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Molecules of Cellular Memory. What AI-Researchers and Pathologists Can Learn From?

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ABSTRACT

There is a science behind the development and storage of memory. There is a technology of recalling, retrieving, and utilizing stored 'information', that includes data, non-digitized information, knowledge, experience, and wisdom. We do not know either. Therefore, we have failed to develop memory in AI. However, even a single biological cell is aware of this science and technology of memory. Some molecules operate as substrates for memory. The cell applies this knowledge and technology in its day-to-day activities of the metabolomes, proteomes, genomes, and epigenomes through signalosomes, organelosomes etc. Intention-based holonomic memory communication between cells happens through exosomes or extracellular vesicles, even breaking through Weismann's Barrier.

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Introduction

Memory is important for intelligent behavior. Biological cells, and nature in general, have memory. According to Edo Liberty, "While AI models such as GPT from Open AI are trained on billions of pieces of data, they don't remember anything you show them or even anything they give back to you….AI models are stateless. They have no memory" (Edo Liberty, the Founder and CEO of Pinecone, 20th March, 2023).

In an earlier paper on memory, the first author raised the question of whether any kind of memory is possible in the absence of life? Our submission remains that without the presence of 'life', memory formation is not possible [1]. Take the evidence from a patient in the ICU on a life support system. Despite having intact brain-wares, not damaged completely by trauma or vascular insult, the patient cannot register any memory for this period if he/she ever comes back to 'life'. There is also no memory formation in unconscious patients when life's priority shifts from memory-making to other vital fronts.

In all kinds of life-forms, the substrates for memory are the molecules; chains of amino acids, proteins in their secondary, tertiary, quaternary, and spherical structure, coding and noncoding genes, and the constituents of the epigenomes.

Functions of Memory

Memory adds 'Time dynamics' to 'life', and maintains continuity of the past and the present into the future. Memory creates an 'identity' of the person. Memory forms the basis for thinking. Memory is essential for learning. Memory helps in intelligent decision-making. Memory helps one to reach one's ultimate source, which has enormous spiritual significance. Old memories might let one down, or push up during forward marching.

In contrast, AI cannot create its own identity. It can be trained on data, but it has no ability or intention to learn. AI, in the absence of memory, cannot participate in any intelligent decision-making! AI, although, cannot think has been wrongly considered to do the same. A biological cell, on the other hand, exhibits all such properties because of its memory.

Data Storage Capacity is Not Memory

AI researchers often mistake data storage capacity as memory, the propulsion of logic as thinking, and the ability to think as consciousness. Probably, these are the constraints of working on a lifeless robot. The distinction is based on the line between the living and lifeless entities.

Does your cell phone, computer, or AI-assistant remember what file it processed during the immediate or long past? No. It is you who remembers it. The devices might have a huge data storage capacity in terms of megabyte, gigabyte or terabyte etc., but it cannot recall, retrieve and use any such data as memory. In addition, such devices deal with only data/signal, not any other information states such as non-digitized information, knowledge (information-ensemble symmetry), experience (information-

manifold), and wisdom (information-crystal) [1]. In contrast to any robot, a biological cell can process all kinds of information-states as mentioned above, starting from signal to wisdom. Wisdom is scale invariant, operates across the system. Wisdom has a cost but it is most economical.

Further, data/signal processing is not synonymous to information processing. Memory forms when any device can process information, knowledge, experience etc.

Thinking is a Property of a Mind in Presence of 'Life' and 'Self'

AI researchers at present rely on the process of human thinking to derive their algorithmic logic. Loud and prolonged thinking has been their inspiration for introducing any change and improvement in their logic [2]. Logic is defunct without a supporting medium. Logic itself is not the mind, nor is the process of thinking. Logic is produced and monitored not by the mind, but by the self.

Sometimes, the very thinking process, even in the presence of 'life', may be illogical, resulting in a kind of directionless confabulation, and a waste of mental energy (intangible dark energy). Nil outcome from the mental process means no logic has worked. Logic is the outcome of the activity of 'self' through a productive mind. Mind, in turn, uses this derived logic for next productive thinking, abandoning illogical and unproductive thinking.

In a living system, the 'self' generates logic while 'life' generates logistics. The mind converts data/signal into a piece of information. The mind also operates as the organ of communication between two conscious systems. Therefore, the existence of the mind is in the duality. The mind has its boundary, which may be stretched up to the boundary of the universe, beyond which the duality melts into the nonduality of the *Essence* of the systems of the Multiverse, called The Multiversity. Like the boundary of the mind, the logic too can extend up to the boundary of the universe.

Thinking Process May be Unconscious Too

The mind could think in the presence of life. Both of them are nonlocal, non-observable and influential. The 'life' has outsourced the thinking properties to the mind, keeping to itself the ability to feel, to become emotional, and develop memory. To surface at the conscious level, a thinking process or a thought, has to cross three thresholds: the intent-threshold of information-state, the concern-threshold of the self, the CEO of consciousness within the system, and the willing-threshold of consciousness. Consciousness admits the matter of thought to its own level only when it 'wills' to do so. Data has no intention and therefore can never reach a conscious level. Data has to be converted into a piece of information by the mind, and only thereafter the generated intention starts playing in the scenario. However, Freudian unconscious thoughts could surface on 'consciousness' as dreams, during sleep. This phenomenon contradicts the theory of absence of consciousness during sleep [3]. Consciousness in the biological or cosmological system never sleeps [4]. Consciousness decides to allow any perception, idea, thought, or logic to reach its own level.

Three Systems of Our Body Usually Deal with Memory

Memory of the human being is in its nervous system, or in the human psyche. In the brain, the primary site of memory is the hippocampus. The seat for emotional memory is amygdala. However, there are views that memory storage inside the brain is holographic. Every synapse has every memory. In the systems psyche, episodic memory is stored with the self. Semantic memory with the mind, and emotional memory with 'life' [5].

Our immune systems have memory T cells and B cells, which maintain memory of DAMP (Damage Associated Molecular Patterns) and PAMP (Pathogen Associated Molecular Patterns). There is evidence of donation of telomeres by antigen presenting cells (APC) to memory T cells for making the memory cell's life specifically longer [6].

The evidence that the heart has a memory comes from a transplanted heart. The recipient is often reported to exhibit the memory stored in the donor's heart. There is a hypothesis on this memory stating the transplanted donor's heart takes over the brain-mind interaction of the recipient [7]. The author's personal view is that entrainment of the brain and the heart could happen by consciousness, and through information holographs, when the environmental memory of the donor's heart is recalled and retrieved in the recipient system [8]. Exosomal communication is a likely cellular mechanism.

The Systems Cell Represents a Universe While Our Multisystem Body Represents the Multiverse

A human or an animal is never an easy model to study memory. However, we can easily watch the behavior of a single eukaryote, or cells from a tissue, a system of a multisystem organism in the laboratory. The system cell represents a universe, and our multisystem body represents the Multiverse [9]. A single cell's behavior is ideology-neutral, solution-centric, and holistic [10].

We observe in a cell its automated, autonomous, and holonomic behaviors, nested one within the other. Each tier represents a different level of complexity; the automated processes are signal-based, autonomous activities are information-based, and the holonomic processes are governed by intention [11].

Signal-driven cellular automation, Tier I, is controlled by signalosomes, run according to the logical cellular algorithm. The purpose is to make the operations effortless and error-free with minimum energy consumption with a high yield per unit of time.

Information-driven Tier II (autonomic behaviors) operates in the model of an organogram, runs the cell's autonomous processes where the cell is required to understand the meaning of the operations going on. It calls for some kind of awareness of the system itself and its environment. The operations are not run by algebraic but by geometric algorithm through hypothetical 'organallosomes', which account for logistics available from different cellular organelles. Following inclusion of logistics with logic, the currency of operation shifts from the digitized signal to the non-digitized information.

Intention-driven Tier III (holonomic behaviors) is required in an organization of multiple cells, where no cell crosses the boundary of others' autonomy, and this intention is made clear to all groups. The key to the success of holonomy is the clarity of its currency of intention, from which emerges ethics (looked after by 'self") and aesthetics (looked after by 'life') also. For this purpose, a unique mechanism has been observed as exosomal and extravesicular (EV) communications e.g., exosomal transfer between stem cells and senescent cells, telomere transfer by APC for prolonging the life of memory-T cells, and even mitochondria transfer from metabolically strong to metabolically weak cells [12,13]. There are examples on the wrong side too; autocratic cancer cells steal mitochondria from nearby neurons to enhance their own metabolic plasticity [14].

Cellular Memory

Every single cell has its memory. The cellular memory consists of short-lived signal memory (possible in the presence of 'life'), memory of other information-states (of information, knowledge experience), and across-the-system-memory of wisdom, which is inclusive of environmental memory that extends from the immediate neighborhood to the system neighborhood, and even to the cosmic neighborhood in case of cortical neurons. This is even reflected in the behavior of even a unicellular ciliate which produces intergalactic patterns in its slime. Conditioned avoidance behaviors are based on memory of environmental cues, and are observed even in a single cell eukaryote [15-17]. Aggregation of cells to form tissue, organs, and systems is based on the memory, and every such aggregation has molecules for it.

Molecular Substrates of Cellular Memory

The substrates for such cellular memories are as under. Without being very specific, the substrate for short-lived signal memory is the metabolome, for informational memory are proteomes and genomes, and for wisdom-kind of memory, the substrate is epigenome, all three are integrated in the medium of protoplasm, the medium for localizing nonlocal 'life' as life-form. In the epigenome, the memory of a cell's total 'self-sense', the sense of the whole and the parts, is proposed to be concentrated. This nonlocal 'self'-sense is in connection with nonlocal multiversal consciousness. Within the cell, the nonlocal mind operates across the boundaries created by different membranous structures.

The cell uses proteins of different structures as carriers/processors of different information states (Figure 1).

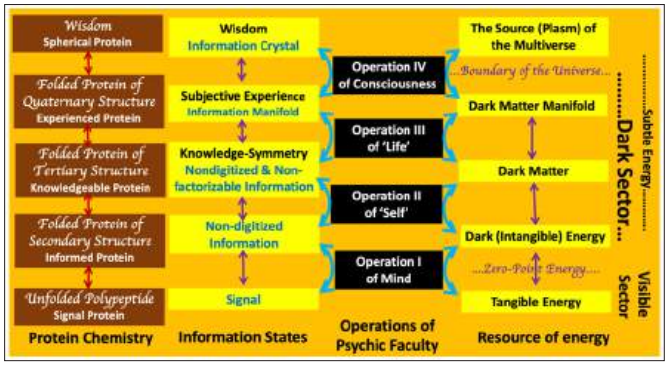

Figure 1: The figure concretizes the idea of the connection between protein chemistry in cell biology, different information states, operations of the psychic faculties, and the resources of energy across the visible and dark sectors. On the extreme left side, the proteins based on their structure are placed on a ladder as signal protein, informed protein, knowledgeable protein, experienced protein, and wisdom protein. Next to this column is shown the ladder of Information states; signal, non-digitized information, non-digitized and non-factorizable information, information manifold, and the information crystal. On the extreme right side, the ladder of the resource of energy shows visible energy, dark energy, dark matter, dark matter-manifold, and the essence (Plasm) of the Multiversity, the last one might be considered the OR (Objective Reality) of the Science of Consciousness. The transition to the dark sector from the visible sector of energy happens across the ZPE. The transition of the dark sector to the world of absolute transparency, the multiverse, happens across the boundary of the universe. Four consecutive operations executed by the four faculties of the Psyche are suggested for the transitions, as shown in black colour in the column three of the figure.

The compelling circumstantial evidence shows us that while protein in its primary structure is a carrier/processor for a signal, the protein in its secondary structure behaves as an 'informed' protein (e.g., a receptor). Protein in its tertiary structure, e.g., an enzyme, is a 'knowledgeable' protein, while in its quaternary structure, it is an 'experienced' protein, e.g., a DNA-repairing enzyme, or perforin which is experienced to make a hole in the cell membrane of an immune-targeted pathogen. Spherical proteins serve as 'wisdom' proteins, concentrated in the nucleus as histone. The cellular wisdom is distributed as spherical ribosomes! Histone operates as a driver of organization of DNA (see epigenetic memory below). Protein folding is associated with changes of information states funded by dark sector energy (Figure 1). Intercellular communication by means of exosomes, on the other hand, is intentional and is mediated by knowledgeable / experienced proteins. Two or three-dimensional infrared, or near-infrared spectroscopy could help us to visualize the protein movement within the cell [18]. Cytoplasmic streaming of cell organelles are observable under advanced light microscopes, e.g., confocal microscope, with or without fluorescent dye.

At the genetic level, we are aware of the memory of checkpoint genes to prevent development of autocratic malignant cells; Gatekeeper (APC) gene, Guardian (P53) gene, and the Governor (retinoblastoma) gene, which when all fail, autonomy transits to autocracy.

Intelligent behaviors require memory and the operations of both intelligence and memory require funding, i.e., energy (Figure 1). Signal memory is funded by conventional energy (ATPs). Memory of three other informational states i.e., of non-digitized information, symmetrically ensembled information (knowledge), and information manifold (experience) is funded by intangible dark-sector energy. Memory in the form of an information-crystal as wisdom, is funded by consciousness-sourced subtle energy.

Role of Subtle Energy in Formation of Memory of Wisdom

Memories are treasures. Treasures are managed by the 'TRUST'. The 'SOCIETY' uses the treasures for educational welfare across the systems. The Trust and the Welfare Society are parts of cellular Consciousness Mission. Most of the memory turnover is funded by matter-sourced conventional energy and information-sourced dark energy. The most economical of all energies is subtle energy that builds up the costliest information-state, the wisdom. Subtle energy is the cheapest since it is consciousness-sourced [19]. In the sub-quantum phenomenal world, subtle energy expresses itself as an information holograph [20]. In the 4-D world of cell biology, the prime target of subtle energy is the epigenomes, although it can operate on the genomes, proteomes and metabolomes. Behavioural manifestations in the 4-D world of the trust and society's educational program on exchange of important memories, messages, and decisions across different cells in a multisystem organization is found in will- and intention-guided exosomal/EV communications (Figure 2).

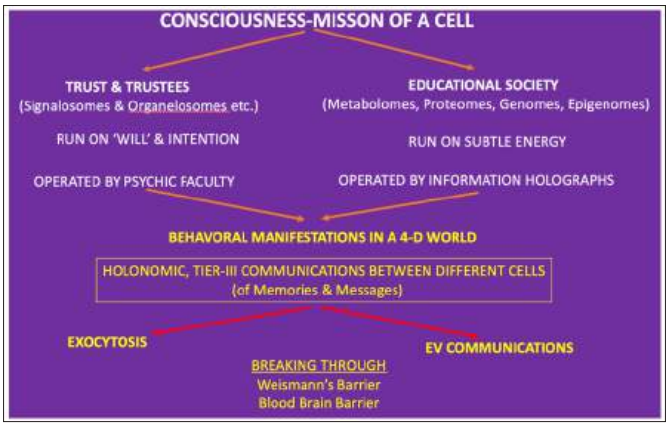

Figure 2: Consciousness Mission of a cell is based on a Trust and a Society. There are trustees and society members. The trust is operated by psychic faculty on the Will & intention of consciousness. The educational welfare society is run on subtle energy, operated by information holographs. Will-, and Intention-based educational program is executed in the 4-D world of cell biology as exocytosis and extravesicular transport, both can happen breaking through Weismann's barrier and Blood Brain Barrier.

EVs, originally thought as cellular waste/debris, are nano-sized particles produced by all cells meant for near and distant intercellular communications based on intention. When originates from endosome exocytosis they are called exosomes. Those are called EVs when originate directly from the cell membrane. Millions of memory molecules packed in exosomes are in circulating blood! Like animals. plants have memory. EV and exosomal communication of memories are also reported in the plant [21].

EVs/Exosomes are transferred breaking through even Weissman's barrier between somatic and germ cells. EVs/exosomes can cross testicular barriers to mediate intercompartmental communication between the interstitium and the seminiferous tubules, between somatic cells and germ cells [22]. Besides, there are prostasomes and epididymosomes in the seminal fluid which modify sperm quality and even influence female reproductive canal activities. EVs/exosomes can cross ovarian barrier [23]. The role of EVs and exosomes in development of oocytes are now being studied. There is a predicted break of the blood-brain barrier in the rare and occasional context of (?) transfer of the donor's heart's memory to the recipient's brain. There is one study in which a real breakthrough of the blood-brain barrier where cardiomyocyte-derived exosomes carrying miRNAs facilitate heart-brain crosstalk and contribute to Methamphetamine (MA) dependence [24].

We wish to draw attention towards another fact. Information crystal is supposed to be near-spherical. Histone, the main epigenome, is spherical. Distributed wisdom inside the cell, represented by ribosomes, are spherical. Extracellular vesicles/exosomes are spherical. Exosomes and ribosomes are reported to work together as a single unit, structural and functional, for co-translational mRNA decay [25]. Ribosomal proteins as exosomal cargo are not always regular random passengers but may act as crucial players in carcinogenesis documented with oncogenic protein, RPS3, transfer [26]. Therefore, one cell's autocratic intention may also be transmitted to another potentially inclined cell (e.g., gastric mucosal cell) to stimulate it to become an autocratic malignant cell.

Genetic Memory

Practically, behaviourally we are what our genes are! The human being has around $3x10^{12}$ cells. Each cell has 23 pairs of chromosomes. The DNA double helix from each cell stretches 2 meters. For $3x10^{12}$ cells it stretches over 6 $x10^{12}$ meters. This covers a distance from earth to moon (384,000 km) 7812 times back and forth. There are 3 x 10^9 Base pairs in 23 chromosomes. Half of the base pairs do not have any obvious function. In this sense, we are supposed to have around 1.5 x 10^6 genes. As only 1/30th of total genes actually code for protein, there could be 50,000 gene products. Only 1.5% of total DNA codes. 98.5% of DNA are non-coding. Practically, it is far less, less than half. Our body functions with about 25,000 genes and genes products. And, genetic memory is translated into the behavior of the cells. The role of noncoding genes in memory is a virgin frontier of research.

Translated RNAs carry the molecular basis of genetic memory, preserved, when required, within endosomes. The package is sent to other cells through exosomes.

Epigenetic Memory

Epigenetic memory in cell biology research, is important in heredity and evolutionary biology. The molecular substrates of epigenetic memory are some enzyme proteins, histones, chromatin, methylated/acetylated DNAs, and memory-carrying RNAs such as mRNAs, lncRNAs, and miRNAs.

More than 40 years back, Lev I Verkhovsky, a Russian scientist published a paper in 1984 titled, "Essays on Biological Memory" in a Soviet science magazine *Chemistry and Life* [27]. Reading first author's earlier paper on Memory (reference no 1), Verkhovsky mailed his paper where he brings the concept of epigenetic memory. There, he distinguishes natural selection theory from a possible natural creativity theory. Should Darwinism represent the Technical Control Department (TCD), according to him, Lamarckism is serving as a Design Bureau. Wonderful! Let us develop this area further.

There are proteins which can modify gene functions directly or through histone modification. The main component of the epigenome is histone protein that has been neglected in cell biology in many ways.

Histone has been neglected in proteomics. Histone should have been offered a royal place in protein chemistry as a spherical protein, a protein of unique shape, wounding around an enormous length of DNA that remains tightly packed in the nucleus. The structure of 'beads-on-a-string' is nature's favourite way of condensing the vast length of DNA to fit within the cell nucleus, where the histones act as spools to facilitate the compacting of the genome.

Revelation of the importance of histone in cellular memory is not a very recent one. There exists a paper of 2002 by Bryan M Turner on cellular memory and the histone code, published in Cell [28]. A few kinds of histone modifications, especially methylation, now considered to be involved in cellular memory, ensure the patterns of gene expression and are preserved through mitosis and meiosis (NIH, National Human Genome Research Institute). BRAHMA (not *Brahman* of Vedantists) is a member of a family of core ATPases of the SW1/SNF chromatin remodeling complexes, which is required for some special genetic expressions e.g., as reported [29,30]. Deciphering the histone code is a problem-based journey [31]. In the cognitive function of the brain, the role of

histone acetylation in memory formation and cognitive decline has also been reported [32].

In nuclear biology research, histone has been put in an auxiliary place. Histone research is considered not as rewarding as DNA, therefore there is scarcity of funding! A very few papers are available on the complexity of the histone structure and functions. However, three important papers are worth mentioning. Chromatin decondensation is sufficient to alter nuclear organization in embryonic stem cells, published in science [33]. Histone as Drivers of Nuclear Organization published in Nat. Rev. Mol. Cell Biol [34]. Histone can be called on from the cell membrane by the membrane lipid as and when needed, published in Molecular Cell [35].

As the part of the epigenome, histone habitually remains outside the scope of our thinking process on heredity in spite of hereditary transmission of epigenetic memory through histone remains a distinct possibility. The views of Darwin and Lamarck remain poles apart because of our obsession with genes and genetics in heredity, neglecting the transmission of histone and chromatin during fertilization, when the epigenome, concerned with environmental wisdom, contributes in zygote formation. How many of us are aware that during fertilization, sperm-head's histone contributes far less than ovum's full-house histone for the zygote? Are we all carrying the original histone quota of Eve, along with a little of chromatin from every generation of Adams, modified remodified by the environment [36].

Besides chromatin and histone, there are small RNAs too involved in epigenetic transmission in heredity. Small RNAs can influence traits and responses in offspring by transmission of gene silencing and other epigenetic marks involving mechanisms like RNA interference (RNAi) and RNA-directed DNA methylation (RdDM) etc. Small RNAs transmit memory of nutritional changes, environmental stresses and even of infection [37]. Paternal contribution of small RNAs (sncRNAs) to the zygote has been reported [38]. Noncoding RNAs can move to the sex organs from other body tissues. In this movement, exosomes are involved [39]. Exosomal transfer, as said, is intention-driven.

There is a recent paper on possible epigenetic inheritance of acquired traits via stem cells dedifferentiation/differentiation or transdifferentiation cycles [40].

Paternal epigenetic materials are reported to help implantation of the zygote and early gene expression following implantation, both discussed in a recently published mini review article. Defect in paternal chromatin has been pointed out to be a cause of infertility [41].

Breaking Through August Weismann's Barrier

How do gametes learn about somatic changes? By transfer of extracellular vesicles containing microRNAs, small RNAs, lncRNAs etc. from somatic cells to germ cells. Somatic RNAs reprogram germ cells that are transmitted to the offspring [42]. Exosomal transfer between Sertoli cells and spermatozoa stem cells in the testes, and between follicular cells and the ovum in the ovary breaks the Weismann's barrier [43]. Besides exosomal transfer between somatic and germ cells, there is evidence of transfer of metabolites through gap junctions in the Drosophila ovary [44].

With the above molecular knowledge, we now have the explanation why Weismann's experiment of cutting the tail of rats for twenty generations could not produce a tailless rat, but why the giraffe has a long neck for chewing leaves of tall trees high enough for the average-height animals. Add psychological factors in the story, somatic stress, anxiety, depression in the biological factor of hunger. Lamarck's 'Appetency', an internal desire for achieving high, originated from the environmental cue of tall trees and the instinct to survive from the claws of hunger where the brain and the psychological system of giraffes were actively engaged. Intention-driven cell biology is triggered as exosomal transfer from nearby somatic cells around the gametogenesis milieu to gametes. Involvement of the brain and the psyche is a major involved factor in the case of giraffes, which is completely absent in the tail-cutting rat experiment of Weismann.

In prolonged hunger and famine, autophagy of cells is another important feature. Autophagy-induced chromatin remodeling is a known science [45]. During periods of starvation, many animals undergo germline quiescence to preserve reproductive capacity. Extra vesicular (EV) transfer of miRNA from neurons are often necessary for this adaptation [46].

How involvement of the brain and the system psyche in recognizing environmental signal creates 'Appetency' and brings a change in the chromatin, histone, methylated DNAs, small RNAs, exosomal transfer from somatic cell to germ cell and thereby to the memory of paternal and maternal gamete, definitely require further research and funding so that Darwin and Lamarck can have cups of coffee together.

Finally, the consequences across several generations of great famines in British Bengal, China, Sweden, Netherland, and now in Gaza and many such war-torn places, are not merely of research and academic interests, but may be recognized as naturally or artificially created onslaughts on human civilization.

Concluding Remarks and Perspectives

The authors have noted a strange coincidence. In 1983, the exosomal transports were discovered [47]. In 1984, Lev I Verkhovsky from Russia published his idea of epigenetic memory. In early 1984, the first author of this paper started his journey through consciousness. He published his first paper on supracortical consciousness in 1985. The meaning of such a coincidence is hidden in the Multiversal Time-code. Following more than forty years of works of several scientists on Exosomes, Epigenetics, Weismann's barrier, Psychology, and Consciousness, we are able to unite diverging concepts in the Consciousness-Mission of a cell and develop a testable project on Molecules of Cellular Memory for pathologists, AI researchers, and spiritualists.

Memory formation requires involvement of 'life', information-processing mechanisms, operations of psychic faculties, suitable biological substrates (proteomes, genomes, epigenomes), and trusted signalosomes and organelosomes etc. for judicious expenditure of energy from conventional, 'dark sector' and consciousness sources. Consciousness-sourced subtle energy acting principally on the epigenome, information holographs working all over the body cells, and the will/intention-based EV/exosomal transfer of one cell's memory to another cell, even breaking through testicular/ovarian barriers, blood-brain barriers have been highlighted.

We are now led to the special perspective areas for the beginning of a new era in pathology, useful lessons for spiritualists, and some concrete guidance to the AI researchers.

Entrance to a New Era of Pathology Through the Body's Memory Lanes:

We already have Rupert Sheldrake's theory of morphic resonance in place, where the past forms the present. The behavior of the organism in its present form is influenced by its past through an unknown mechanism [48]. Regeneration of a lost organ happens because of memory. Phantom limb is a subconscious proprioceptive memory phenomenon of limb's position [49]. Should a disease have its origin in the cell (Rudolf Virchow), could the consecutive slips in memory lead to sickness of a cell? Or, the arousal of a repressed memory at the level of metabolome, proteome, genome, and epigenome is a root causative factor in the pathogenesis of disease? It is time to reread the acronym DAMP (Damage Associated Molecular Pattern) and PAMP (Pathogen Associated Molecular Pattern) as Damage Associated Memory Pattern and Pathogen Associated Memory Pattern. Molecular pattern is the hardware. Memory pattern is the software. Having done molecular pathology for decades, the pathologists are to dive deep into the memory pathology related to memory substrates in proteins, genes etc. and the geometric algorithms of memory in the software for understanding the pathogenesis of the diseases. Should our anticipation arise on the basis of memory, we have evidence now that even neural anticipation of viral infection triggers an immune response [50]. This anticipation factor may revive the proposition of water-memory discarded as poor science [51]. It is also a wonder whether the unique marker of the individual, the specific design of the individual's fingerprint, has anything to unravel the relationship between cosmological and the individual's biological memory.

Lessons for the Spiritual Scientists

The spiritualists understand the power of memory. In their journey for absolute independence, they stepwise achieve freedom from the memory of psychology, of different information states, and of biology. They replace their evolutionary sexual memory with the memory of penance, hard work, self-reliance, and non-begging, with self-confidence and a desireless no-expectation attitude. Gut feelings could be the memories from the future! Research on the relationship between BRAHMA (ATPases in the nucleosome) and the *Brahman* of spiritualists, the multiversal consciousness in science, could open up the connection between the local and the nonlocal entities, along with the key for the entire spectrum of funding of energy from the dark sector [52].

Lessons for the AI Researchers

We have miles to go. We are to replace the data chips with the memory chips. Easier said than done! One has to change the hardware, the substrate, and develop a new algorithm for the memory software. The study of cellular memory is relevant here. Could a shift from semiconductor chips to superconductor chips help in this matter? Could we shift from algebraic algorithms to geometric algorithms? Activation of memory without developing proper substrate and its distribution channels has its consequences.

References

1. Mukhopadhyay AK (2023) The Mystery of Memory: No "Life", No Memory. World J Psychiatry Ment Health Res 6: 1035
2. Korbak T, Balesni M, Barnes E, Benton J, Chen M, et al. (2025) Chain of Thought Monitorability: A New and Fragile Opportunity for AI Safety. https://tomekkorbak.com/cot-monitorability-is-a-fragile-opportunity/cot_monitoring.pdf.
3. Tononi G, Boly M, Cirelli C (2024) Consciousness and sleep. Neuron 112: 1568-1594.
4. Mukhopadhyay AK (2025) Consciousness and Sleep: Quality assurance of Rest. Neurol Neurosci 6: 020.
5. Mukhopadhyay AK (2016) Systems psyche: Its structure, operation and possible molecular links. Psychol Behav Sci Int J 1: 555565.
6. Lanna A, Vaz B, D'Ambra C, Valvo S, Vuotto C, et al. (2022) An intercellular transfer of telomeres rescues T cells from senescence and promotes long-term immunological memory. Nature Cell Biol 24: 1461-1474.
7. Lakota J, Jagla F, Pechanova O (2021) Heart Memory or can transplanted heart manipulate recipient's brain control over mind interactions? Act Nerv Super Redviva 63: 49-51.
8. Mukhopadhyay AK, Relan J (2020) The DeepScience of Neuro Cardiology. Ann Psychiatr Clin Neurosci 3: 1030.
9. Mukhopadhyay AK (2025) Multiversal consciousness: The peer, the point of reference, and the meme. J Neurol Neurosci Res 6: 138-143.
10. Mukhopadhyay AK (2015) Systems Cell: a Testable Model for Systems Holism. International Archives of Medicine 1: 1-105
11. Mukhopadhyay AK, Kumar V, Singh A, Ranjan M, Mukhopadhyay T, et al. (2023) Future of AI: The Cell shows the Way. Austin J Clin Pathol 10: 1079.
12. Oh C, Koh D, Jeon HB, Kim KM (2022) The Role of Extracellular Vesicles in Senescence Mol. Cells 45: 603-609.
13. Brestoff JR, Wilen CB, Moley JR, Li Y, Zou W, et al. (2021) Intercellular Mitochondria Transfer to Macrophages Regulates White Adipose Tissue Homeostasis and Is Impaired in Obesity. Cell Metab 33: 270-282.
14. Hoover G, Gilbert S, Curley O, Obellianne C, Lin MT, et al. (2025) Nerve-to-cancer transfer of mitochondria during cancer metastasis. Nature 644: 252-262.
15. Schenz D, Nishigami Y, Sato K, Nakagaki T (2019) Unicellular integration of complex spatial information in slime moulds and ciliates. Curr. Opin. Genet Dev 57: 78-83.
16. Burchett JN, Elek O, Tejos N, J. Prochaska JX, Tripp TM, et al. (2020) Revealing the Dark Threads of the Cosmic Web. The Astrophysical Journal Letters 891: L35.
17. Dexter JP, Prabakaran S, Gunawardena J (2019) A Complex Hierarchy of Avoidance Behaviors in a Single-Cell Eukaryote. Current Biology 29: 4323-4329.
18. Barth A (2007) Infrared spectroscopy of proteins, Biochimica et Biophysica Acta (BBA) – Bioenergetics 1767: 1073-1101.
19. Mukhopadhyay AK (2024) Non-Polluting Soundless Energy Ecosystem of a Cell. Journal of Pathology Research Reviews & Reports 6: 1-5.
20. Mukhopadhyay AK (2012) Informaion Holograph. The Structure, the Source and its Operation. International Journal of Bio Engineering, Neuro Sciences and Technology 2: 12-32.
21. Farley JT, Eldahshoury MK, de Marcos Lousa C (2022) Unconventional Secretion of Plant Extracellular Vesicles and Their Benefits to Human Health: A Mini Review. Front Cell Dev Biol 10: 883841.
22. Ma Y, Ma QW, Sun Y, Chen XF (2023) The emerging role of extracellular vesicles in the testis. Hum Reprod 38: 334-351.
23. Zhao Z, Sun Y, Guo R, Liang J, Dai W, et al. (2025) Extracellular vesicles: Roles in oocytes and emerging therapeutic opportunities. Chin Med J Engl 138: 1050-1060.
24. Li H, Peng Y, Wu Y, Chen Y, Li J, et al. (2025) Cardiomyocyte-derived exosomes carrying miR-181a-5p facilitate heart-brain crosstalk and exacerbate methamphetamine dependence in

rats. Front Pharmacol 16: 1541442.
25. Kögel A, Keidel A, Loukeri MJ (2024) Structural basis of mRNA decay by the human exosome–ribosome supercomplex. Nature 635: 237-242.
26. Graifer D, Malygin A, Shefer A, Tamkovich S (2025) Ribosomal proteins as exosomal cargo: Random passengers or crucial players in carcinogenesis? Advanced Biology 9: 2400360.
27. Verkhovsky LI (1984) Essays on Biological Memory. Chemistry and Life. English Translation uploaded in December 2022 in Research Gate, https://www.researchgate.net/publication/366249573_Essays_on_Biological_Memory?enrichId=rgreq-1586e52023fefe243dfd4a351d3e5a93- XXX&enrichSource=Y292ZXJQYWdlOzM2NjI0OTU3MztBUzoxMTQzMTI4MTEwNzMxMjE4M0AxNjcxMDEwNzI3OTM4&el=1_x_2&_esc=publicationCoverPdf.
28. Turner BM (2002) Cellular Memory and the Histone Code. Cell 111: 285-291.
29. Jin Y, Xu J, Yin MX, Lu Y, Hu L, et al. (2013) Brahma is essential for Drosophila intestinal stem cell proliferation and regulated by Hippo signaling. Elife 2: e00999.
30. Yiying Li, Yuanyuan Hu, Bei Wang, Mengyao Lang, Shutang Zhou, et al. (2025) Transcriptome-based analysis reveals chromatin remodeling in post-adult eclosion reconstruction of the insect fat body. Journal of Integrative Agriculture 24: 668-679.
31. Li X, Li XD (2021) Integrative Chemical Biology Approaches to Deciphering the Histone Code: A Problem-Driven Journey. Acc Chem Res 54: 3734-3747.
32. Peixoto L, Abel T (2013) The role of histone acetylation in memory formation and cognitive impairments. Neuropsychopharmacology 38: 62-76.
33. Therizols P, Illingworth RS, Courilleau C, Boyle S, Wood AJ, et al. (2014) Chromatin decondensation is sufficient to alter nuclear organization in embryonic stem cells. Science 346: 1238–1242.
34. Baumann K (2015) Drivers of Nuclear Organization. Nat. Rev. Mol. Cell Biol 16: 67.
35. Zheng Y, Cantley LC (2017) Membrane Lipids Speak to Histones Mol Cell 20 66: 163-164.
36. van der Heijden GW, Ramos L, Baart EB, van den Berg IM, Derijck AA, et al. (2008) Sperm-derived histones contribute to zygotic chromatin in humans. BMC Dev Biol 8: 34.
37. Cecere G (2021) Small RNAs in epigenetic inheritance: from mechanisms to trait transmission. FEBS Lett 595: 2953-2977.
38. Sharma U (2019) Paternal Contributions to Offspring Health: Role of Sperm Small RNAs in Intergenerational Transmission of Epigenetic Information. Front Cell Dev Biol 7: 215.
39. Cossetti C, Lugini L, Astrolog L, Saggio I, Fais S, et al. (2014) Soma-to-Germline Transmission of RNA in Mice Xenografted with Human Tumour Cells: Possible Transport by Exosomes. PLoS ONE 9: e101621.
40. Alexanian AR (2024) Epigenetic inheritance of acquired traits via stem cells dedifferentiation/differentiation or trans differentiation cycles. Cells & Development 179: 203928.
41. Dodd AR, Luense LJ (2024) Contribution of the paternal histone epigenome to the preimplantation embryo. Front. Cell Dev. Biol 12: 1476312.
42. Phillips D, Noble D (2023) Bubbling beyond the barrier: exosomal RNA as a vehicle for soma–germline communication. The Journal of Physiology 602: 2547-2563.
43. Eaton SA, Jayasooriah N, Buckland ME, Martin DI, Cropley JE, et al. (2015) Roll Over Weismann: Extracellular Vesicles in the Transgenerational Transmission of Environmental Effects. Epigenomics 7: 1165-1171.
44. Vachias C, Tourlonias C, Grelée L, Gueguen N, Renaud Y, et al. (2025) Gap junctions allow transfer of metabolites between germ cells and somatic cells to promote germ cell growth in the Drosophila ovary. PLoS Biol 23: e3003045.
45. González-Rodríguez P, Füllgrabe J, Joseph, B (2023) The hunger strikes back: an epigenetic memory for autophagy. Cell Death Differ 30: 1404–1415.
46. Wong C, Jurczak EM, Roy R (2024) Neuronal exosomes transport an miRISC cargo to preserve stem cell integrity during energy stress. Cell Reports 43: 114851.
47. Harding CV, Heuser JE, Stahl PD (2013) Exosomes: looking back three decades and into the future. J Cell Biol 200: 367-71.
48. Sheldrake R. Morphic Resonance and Morphic Fields – an Introduction. Morphic Resonance https://www.sheldrake.org/research/morphic-resonance/introduction.
49. Anderson-Barnes VC, McAuliffe C, Swanberg KM, Tsao JW (2009) Phantom limb pain - A phenomenon of proprioceptive memory? Medical Hypotheses 73: 555-558.
50. Trabanelli S, Akselrod M, Fellrath J, Vanoni G, Bertoni T, et al. (2025) Neural anticipation of virtual infection triggers an immune response. Nature neuroscience https://doi.org/10.1038/s41593-025-02008-y
51. Beauvais F (2021) "Memory of water" experiments explained with no role assigned to water: Pattern expectation after classical conditioning of the experimenter. Explore 17: 130-140.
52. Rayne E (2025) Your Consciousness can jump through Time – meaning 'Gut-Feelings' are memories from the future, Scientist say. Popular Mechanics https://www.popularmechanics.com/science/a65653221/science-of-precognition-explained/.