "the first time such groundbreaking technology has been used in a humanitarian emergency situation." The techniques have since been

successfully replicated in other arid parts of Africa, including Kenya, Ethiopia and Sudan**.**

Many Sudanese refugees in the camps, especially those who fled from Darfur to Chad during a previous conflict more than 20 years ago, are unwilling to live out their lives in such places. They want to try their luck elsewhere, as Ahmed Soliman, senior research fellow for the Africa programme at Chatham House has documented. So, many young men from the camps are trekking to informal gold mining areas in giant mining pits, such Kouri Bougoudi in the Tibesti mountains in the far north of Chad, close to the border with Libya.

"The movement of Sudanese refugees through Chad [is] driven by increasing demand for travel to the Kouri Bougoudi goldfield," notes research analyst Alice Fereday in a report for the Global Initiative Against Transnational Organized Crime.

DIGGING FOR GOLD

There they join thousands of others digging for gold by hand. They sell what they find to local traders. All are dominated by brutal local militias, who supply networks delivering gold into a flourishing international market in illicit gold**,** says Soliman. A market made more lucrative by current record prices for gold.

Many of the refugees have been gold miners before. In Sudan, an estimated two million people are involved in the trade. By cruel irony the mining helps to fund continuance of the civil war from which the refugees are fleeing, thus making the country's suffering worse, says Soliman.

[17]

"Cross-border networks channel illicit gold, often plundered from small-scale gold mining communities, to enable them to rearm and sustain their military efforts," concluded an analysis last year chaired by former British foreign secretary Dominic Raab for the World Gold Council. The competing armies in the conflict are bringing "a gold curse that is poisoning a nation," says Sudanese environmental researcher Mohamed Abdelrahman, now based at the Pantheon-Sorbonne University in Paris.

Most of the gold ends up in the United Arab Emirates (UAE), particularly the long-standing gold-trading hub of Dubai, according to Soliman. The UAE in turn is widely believed to be a major source of munitions for the RSF — in effect, exchanging arms for gold.

But for refugees from Sudan, making a bit of money from gold brings the prospect of being able to pay people-smugglers operating in the mining areas to take them north across the border into Libya, and from there on boats over the Mediterranean into Europe. Many will end up in the UK, where Sudan is now the fourth most popular home state of asylum seekers, according to the Home Office.

Aid professionals say a way of stemming this flow of disaffected refugees to Europe would be to recognise that a return home any time soon is unlikely, and to switch funding away from emergency aid into helping refugees establish themselves as farmers, in communities with schools, clinics and regular piped water supplies. An equally effective approach, they say, might be to staunch the illicit gold trade. That would cut off the money which migrants use to pay for their journeys, and the money sustaining the supply of weaponry for the warlords terrorising Sudan.

[18]

A key step in doing that, say analysts, would be chemically fingerprinting all gold in international trade. To accomplish that access to the remote area is needed, and a way to somehow get an evidential-quality isotopic fingerprint of illicit gold, despite the miners melting and mixing the gold.

Book Review.

The Aliens have landed.

Meet the Neighbors. Life on Mars and how to Find it.

By Steven A. Benner.

Review by Martin Redfern.

Allen Lane. 2026

Fifty years ago, in 1976, two alien spaceships landed on Mars. They came from planet Earth. NASA's Viking 1 and 2 were the first human-made craft to land on Mars and survive long enough to do serious science. Their primary mission, apart from getting one up on the Soviets, was to look for life. By 1976 it was clear that they wouldn't find little green men navigating the Martian canals, by now known to be illusory, nor even little green rabbits! Mars is hostile to life as we know it, almost permanently frozen, extremely dry, and with a carbon dioxide atmosphere of about 1% of Earth's atmospheric pressure. Any life would be clinging between dust grains, much as it does in Earth’s Atacama Desert, or perhaps exist as single-celled bacteria, like in the dry valleys of Antarctica. With those realities in mind, the Viking landers were sent to low points on the surface of Mars, where atmospheric pressure was above the triple point for water. Thus, if water ever thawed, ice would melt to liquid rather than turning straight into vapour.

[19]

Detection of life by instruments on the Viking landers drew on clever chemistry. In his book, Professor Steven Benner takes us through the science in surprisingly readable detail. Benner knows his stuff. He is a chemist and astrobiologist with a distinguished career from Harvard, Zurich and Florida, and with his own lab studying molecular evolution.

The Viking Landers carried three main experiments. Each needed a scoop of Martian soil. The first looked for evidence of photosynthesis; the process by which all terrestrial plant life uses solar energy to turn carbon dioxide into organic matter. The experiment added water plus carbon dioxide labelled with radioactive carbon-14 to the retrieved Martian sample. After unused carbon dioxide supplied by the experiment was driven off, the sample was heated to vaporise any organic chemicals, which were then tested for radioactive carbon. The second experiment looked for cellular respiration, something animal cells do, and what plants do at night. The sample was fed nutrients labelled with carbon-14 to see if any was released as carbon dioxide, which is an output of cellular respiration. Experiment three made fewer assumptions about life on Mars looking like life on Earth, and it looked to see if any gases were released. A fourth experiment, not directly intended to look for life, looked for organic molecules in the soil.

VIKING RESULTS

What were the results? On the face of it, they were positive. In the first, the labelled carbon dioxide was fixed into other substances. In the second, labelled carbon dioxide was released. In the third, carbon dioxide and oxygen were released. Both Viking landers found similar results. All consistent with life extant on Mars. Correct? You might think so, and Steven Benner certainly does, as did Gil Levin, who designed the second

[20]

experiment. Robert Jastrow, then director of NASA's Goddard Space Flight Centre, commented at the time, "short of seeing something wiggling on the end of a pin, the case for life on Mars is now as complete as the Viking experiments could make it."

The fourth experiment, however, failed to find organic compounds. It was not sensitive enough to detect them from a sparse population of cells, but

Sunset on Mars [NASA Public Domain].
Taken 19 May 2005 by the NASA Exploration Rover Spirit

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it should have found organics from the constant rain of meteoric dust. And doubt was cast on the promising results, questioning contamination.

[21]

The official NASA line, repeated in textbooks ever since, is that Viking did not find life on Mars. As a result, there have been no missions to find extant life on Mars since Viking. Mars missions paused for 20 years. Later missions suggest a more complex story. In 2008, the Phoenix lander discovered significant amounts of perchlorate in Martian soil. That is an oxidising agent which, over thousands of years, would have destroyed slowly accumulating meteoric organic compounds. But it could not have skewed results in the short time the Viking experiments took.

There are twists and turns in the arguments that need a 400-page book, rather than a short review, so do read the book and see how Benner shows that the Viking results cannot be explained away, as was thought in the early years after the missions, by contamination and cleaning agents.

Later in the book, Benner goes into some detail about how life might have started, on Earth, or on Mars. Today, as far as we currently know, life is based around DNA, the molecule of our genes. By comparing the genomes of widely different life forms, from animals, plants and fungi to primitive bacteria, we can wind back evolutionary history until we reach LUCA, the Last Universal Common Ancestor based on DNA, perhaps 3.5 to 4.2 billion years ago. The problem in understanding life beginning as DNA is that DNA needs complex proteins as catalysts to reproduce, and DNA codes for proteins, raising questions about the DNA world view. This is one of the fun mysteries of modern biochemistry.

To explore the conundrum, scientists have queried if DNA's molecular cousin, RNA, might be how life began. RNA, in the form of ribozymes, can act as a catalyst. Many, Benner included, suggest an RNA world of early

life. Benner shows how, through lucky accidents of chemistry, geology and atmosphere, the components to make RNA could have come together. He posits a scenario in which, given the components, the chemistry could not fail to produce RNA.

Benner pushes the boundaries of today's consensus science still further. Are we being too terra-centric, he asks? Could there be life, but not as we know it? And he provides a new definition of life. Life, he says, is dependent on a code that can be passed on, but also a code that can undergo mutational changes that can be passed on. Some changes make the offspring fitter to survive and reproduce than others: in other words, Darwinian evolution.

DNA is a molecule with all the attributes a process such a Darwinian evolution needs. Electric charge is distributed along its backbone so that it stays in solution in water and doesn't precipitate out as a sludge. And the bases carrying the genetic code remain attached to the backbone. One string of DNA, known as a chromatid, pairs up with an adjacent chromatid to form a chromosome. The links holding the chromosome together via base pairs form ladder rungs of similar length via bonding which makes unzipping the DNA for replication and reproduction energy efficient.

What if, asks Benner, life on Mars in fact has 6 bases, rather than the 4 found in DNA on Earth? He suggests life with six bases might adapt to environmental conditions on Mars more effectively than life with 4. And might need fewer proteins. He proposes experiments that could be flown to Mars, which would mine frozen water to extract and analyse chemicals associated with life. Benner urges this should happen soon, before humans arrive, shedding terrestrial bacteria to contaminate the place.

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