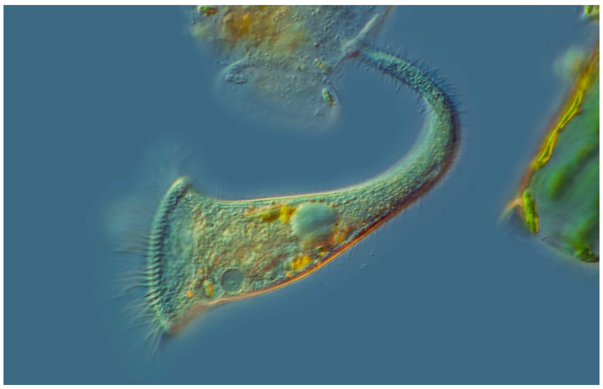
Excerpt from the chapter "Cellular Cognition"

The first piece of evidence comes from planarian flatworms that have long fascinated biological researchers because of their ability to fully regenerate limbs and even a full body from just a small piece of the worm. In the late 1800's T.H. Morgan demonstrated that planarian could regenerate a new body, complete with brain and other organs, from fragments of the worm as small as 1/279th the size of its original body.[5] Decades later James McConnell trained planarians to recoil from flashing lights by electrically shocking the worms each time a light was flashed. Once trained, the worms would recoil from a flashing light even when no electric shock was applied.[6] He then cut small tail pieces off of the trained worms when the tail pieces regenerated into complete worms with newly constructed brains, they somehow retained the memory to recoil from flashing lights. Numerous researchers have since confirmed McConnell's planarian memory results using a variety of other memory protocols.[7,8]

Caterpillars trained to avoid certain odors retained this memory as adult moths despite their brains being completely disassembled, liquified, mixed with the other cells and molecules of the former caterpillar body inside the chrysalis and completely rebuilt into a different brain structure with different organs, sensory and muscles systems during metamorphosis.[9] Experiments on plants, fungi and other simpler life forms also demonstrate memory capabilities in organisms that lack a brain altogether.[10] Collectively these experiments provide compelling evidence that memories can be stored and retrieved from biological structures other than brains.[11]

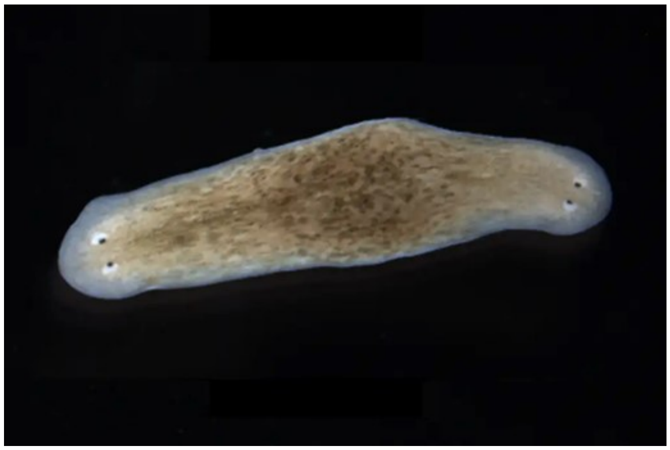
Researchers found that the single cell stentor develops memories of whether certain types of stimuli are threatening or non-threatening, learning over time to ignore non-threatening stimuli, demonstrating a rudimentary level of intelligence and memory.[12]



Single cell Stentor. Credit Wikimedia commons license.

Other researchers demonstrated that single cell slime molds can remember the locations of food sources.[13] The number of experiments demonstrating that individual cells and microorganisms can store and retrieve memories is too long to list, hence the citations discussed are deemed sufficient to make the point that individual cells can carry organism memories. It's important to note that the flatworm memories of flashing lights, odors, food locations and other memory protocols in the various experiments cited were memories of experiences that occurred at the level of the whole multicellular organism, not experiences of the individual cells as was the case in the stentor and slime mold experiments. This suggests that multicellular organism memories are stored "inside" neurons and non-neural cells throughout the body. Centuries of scientific study and experimentation have failed to find memories stored in macroscopic structures or regions of the human brain because memories are stored inside microscopic cells throughout the body.

Researchers at Tufts University discovered that the electromagnetic field is involved in guiding body structure during Planarian flatworm regeneration.[14] They discovered an electromagnetic pattern in developing worm heads during regeneration, and simulated the same pattern on tail regions of regenerating worms to create worms with heads on both ends of their body. Subsequent segments taken from these two-headed worms continued to regenerate into two-headed worms.



Credit to Tufts University Center for Regenerative & Developmental Biology

The worms could be converted back to the single head variety by simulating the electromagnetic field of a tail on one of the two head regions during regeneration, whereby subsequent regenerations produced single head worms. It's important to note there was no DNA manipulation in these flatworm experiments, only exposure to abnormal electromagnetic patterns on regions of the worm bodies during regeneration. This provides direct evidence that DNA does not encode for body structure, because if it did then pieces of two-headed worms would regenerate the single head variety that remained encoded in its unaltered DNA. They did not. This experiment demonstrates that the electromagnetic field plays a key role in organism morphology in ways that remain a complete mystery to science.

The researchers also used electromagnetic patterns to change the species of regenerating planarian with no DNA modification.

> "We demonstrated that briefly reducing gap junction-mediated connectivity between adjacent cells in the bioelectric network that guides regeneration led worms to regenerate head and brain shapes appropriate to other worm species whose lineages split more than 100 million years ago. The information stored in the body's bioelectric circuits can be permanently rewritten once we understand the dynamics of the biophysical circuits that make the critical morphological decisions. This permanent editing of the encoded target morphology without genomic editing reveals a new kind of epigenetics, information that is stored in a medium other than DNA sequences and chromatin".[15]

The existence of other memory and cellular process control systems beyond DNA are collectively referred to as epigenetics. "Epi" means "above or beyond" so epigenetics is the term used for cellular memory and processes that are "above or beyond the genetic code." No scientific theory has been developed to explain either epigenetic memory nor epigenetic control processes using reductionist scientific principles or processes, yet scientists routinely attribute complex cellular phenomena they observe to epigenetic factors or processes. Epigenetics has essentially become a catch-all term that applies to cellular processes that are unexplained by scientific theories, principles, and processes.

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Biologist Brian Ford discusses the fallacy of the widely held view that cells are simple biological building blocks when the reality is their behaviors demonstrate levels of cognition and agency that cannot be explained by science:

> "The essential processes of cognition, response and decision-making inherent in living cells transcend conventional modelling, and … reveal a level of cellular intelligence that is unrecognized by science and is not amenable to computer analysis … biological systems are non-linear systems that are not amenable to digital modelling…Single cells truly can consider their options and modify their responses in the light of contingency. Under the microscope, we can observe a predatory single-celled ciliated microorganism as it inspects its prey from a distance. The ciliate can then select a specific microbial cell, pause, and then swoop upon its prey and capture it within a second. The coordination of this activity is similar to watching a cat catch a sparrow on the lawn, yet it is done within the confines of a single cell….The essential processes of cognition, response and decision-making inherent in living cells transcend conventional modelling, and microscopic studies of organisms like the shell-building amoebae and the rhodophyte alga Antithamnion reveal a level of cellular intelligence that is unrecognized by science and is not amenable to computer analysis…Ingenious, perceptive and intelligent behaviour is apparent in a single living cell."[19]

Neuroscientist John Leif's details the extraordinary capabilities of cells in his book The Secret Language of Cells. Leif discusses the myriad of complex signaling systems cells use to communicate with each other, how they go about solving problems, and he even covers sub-cellular organelles that also communicate and coordinate with each other. His book provides many mind-boggling examples that make it hard to deny that cells have cognitive abilities and agency far beyond a level that can be explained by known science. The opening paragraph of his book captures the essence of his message:

> "The greatest secret of modern biological science, hiding in plain sight, is that all of life's activity occurs because of conversations among cells. During infections, immune T cells tell brain cells that we should 'feel sick' and lie down. Long distance signals direct white blood cells at every step of their long journey to an infection. Cancer cells warn their community about immune and microbe attacks. Gut cells talk with microbes to determine who are friends and enemies. Instructor cells in the thymus teach T cells not to destroy human tissues." [20]

Excerpt from the chapter "Cellular Mind"

Brain researcher Lain McGilchrist makes the case that cells have minds in his book *The Matter with Things*:

"Describing how cells often act apparently as individuals, so as to 'seek out and destroy an invading pathogen without external mediation', if necessary, altering conventional behaviour to pursue it, and 'maintain pursuit relentlessly until the organism is consumed and eliminated'…the human polymorph, a white blood cell that forms an important part of the body's immune defences, is an amoeba, although a constituent part of our bodies. This is a cell with a mind of its own. Conceptualising the human body as a cooperative community of essentially autonomous entities gives us a more reasonable understanding than our modern models, which see the body as a collection of mechanical organs enclosed in skin. Such behaviour, 'including the continual and carefully choreographed machinations of mitochondria, the endless migration of granules and voiding of vacuoles, the conduction of discrete particles in two-way streams of cytoplasm like traffic on a highway, the meticulous changes of position of the nucleus in diatoms during division. Plasmodia regularly break out of Petri dishes in laboratories and can escape from traps and solve mazes. Slime mould colonies can learn to avoid certain paths that lead to a noxious stimulus, and moulds that have so learnt can transfer this memory of the adaptive response by cell fusion to new colonies that have never encountered the noxious stimulus. Even in cases where three out of four moulds in the fused organism were 'naïve' and had had no opportunity to learn, the information was transferred to the resulting fused slime mould from the one that had had the noxious encounter."[3]

Neuroscientist Anil Seth appears to support the premise that cognition and survival agency exists at all scales of life:

"This imperative for self-organization and self-preservation in living systems goes all the way down: Every cell within a body maintains its own existence just as the body as a whole does. What's more, unlike in a computer where you have this sharp distinction between hardware and software — between substrate and what "runs on" that substrate — in life, there isn't such a sharp divide."[24]

Researchers in the 1940's modified the size of cells forming vessels in the kidneys of developing newts.[25] Normal kidney vessels are formed with 10 cells around a circular formation to create a vessel with the correct diameter. When the embryonic cells were artificially doubled in size, 5 cells would connect in a circular formation to create vessels of the correct diameter instead of the normal 10 cells. Pushed to the limit by artificially making the cells as large as the circumference of the target vessel, single cells would literally fold themselves into a circle and connect to themselves to produce a vessel of the correct diameter. The evolutionary history of the newt always produced kidney vessels with a diameter that required 10 cells, thus there was no evolutionary history nor cellular memory providing templates nor instructions for a single cell to fold itself into a circle and connect to itself to produce the proper diameter kidney vessel, yet this is precisely what the cells did. The morphogenic flexibility and problem-solving skills demonstrated by these newt cells simply cannot be explained by known scientific principles or processes, even in principle. The only logical conclusion is the embryonic newt cells had the survival agency to pursue the collective morphological goal of building kidney vessels with a diameter that would allow the newt to survive after birth, and the cognitive and problem-solving skills required to achieve that goal independent of cell size.

"There is also ample empirical evidence that establishes cell sentience from the perspective of cell functions. Cells can cognitively read their environment, analyze the received information, and then execute the necessary action to continue their survival. This coordinated cell action is known as cell signaling, which substantiates the possibility that the cell too has a mind. Living entities display sentient-like cell-cell communication and chemotaxis. Sperm cells and oocytes use several cognitive transmitters. Even plant cells have the sensory perceptions and the ability to integrate these multiple sensory perceptions into adaptive actions. Root cells of plants exhibit sentient features at the transition zone interpolated between the apical meristem and elongation region."[26]

Excerpt from the chapter "Cellular Evolution"

Researchers created new artificial organisms called "Xenobots", which are made by culturing embryonic skin cells taken from the African frog Xenopus laevis.[28] These embryonic skin cells did not grow into skin, tadpoles, nor frogs. They combined to form novel multicellular organisms with no evolutionary history, quickly forming into spherical shapes and began to pursue collective survival. They began to communicate via bioelectric signaling well beyond normal skin cell gap junction communication that was described by the researchers as similar to synapses in a brain. Xenobots proceeded to convert exterior cells into cilia to enable the organism to swim around and explore its environment in search of nutrients to consume and grow. The increase in bioelectric signaling presumably facilitated, among other things, the coordinated movement of cilia to ensure the Xenobot swims coherently in a single direction as the collective pursued resources to survive. Frogs have legs and tadpoles have tails but neither has cilia for locomotion, hence the Xenobot cells demonstrated cognition and agency as they creatively formed a body structure best suited to survive in its new environment.

Xenobots communicate and work together in swarms, demonstrate awareness of their physical environment by swimming around corners in a maze without bumping into walls, demonstrating the presence of an unknown sensory system that detects some aspects of their physical environment. Xenobots repair themselves when damaged and break themselves into smaller Xenobots in a form of reproduction similar to planarian and gather up random isolated skin cells into balls that also start behaving as Xenobots, demonstrating a second novel reproduction method.

Xenobots. Source: Tufts University Center for Regenerative & Developmental Biology

The Xenobots pursued the same multi-level survival imperative that all forms of life pursue, creating an entirely novel organism with an entirely novel morphology, sensory system, and reproduction methods that required neither genetic mutation nor natural selection, seemingly in direct defiance of the entirety of modern evolution theory. The behaviors of Xenobots were not predicted nor explained by the researchers using known scientific principles or processes. It's simply impossible to explain Xenobot behavior under the "cells are biological robots" paradigm as robots require the equivalent of software instructions and an operating system to drive their behavior, and if such a hypothetical system existed in the frog skin cells then it's hard to imagine that the robot cells would create anything other than frog skin cells, a frog, a partial frog, or some frog-like mini creature.

The actions taken by frog skin cells that suddenly found themselves in a culture consisting only of other skin cells without the rest of the frog's embryonic cells can best be explained by granting these skin cells cognitive capabilities and survival agency, as evidenced by their awareness of their environment, problem solving behavior, drive to reproduce, and so on. Xenobots meet the CMT definition of mind as there can be little doubt that their behavior defies explanation by all known scientific principles and processes, even in principle. The Xenobot creators were surprised by the behaviors exhibited and noted the shortcomings of current scientific paradigms in explaining their behaviors, suggesting that traditional scientific paradigms "need considerable revision".

> "The ability to produce living organisms in novel configurations makes clear that traditional concepts, such as body, organism, genetic lineage, death, and memory are not as well-defined as commonly thought, and need considerable revision to account for the possible spectrum of living entities."

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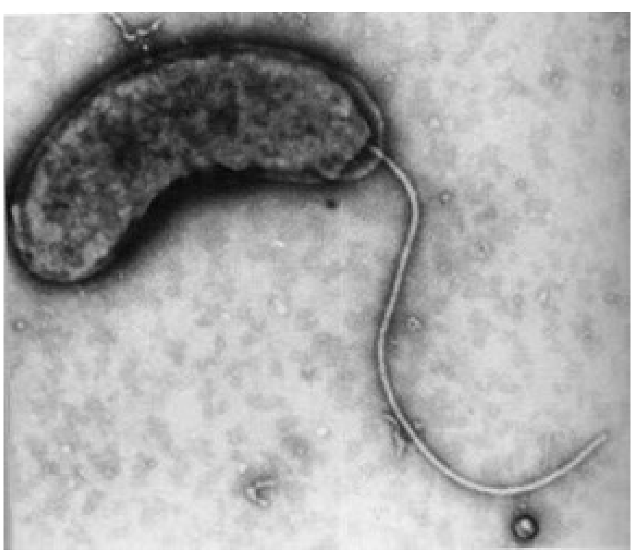
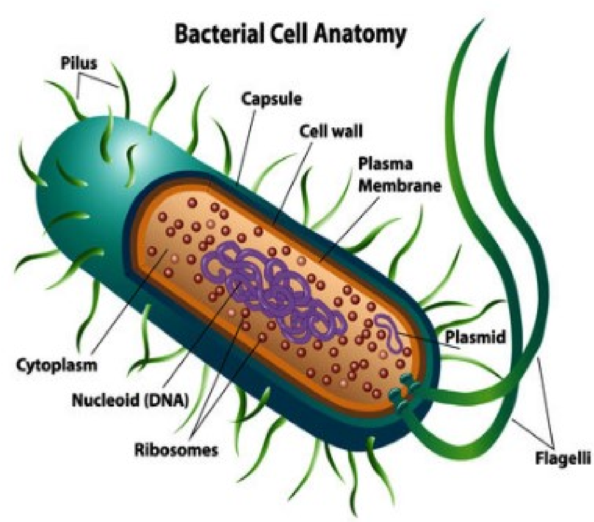
The simplest form of life is bacteria, single cell microorganisms that are several orders of magnitude smaller than the average human cell and contain far fewer internal organelles than eukaryotic cells.





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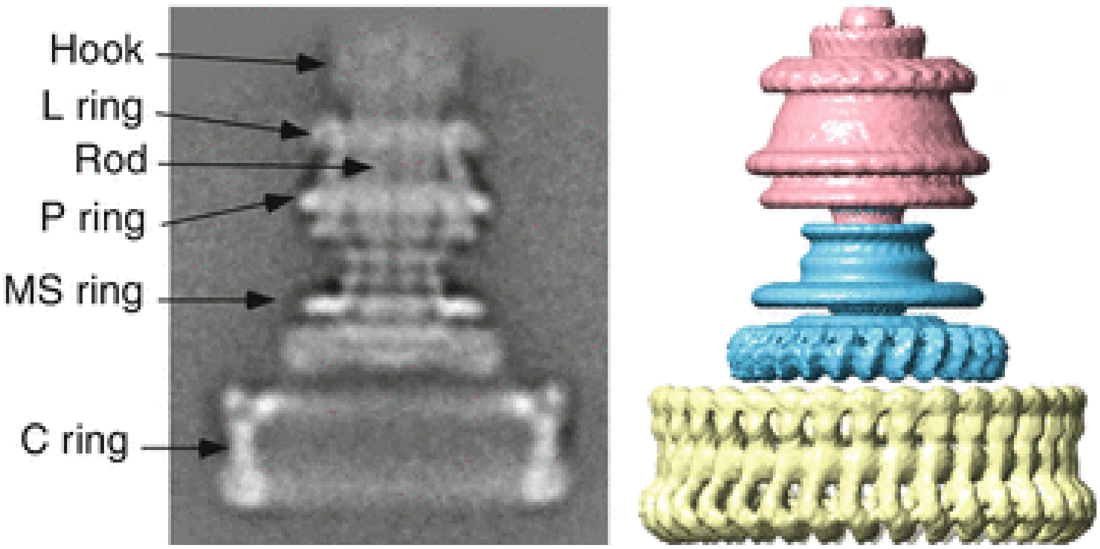
Bacteria have finger-like appendages called pilus that are used to sense, grab, and move objects they encounter. They also have tails that are connected to an internal spinning molecular motor that controls the rotation of the tail to move the bacteria around its world. This structure is literally a spinning electromagnetic motor that is eerily similar to electric motors at the human scale. Below is an electron microscope image of this molecular motor and a graphical illustration of its components. Bacteria control the dynamics of this motor to alter the speed and direction of movement when searching for food or fleeing from a predator.



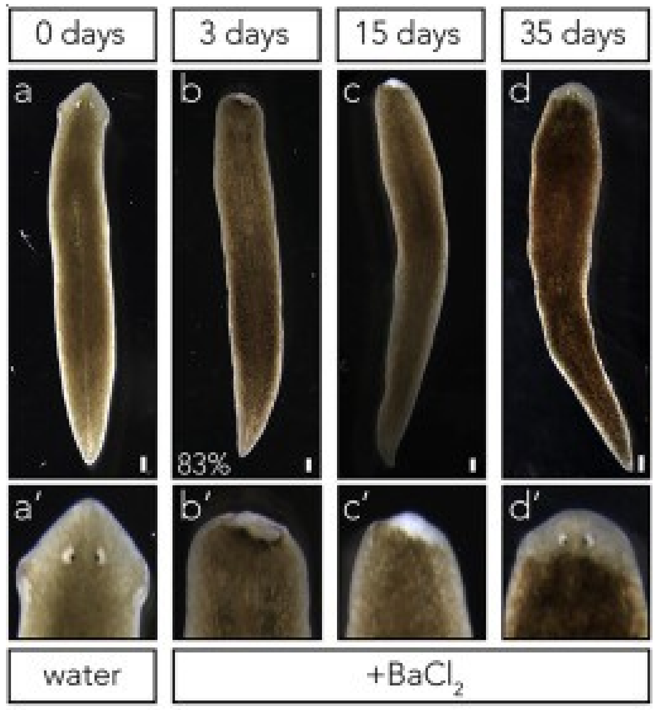
Source: Encyclopedia of Biophysics, pp 591–596.

Biochemist Michael Behe's book *Darwin's Black Box* makes the argument that natural selection of random DNA mutations simply cannot explain the development of this nano-scale molecular motor because it is "irreducibly complex", meaning it required the simultaneous evolution of multiple molecular components that are so precisely tuned to operate together and perform such highly specific functions that any minor mutation to any one of its components would render the motor completely unusable. Bacterial DNA includes templates for the proteins used to build the components of this molecular motor, but it does not contain any instructions that specify how much of each protein is used in the components, the shape of the components, nor how the components fit together to create a functioning motor. Believing that DNA is a blueprint with instructions for how to assemble this molecular motor is akin to believing that a list of materials such as copper, iron, insulating rubber, and other raw materials is a blueprint with instructions to assemble an electric car motor.

…

An extremely difficult mutation to explain with modern evolution theory involves planarian placed in barium chloride solution.[49]. The solution dissolves the head of the flatworm but does not kill the cells in the rest of the body. Within a few weeks a new head regenerates that is able to survive in the barium chloride solution. The researchers note:

> "We conclude that BaCl2-adapted heads exhibit transcriptional changes reflective of several subsystems' adaptation to this novel bioelectrical condition and include proteins that could implement physiological homeostasis in response to BaCl2."[49]



Planarian exposed to barium chloride solution.[49]

Genetic analysis of the regenerated worms shows at least 9 genes were changed that were related to the materials used in multiple cellular subsystems. Clearly new cellular materials were needed to construct barium chloride resistant heads, and those new materials were updated in the flatworm's edited genome. Using the 1.3% odds of a beneficial random mutation discussed earlier, the odds of 9 simultaneous beneficial gene mutations occurring is 1 in 10^{15}. That these mutations occurred across multiple specimens in the experiment simultaneously reduces random chance odds exponentially further, and the fact that they all occurred within a few weeks reduces the odds that this occurred by chance is effectively zero. The fact that these mutations did not even occur during a reproduction event makes it impossible to explain this experiment with modern evolution theory.

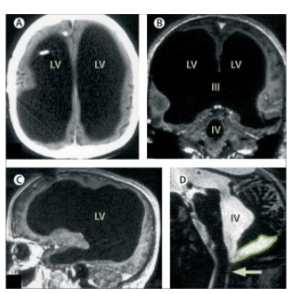
That the cells in a worm body with its head dissolved recognized that its continued survival depended upon rebuilding a head that could survive in the suddenly corrosive environment in order to have vision to find food and a mouth to ingest it did not involve random mutation nor natural selection. The barium chloride resistant head is clear evidence of cellular processes that demonstrate cognitive skills and survival agency, evidence that the worm's mind continued to live on as it desperately tried to find a way to rebuild its head to survive. The headless cellular collectives experimented with various cellular structures until they found a head design that survived in the barium chloride solution, providing concrete evidence that a non-random, cognitive, survival-driven process is responsible for evolutionary mutations.

Excerpt from the chapter "Human Mind"

Hydranencephaly is a rare birth defect where patients are born with a cerebral cortex that is filled with sacs of cerebrospinal fluid instead of networks of neurons. Newborns with this condition demonstrate normal behaviors such as sucking, swallowing, crying, and moving of arms and legs that seem quite normal at birth. After a few months the infants are awake, alert, smile, laugh, feel pain, have emotions, recognize their parents, have favorite songs, reach for their favorite toys to play with, and some can even recognize themselves in a mirror.[76] While these behaviors are consistent with infants of a few months of age, babies with hydranencephaly soon begin to fall behind infants that have a normal developing cortex.

> "Professor Patrick Wall, of University College London, commented that 'scores of similar accounts litter the medical literature, and they go back a long way.' Indeed a more recent report of four children aged between 5 and 17 with hydranencephaly, a condition in which the cerebral hemispheres are very largely or totally absent and the space filled with cerebrospinal fluid, demonstrated that, despite each having minimal or practically non-existent cortex, they all nevertheless possessed discriminative awareness: they had functional vision, could orient themselves, could distinguish familiar from unfamiliar people and environments, showed toy preferences, could interact socially, could respond to and discriminate pieces of music, and demonstrated not just awareness of their own body, but appropriate affective responses to others, as well as associative learning. One passed the 'mirror test', supposedly a test of self-awareness, that very few species pass. All of which invites the question whether neuronal complexity is necessary for awareness at all since the remaining areas of diencephalon and brainstem amount to only 6– 10% of the neuronal mass of the normal brain. Another survey of hydranencephaly concludes: Most cortical areas are simply missing in hydranencephaly, and with them the organized system of cortical connections that underlie the integrative activity of cortex and its proposed role in functions such as consciousness … The evidence and functional arguments reviewed in this article are not easily reconciled with an exclusive identification of the cerebral cortex as the medium of conscious function."[3]

Humans born without a cortex lack the physical substrate to build the massive amounts of neuronal interconnections required to enable more advanced levels of human intelligence, hence these children remain at the intelligence level of infants for their entire life. CM theory posits that these children have conscious experience without a cortex because the rest of their nervous system and their neural and body biofields remain intact. They have moods and emotions, can interact with other people and toys, and some have self-awareness. They demonstrate memory and rudimentary comprehension of the world around them, demonstrating a rudimentary level of cognition. They demonstrate agency when reaching for toys and when interacting with people. Regardless of whether one accepts the CM hypothesis, these children provide compelling evidence that the cerebral cortex does not generate the mind because infants without a cortex appear to have minds. This means the search for the conscious mind processes in brains should look at brain regions other than the cerebral cortex.



Hydranencephaly[77] Cerebellar agenesis[78]

The figures above show a brain scan of a child with hydranencephaly on the left, and a 44 year old man who led a normal life as a white collar worker despite missing 90% of his cerebellum, a condition called cerebellar agenesis.[73]

Apparently 10% of the cerebellum is sufficient to lead a normal life. In both images the dark areas in the scans show sacs filled with cerebral spinal fluid instead of normal brain tissue containing neurons and glial cells. Cerebellar agenesis patients usually have some mental and/or physical impairments but generally behave as if they have normal conscious experiences.[79] This congenital defect provides compelling evidence that the cerebellum also does not generate the mind. The cerebral cortex contains 18% of the neurons in the average brain and the cerebellum contains another 80% of the neurons in the brain. Collectively these two well documented medical conditions eliminate 98% of the neurons in the higher brain regions from being candidates to host the neuronal processes that could possibly generate the mind. If the mind is a brain process, then the process must be contained in the 2% of the neurons contained in the organs that form the more primitive limbic system of the brain such as the amygdala, hippocampus, thalamus, hypothalamus, basal ganglia, and/or cingulate gyrus. But each of these organs are known to perform very specific functions in support of the brain and body, leaving little surplus neuronal processing capacity for brain processes sufficiently complex to produce conscious experience, thinking, memory storage and management, emotional processing and so on. Additionally, since these brain regions are not integrated with the sensory information processing that occurs in the visual cortex, there is no plausible explanation for how they could create integrated conscious visual experience.

The impairments that these patients experience relate only to the specific functions of the cortex or cerebellum they are missing, neither of which can possibly contain brain processes that hypothetically generate the conscious mind. Congenital brain defects collectively provide strong evidence that the mind simply cannot be generated by the brain. The fact that contradictory evidence of this magnitude has been around for decades, yet neuroscientists continue to primarily focus on studying the cortex when searching for consciousness is simply baffling.

In Cellular Mind theory the brain does not produce the mind which explains how minds can exist in humans missing major parts of their brains. In each of these severe congenital defects, the patients have normal bodies that generate normal body biofields thus have normal human minds. They also have normal nervous systems that generate normal neural biofields which generate normal sensory experiences for their minds. It is only their abnormal brains that generate abnormal brain biofields that create impairments from minor to severe in their ability to live normal lives.