When exploring the vast diversity of life on Earth, one fundamental classification that emerges is between unicellular and multicellular organisms. This distinction forms the basis for understanding how life evolves, functions, and interacts within various ecosystems. Unicellular organisms, comprising a single cell, represent the simplest form of life. They include bacteria and protozoa, showcasing incredible adaptability and survival strategies in diverse environments. On the other hand, multicellular organisms consist of multiple cells that may organize into tissues, organs, and complex structures. This group includes plants, animals, and fungi, each demonstrating sophisticated systems for growth, reproduction, and responding to their surroundings. Unicellular organisms are life forms that consist of a single cell, which carries out all the necessary functions required for survival. These organisms are incredibly diverse, inhabiting a vast array of environments from the deepest oceans to the highest mountains. Their simplicity and adaptability make them crucial subjects of study in biology, providing insights into the fundamental processes of life. Unicellular organisms exhibit several distinct characteristics: Simplicity: Each cell functions independently and performs all life processes including digestion, respiration, reproduction, and waste elimination within a single cell structure. Types: They can be prokaryotic, such as bacteria and archaea, where the cell lacks a distinct nucleus, or eukaryotic, like protozoa and certain algae, where the cell has a well-defined nucleus. Reproduction: Most unicellular organisms reproduce asexually through processes like binary fission, budding, or spore formation, enabling rapid population growth. Adaptability: These organisms can adapt to extreme environments, which is evident in extremophiles that thrive in conditions like high salinity, extreme temperature, or high acidity. Bacteria: Perhaps the most well-known unicellular organisms, bacteria can be found in every ecosystem on Earth. They play vital roles in processes like fermentation and nitrogen fixation. Archaea: Similar to bacteria in shape and size but genetically distinct, archaea are often found in extreme environments, such as hot springs and salt lakes. Protozoa: These eukaryotic unicellular organisms are often motile, using cilia, flagella, or pseudopodia to move. They are primarily found in aquatic environments and moist soil. Yeast: A type of fungus that is used widely in baking and brewing, yeast cells are eukaryotic and reproduce typically by budding. A multicellular organism is any organism made up of multiple cells. The cells in multicellular organisms become specialized and organized into tissues and organs that perform specific functions. This specialization is crucial for the survival and efficiency of the organism. Cell Specialization and Differentiation: Each cell type in a multicellular organism specializes to perform specific functions. This specialization results from the process of differentiation, where unspecialized cells become specialized in structure and function. Complexity and Organization: Multicellular organisms exhibit a higher level of complexity and organization. Their bodies are composed of various organs and tissues, each dedicated to performing specific life functions such as digestion, respiration, and reproduction. Interdependent Cells: Cells in multicellular organisms are interdependent, meaning they rely on each other to survive. For example, muscle cells require oxygen transported by blood cells, and both depend on the nutrients absorbed by cells in the digestive tract. Higher Levels of Biological Processes: These organisms demonstrate complex biological processes such as growth, reproduction, and response to stimuli, which involve coordinated interactions among various cells, tissues, and organs. Humans and Animals: All animals, including humans, are multicellular organisms. They have complex body structures with systems such as circulatory, nervous, and skeletal systems that perform specialized functions. Plants: All plants are multicellular, from towering trees to simple grasses. They have specialized structures such as roots, stems, and leaves, each performing vital roles like nutrient absorption, photosynthesis, and reproduction. Fungi: Many fungi, such as mushrooms and molds, are also multicellular. They have a body structure known as a mycelium made up of hyphae, which are tiny filaments that absorb nutrients from the environment. FeatureUnicellular OrganismsMulticellular OrganismsCell NumberConsists of a single cellComposed of multiple to many cells organized into tissues and organsComplexitySimple, with all life processes occurring within one cellComplex, with specialized cells performing different functionsReproductionTypically asexual through binary fission, budding, or sporesCan be asexual or sexual, involving complex reproductive processesExamplesBacteria, archaea, protozoa, some algae, and yeastsHumans, animals, plants, and most fungiCell StructureMay be prokaryotic (no nucleus) or eukaryotic (nucleus present)Always eukaryotic with defined nucleus and organellesLifespanGenerally short, often rapidly dividingVaries widely, generally longer with regulated growth and developmentSizeMicroscopic, typically less than 0.1 mm in diameterCan range from microscopic to several meters tall or longAdaptabilityHigh adaptability to environmental changes due to simple structureLess adaptable on a cellular level but can adapt through complex processesOrganizational LevelCellular level onlyCellular, tissue, organ, and system levelsRole in EcosystemFundamental in nutrient cycles, often producers or decomposersCan be producers, consumers, or decomposers, depending on the organismEnvironmental SensitivityQuick to respond to environmental changes, used as bioindicatorsSlower response, but adapt through behavioral, physiological changesGrowthGrowth typically involves an increase in cell size rather than cell numberGrowth involves an increase in cell number, size, and specializationEnergy EfficiencyLess energy-efficient in resource use due to lack of shared functionsMore energy-efficient due to division of labor among specialized cellsHealing and RegenerationTypically regenerate and repair through simple cell replacement or divisionHave more complex healing processes involving specialized cellsDevelopmentLack true developmental processes; life cycle involves direct replicationUndergo complex developmental processes including differentiation and morphogenesisGenetic VariationLess genetic variation within a population due to asexual reproductionHigher genetic variation through sexual reproduction and crossbreedingCell CommunicationLimited to immediate environmental interactionsExtensive cell-to-cell communication through chemical signals, hormones, etc. Unicellular and multicellular organisms represent two fundamental categories of life forms, distinguished primarily by their cellular complexity. Despite the apparent differences in structure and complexity, these organisms share several fundamental characteristics essential for life. Understanding these similarities provides a foundational perspective on the basic principles of biology that apply to all living organisms. Both unicellular and multicellular organisms are composed of cells, which are the basic units of life. These cells perform several core functions that are crucial for their survival: Metabolism: All cells carry out metabolic processes, which involve chemical reactions that provide the energy necessary for maintaining cellular activities and overall organism growth. Genetic Material: Cells in both types of organisms contain genetic material, primarily DNA, which stores the information needed for the regulation of cellular functions and the transmission of genetic traits to offspring. Reproduction: Cellular reproduction is fundamental to both unicellular and multicellular organisms. Unicellular organisms reproduce asexually by processes like binary fission, while multicellular organisms can reproduce both sexually and asexually, depending on the species. Homeostasis: Both unicellular and multicellular organisms maintain a stable internal environment to function effectively, despite changes in their external environment. All cells, whether part of a multicellular system or a single-celled organism, can respond to changes in their environment. This ability allows them to adapt to varying conditions, which is critical for survival. Responses can include moving toward nutrients or away from harmful substances (chemotaxis), and changes in cellular activity in response to temperature or light. At the cellular level, both unicellular and multicellular organisms share similar structural components: Cell Membrane: Both types of organisms have cell membranes that regulate the entry and exit of substances, maintaining the appropriate chemical balance required for cell functions. Ribosomes: These essential cellular structures are responsible for protein synthesis in all living cells, reflecting a universal mechanism for building cellular machinery. Cytosol: The fluid inside cells, where numerous cellular processes occur, is a common feature in both unicellular and multicellular organisms. From an evolutionary perspective, multicellular organisms are thought to have evolved from unicellular ancestors. This evolutionary link highlights a shared heritage and suggests that the fundamental cellular processes have been conserved throughout evolution, emphasizing the robustness of these mechanisms in sustaining life. Unicellular organisms reproduce by simple cell division, while multicellular organisms use complex sexual or asexual methods. Cells in multicellular organisms are specialized and interdependent, forming tissues and organs. Humans are multicellular, composed of many specialized cells. Mosquitoes are multicellular organisms. All animals are multicellular; no true animals are unicellular. Fungi can be either unicellular (like yeasts) or multicellular (like mushrooms). Most bacteria are unicellular, though some can form complex colonies. The largest single-celled organism is the marine alga Caulerpa taxifolia. Viruses are neither; they lack cells and are not considered living organisms. Yes, a tree is a multicellular organism with complex structures. Add Tone Friendly Formal Casual Instructive Professional Empathetic Humorous Serious Optimistic Neutral 10 Examples of Public speaking 20 Examples of Gas lighting Which of the following organisms is an example of a unicellular organism? Choose the correct answer What is a key characteristic that differentiates multicellular organisms from unicellular organisms? Choose the correct answer Ability to perform photosynthesis Presence of multiple cells Which of the following structures is found in multicellular organisms but not in unicellular organisms? Choose the correct answer Which of the following processes is typically carried out by multicellular organisms to maintain homeostasis? Choose the correct answer Specialized organ systems How do unicellular organisms typically reproduce? Choose the correct answer Which of the following best describes the cellular organization of multicellular organisms? Choose the correct answer Single cell with a simple structure Single cell with complex functions Multiple cells with specialized functions Multiple cells with identical functions Which of the following is a feature common to both unicellular and multicellular organisms? Choose the correct answer Ability to perform all life functions within a single cell Ability to grow larger than a single cell Ability to interact with the environment What type of organism is typically simpler in structure, unicellular or multicellular? Choose the correct answer It depends on the specific organism Which of the following is an example of a multicellular organism? Choose the correct answer How do multicellular organisms achieve greater complexity compared to unicellular organisms? Choose the correct answer By increasing the size of individual cells By developing multiple types of cells with different functions By having a single cell that performs all functions By reproducing more rapidly Go ExploreNASA Astrobiology Mailing ListSign-up to get the latest in news, events, and opportunities from the NASA Astrobiology Program.Sign up Any reference in this website to any person, or organization, or activities, products, or services related to such person or organization, or any linkages from this web site to the web site of another party, do not constitute or imply the endorsement, recommendation, or favoring of the U.S. Government, NASA, or any of its employees or contractors acting on its behalf. External LinksScience Mission DirectorateNASABack to Top Unicellular organisms are single-celled, quick to adapt, while multicellular organisms have special... Imagine a world where life thrives in the tiniest of spaces. Unicellular organisms, like bacteria, live as a single cell. They perform all life functions within this one unit. On the other hand, multicellular organisms consist of many cells working together. This fundamental difference shapes how these organisms grow, adapt, and survive. While unicellular life forms can quickly respond to environmental changes, multicellular beings benefit from specialized cells that enhance their survival strategies. This specialization allows them to thrive in diverse environments, showcasing the beauty of life's complexity. Figure 1: Unicellular and Multicellular Organisms Unicellular organisms operate as a single cell, performing all life functions independently, which allows for rapid adaptation but limits complexity. Multicellular organisms consist of many specialized cells that work together, enhancing efficiency and enabling them to thrive in diverse environments. The lack of cellular differentiation in unicellular organisms means they must be versatile, while multicellular organisms benefit from specialized cells that perform unique functions. Unicellular organisms reproduce asexually, leading to limited genetic diversity, whereas multicellular organisms often reproduce sexually, promoting genetic variation crucial for adaptation. Unicellular organisms can quickly respond to environmental changes, but their simple structure limits long-term adaptability compared to the complex response mechanisms of multicellular organisms. BiologyRead moreUnicellular organisms' size and growth potential are restricted, while multicellular organisms can grow larger and develop intricate systems, providing them with a competitive edge. Figure 2: Structural Complexity Understanding the structural complexity of unicellular and multicellular organisms can be quite fascinating. Let's dive into how these life forms differ in their organization and cellular differentiation. When you think about unicellular organisms, imagine a tiny powerhouse. These organisms, like bacteria, consist of just one cell. This single cell performs all the necessary functions for survival. It's like having a one-person band where the musician plays every instrument. The simplicity of their structure allows them to thrive in various environments, adapting quickly to changes. However, this simplicity also limits their size and complexity. In contrast, multicellular organisms are like a well-coordinated orchestra. They consist of many cells working together, each with a specific role. This complex organization allows them to grow larger and live longer. The division of labor among cells means that each cell can specialize in a particular function, enhancing the organism's overall efficiency. This specialization enables them to occupy diverse ecological niches and adapt to different environments. In unicellular organisms, the single cell must handle everything. There's no room for specialization. This lack of differentiation means that the cell must be versatile, performing all life processes independently. While this can be efficient in stable environments, it limits the organism's ability to adapt to new challenges. Multicellular organisms, on the other hand, benefit from cellular differentiation. This process allows cells to become specialized, each performing a unique function. For example, in humans, nerve cells transmit signals, while muscle cells enable movement. This specialization not only increases efficiency but also allows these organisms to develop complex structures and systems, such as organs and tissues. This complexity gives them a competitive edge in survival and adaptation. Real World Examples of cell types and their specialized functions: Nerve Cells (Neurons): These highly specialized cells transmit electrical signals throughout the nervous system. They have long extensions called axons that allow them to communicate with other cells over long distances. Xylem Cells: These cells transport water and minerals from the roots to the leaves. They have thick cell walls and lack living contents at maturity. Understanding how unicellular and multicellular organisms function can be quite intriguing. Let's explore the roles of cells and how these life forms adapt to their environments. Figure 3: Cellular Roles In the world of unicellular organisms, a single cell does it all. Imagine being a one-person show where you handle every task. This cell manages everything from obtaining nutrients to reproducing. It's like having a Swiss Army knife, versatile and ready for any challenge. However, this versatility comes with limitations. The cell must juggle multiple roles, which can restrict its efficiency and adaptability. Now, picture a bustling city where each person has a specific job. That's how multicellular organisms operate. They have many cells, each with a unique role. This division of labor allows them to function more efficiently. For instance, in humans, red blood cells carry oxygen, while white blood cells fight infections. This specialization means that each cell can focus on its task, enhancing the organism's overall performance. It's like having a team of experts working together to achieve a common goal. Unicellular life forms face significant challenges when adapting to new environments. Their single-cell structure, while efficient in many ways, limits their ability to undergo complex changes. Although they can respond quickly to immediate threats, long-term adaptation proves to be much more difficult. To put it another way, it's like trying to solve a complex problem with only a few tools at your disposal. As a result, this limitation can make survival increasingly difficult, especially in rapidly changing conditions where more flexible adaptations are essential. In contrast, multicellular organisms excel in efficiency and adaptation. Their complex structure allows them to adjust to various environments. With specialized cells, they can develop intricate systems like organs and tissues. This complexity gives them an edge in survival. They can thrive in diverse habitats, from deep oceans to high mountains. It's like having a toolbox full of specialized tools, each designed for a specific task. "The whole is greater than the sum of its parts." – Aristotle This quote perfectly captures the essence of multicellular life. By working together, these cells create something extraordinary, showcasing the beauty of life's complexity. Exploring how unicellular and multicellular organisms reproduce reveals fascinating insights into their survival tactics. Let's delve into their reproductive strategies and the resulting genetic diversity. In the world of unicellular life, asexual reproduction reigns supreme. To illustrate, imagine a single cell splitting into two identical copies through a process called binary fission. This method enables these organisms to reproduce quickly and efficiently. In fact, you might think of it as a photocopier, producing exact duplicates with precision. While this process undoubtedly ensures rapid population growth, it also comes with a significant drawback: it limits genetic diversity. Specifically, each new organism is essentially a clone of its parent. Consequently, this lack of genetic variation can pose a disadvantage, especially in rapidly changing environments where adaptability is crucial for survival. On the flip side, multicellular organisms often engage in sexual reproduction. This method involves the combination of genetic material from two parents, creating offspring with unique genetic profiles. Think of it as mixing paints to create new colors. This genetic variation is crucial for adaptation and survival. It allows these organisms to evolve and thrive in diverse environments. The Evolutionary Advantages of Sexual Reproduction highlight how this process introduces variation among offspring, providing a competitive edge. Unicellular organisms face a significant challenge when it comes to genetic diversity. Since their asexual mode of reproduction produces offspring that are nearly identical to the parent, there is limited variation within their population. Consequently, this lack of diversity can make them particularly vulnerable to sudden environmental changes or the emergence of diseases. For instance, imagine a group of identical soldiers confronting an unpredictable and unfamiliar enemy; their uniformity could quickly become a serious disadvantage. Nevertheless, these organisms possess a remarkable ability to reproduce rapidly, which, in many cases, helps to offset this limitation. As a result, their swift reproduction can allow them to adapt more effectively to immediate threats, ensuring their survival in dynamic environments. In contrast, multicellular organisms benefit from greater genetic variation. Sexual reproduction introduces new combinations of genes, enhancing their ability to adapt and survive. This diversity acts like a genetic toolbox, equipping them with the tools needed to face various challenges. The Genetic Variation and Reproductive Strategies in Organisms study emphasizes how meiosis and fertilization contribute to this variation, ensuring the evolutionary success of these organisms. As Charles Darwin once said, "It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change." When it comes to adaptability and survival, unicellular and multicellular organisms showcase fascinating differences. Let's explore how these life forms respond to their environments and the strategies they employ to survive. Imagine a world where quick reactions are not just beneficial but essential for survival. In this context, unicellular organisms, such as bacteria, truly excel. Their simple, single-cell structure enables them to respond rapidly and efficiently to environmental changes. For instance, picture a tiny boat skillfully navigating through turbulent waters. Similarly, these organisms can swiftly adjust their metabolism and behavior in response to shifting conditions, providing them with a significant advantage in unpredictable environments. Moreover, this remarkable agility allows them to thrive in an astonishing variety of habitats, ranging from scorching hot springs to freezing icy waters. In contrast, multicellular organisms have developed intricate response systems. Think of a well-coordinated team tackling a complex problem. These organisms rely on specialized cells to detect and respond to environmental cues. For example, plants use guard cells to regulate water loss, while animals have nervous systems to process information. This complexity allows them to adapt to a wide range of environments, from dense forests to arid deserts. The evolution of multicellularity in C. reinhardtii populations highlights how these phenotypes provide a fitness advantage in the presence of predators. Unicellular life forms, in general, often employ straightforward yet effective survival tactics. For example, they rely on rapid reproduction and metabolic flexibility to withstand harsh conditions. To illustrate, imagine a lone survivor using basic tools to navigate a challenging and unpredictable landscape. Similarly, these organisms can quickly multiply, ensuring their continued presence even in unfavorable environments. However, despite their efficiency, their simplicity can become a significant drawback when confronted with more complex challenges or environmental demands. In contrast, multicellular organisms showcase a remarkable variety of survival strategies, highlighting their adaptability and resilience. Specifically, they utilize specialized cells and intricate systems to overcome obstacles that would be insurmountable for simpler organisms. Picture a diverse team of experts, each contributing unique skills to achieve a common goal. Similarly, multicellular organisms can develop protective structures, such as shells or spines, and engage in sophisticated behaviors like migration or hibernation. Furthermore, this diversity equips them to face a wide range of challenges, significantly enhancing their chances of survival. Ultimately, the evolution of multicellularity demonstrates how these advanced strategies provide a competitive edge in the natural world, emphasizing the power of cooperation and specialization in thriving under diverse conditions. "Adaptability is not imitation. It means power of resistance and assimilation." – Mahatma Gandhi This quote captures the essence of survival in the natural world. Whether through rapid responses or complex strategies, both unicellular and multicellular organisms showcase the incredible adaptability of life. Figure 4: Size and Growth When you explore the world of unicellular and multicellular organisms, you'll notice fascinating differences in their size and growth patterns. Let's dive into how these life forms vary in physical dimensions and growth. Imagine a world where life exists in its tiniest and most fundamental forms. Unicellular organisms, such as bacteria, are incredibly small and fascinatingly efficient. Specifically, they consist of a single cell that carries out all the essential functions required for survival. This compact size not only allows them to thrive in diverse environments, ranging from the vast depths of the ocean to the intricate ecosystem of the human gut, but also provides them with remarkable adaptability. Moreover, their small size enables them to reproduce rapidly, ensuring their survival even in constantly changing conditions. In contrast, multicellular organisms can grow much larger. They consist of many cells working together, each with a specific role. This complexity allows them to exceed the size limits imposed by diffusion, giving them a competitive edge. Think of a towering tree or a majestic elephant. These organisms can occupy diverse ecological niches, from dense forests to open savannas. Their larger size also provides protection against predators and environmental challenges. Unicellular life forms, by their very nature, have limited growth potential. Specifically, their single-cell structure restricts both their size and complexity. While they can reproduce rapidly, their overall growth remains constrained. To illustrate, imagine a tiny seed that can sprout quickly but never develops into a towering tree. Consequently, this limitation can pose a disadvantage in environments where size and complexity are crucial for survival. In contrast, multicellular organisms demonstrate the remarkable ability for continuous growth. Because of their complex structures, they can develop intricate systems such as organs and tissues, allowing them to grow and adapt throughout their lives. For instance, picture a tree that becomes taller and stronger with each passing year. Furthermore, this capacity for ongoing growth and adaptation provides multicellular organisms with a significant edge in navigating and thriving within the natural world. "Growth is the only evidence of life." – John Henry Newman This quote beautifully captures the essence of growth in both unicellular and multicellular organisms. Whether through rapid reproduction or continuous development, these life forms showcase the incredible adaptability of life. Organism: Chlamydomonas reinhardtii Mechanism: This unicellular alga differentiates a specialized eyespot organelle, which allows it to detect light. The organism uses flagella to move toward optimal light conditions for photosynthesis. Impact on Adaptability: The ability to locate light enhances energy production, ensuring survival in varied aquatic environments. Expert research on phototaxis helps develop bio-inspired designs for solar energy harvesting Mechanism: Xylem transports water and minerals from roots to leaves, while phloem distributes sugars from photosynthesis. These tissues arise from undifferentiated cells in the vascular cambium. Impact on Adaptability: This differentiation supports the survival of tall plants in terrestrial ecosystems by efficiently managing resource distribution. Studies on vascular tissue evolution offer insights into how plants colonized land millions of years ago. Figure 5: Unicellular and Multicellular In exploring the world of unicellular organisms and multicellular organisms, you've uncovered fascinating differences. Unicellular organisms, on the one hand, thrive as single cells, independently performing all life functions. Their simplicity, while enabling rapid adaptation, also imposes limitations on complexity. On the other hand, multicellular organisms present a remarkable symphony of specialized cells, each working in harmony to support the organism's survival and growth. Consequently, this complexity enhances their adaptability and overall efficiency. By understanding these distinctions, we can better appreciate the beauty of life's diversity and the evolutionary paths that have shaped these organisms. Moreover, as you reflect on these insights, consider how these differences profoundly impact survival strategies and functionality within the natural world. Multicellular organisms stand out because of their complex interactions. In these systems, cells work together to form organized entities. This cooperation allows them to perform specialized functions, which unicellular organisms cannot achieve. Imagine a team where each member has a specific role, enhancing the group's overall performance. Predation is believed to be a significant factor in the evolution of multicellularity. By forming groups, organisms could better protect themselves from predators. Think of it as a herd of animals banding together for safety against a common threat. Unicellular organisms often reproduce asexually because it's quick and efficient. This method allows them to rapidly increase their population. However, it limits genetic diversity, making them more vulnerable to environmental changes. Sexual reproduction introduces genetic variation, which is crucial for adaptation and survival. This diversity equips multicellular organisms with the tools needed to face various challenges. It's like having a diverse toolbox, ready for any task. Indeed, unicellular organisms can adapt rapidly, largely due to their simple structure. For instance, they can quickly adjust their metabolism and behavior, allowing them to survive in constantly changing conditions. Consequently, this remarkable agility provides them with a significant edge, especially in unpredictable environments where flexibility is crucial for survival. Multicellular organisms rely on specialized cells to detect and respond to environmental cues. This complexity allows them to adapt to a wide range of environments. Imagine a well-coordinated team tackling a complex problem, each member contributing their expertise. Unicellular organisms are typically small, consisting of a single cell. This compact size allows them to thrive in diverse environments. In contrast, multicellular organisms can grow much larger, thanks to their complex structure. This size provides protection and enables them to occupy various ecological niches. The complex structure of multicellular organisms allows them to develop intricate systems, such as organs and tissues. As a result, this structural complexity enables continued growth throughout their lives, providing them with the ability to adapt to changing environments. For example, picture a tree that grows taller and stronger with each passing year, constantly adjusting to its surroundings and becoming more resilient over time. Unicellular organisms often employ straightforward survival tactics. 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There can be one or more cells in a living organism, and an organism with a single cell is known as a unicellular organism, while on the other hand, organisms with multiple cells are known as multicellular organisms. What is a Unicellular Organism?A unicellular organism or commonly referred to as a single-celled organism is an organism made up of a single cell and these organisms rely on this single cell for all their functionality. These unicellular organisms are further divided into two categories i.e. eukaryotic and prokaryotic. Eukaryotic are multicellular organisms whose cell contains the nucleus and other organelles, while on the other hand, most prokaryotic are unicellular in which the nucleus is absent. These unicellular organisms are considered to be the oldest living organisms, whose occurrence dates around 4 billion years ago. Amoeba, plasmodium, euglena, algae, protozoa, paramecium, and fungi are some of the common unicellular organisms. What is a Multicellular Organism?Just opposite to unicellular or single-celled organisms, multicellular organisms are one that contains multiple cells, which work together to achieve the proper functionality in that living organism. In Multicellular organisms, different cells are responsible for different tasks. Almost all species of land plants and animals are multicellular, however, some plants and bacteria can be partially multicellular as well. These multicellular organisms are the result of cell division or a combination of cells. Humans, dogs, cows, cats, trees, chickens, and other animals are examples of multicellular organisms. Difference Between Multicellular and Unicellular Organisms?Unicellular Organisms Multicellular Organisms Made up of a single cellMade up of a combination of multiple cellsThe whole cell is exposed to the outer environmentOnly outer cells are in contact with the environmentIt usually has a shorter lifespanIt has a longer lifespanThe body formation is quite simpleThe body formation is quite complex in natureBoth eukaryotes and prokaryotes fall into this categoryOnly eukaryotes come under this categoryThe whole life process is controlled by a single cellMultiple cells together are responsible for proper functioningThese species are microscopic in natureMost of these organisms are macroscopic in natureUnicellular organisms can be either autotrophs or heterotrophsMulticellular organisms are both autotrophs and heterotrophsAny serious injury to a cell can lead to deathAny physical damage to a cell doesn't lead to deathBacteria, yeast, amoeba, and paramecium falls under unicellular organisms.Humans, plants, animals, and birds fall under multicellular organisms.ConclusionBoth unicellular and multicellular organisms have different body structures the unicellular organisms are more prone to extreme temperatures and are thus often called extremophiles. Unicellular organisms can sustain extremely cold to extremely hot temperatures. While on the other hand, normally multicellular organisms can resist extreme temperatures. For example, a small injury or physical damage to a multicellular organism doesn't lead to death but can surely lead to death in unicellular organisms. Apart from body construction, unicellular organisms rely upon a single cell for whole-body functions, while multicellular organisms rely on multiple cells. Written byCharles Q. ChoiSourceastrobio.netCells of Dictyostelium purpureum, a common soil microbe, streaming to form a multicellular fruiting body. Credit: Natasha Mehdiabadi/Rice UniversityScientists are discovering ways in which single cells might have evolved traits that entrenched them into group behavior, paving the way for multicellular life. These discoveries could shed light on how complex extraterrestrial life might evolve on alien worlds.Researchers detailed these findings in the October 24, 2016 issue of the journal Science.The first known single-celled organisms appeared on Earth about 3.5 billion years ago, roughly a billion years after Earth formed. More complex forms of life took longer to evolve, with the first multicellular animals not appearing until about 600 million years ago.The evolution of multicellular life from simpler, unicellular microbes was a pivotal moment in the history of biology on Earth and has drastically reshaped the planet's ecology. However, one mystery about multicellular organisms is why cells did not return back to single-celled life."Unicellularity is clearly successful — unicellular organisms are much more abundant than multicellular organisms, and have been around for at least an additional 2 billion years," said lead study author Eric Libby, a mathematical biologist at the Santa Fe Institute in New Mexico. "So what is the advantage to being multicellular and staying that way?"The answer to this question is usually cooperation, as cells benefitted more from working together than they would from living alone. However, in scenarios of cooperation, there are constantly tempting opportunities "for cells to shirk their duties — that is, cheat," Libby said.When social amoeba Dictyostelium discoideum starves, it forms a multicellular body. Credit: Scott Solomon"As an example, consider an ant colony where only the queen is laying eggs and the workers, who cannot reproduce, must sacrifice themselves for the colony," Libby said. "What prevents the ant worker from leaving the colony and forming a new colony? Well, obviously the ant worker cannot reproduce, so it cannot start its own colony. But if it got a mutation that enabled it to do that, then this would be a real problem for the colony. This kind of struggle is prevalent in the evolution of multicellularity because the first multicellular organisms were only a mutation away from being strictly unicellular."Experiments have shown that a group of microbes that secretes useful molecules that all members of the group can benefit from can grow faster than groups that do not. But within that group, freeloaders that do not expend resources or energy to secrete these molecules grow fastest of all. Another example of cells that grow in a way that harms other members of their groups are cancer cells, which are a potential problem for all multicellular organisms.Indeed, many primitive multicellular organisms probably experienced both unicellular and multicellular states, providing opportunities to forego a group lifestyle. For example, the bacterium Pseudomonas fluorescens rapidly evolves to generate multicellular mats on surfaces to gain better access to oxygen. However, once a mat has formed, unicellular cheats have an incentive to not produce the glue responsible for mat formation, ultimately leading to the mat's destruction.Groups of yeast cells. If key cells die a programmed death, these groups can separate. Credit: E. Libby et al., PLOS Computational BiologyTo solve the mystery of how multicellular life persisted, scientists are suggesting what they call "ratcheting mechanisms." Ratchets are devices that permit motion in just one direction. By analogy, ratcheting mechanisms are traits that provide benefits in a group context but are detrimental to loners, ultimately preventing a reversion to a single-celled state, said Libby and study co-author William Ratcliff at the Georgia Institute of Technology in Atlanta.In general, the more a trait makes cells in a group mutually reliant, the more it serves as a ratchet. For instance, groups of cells may divide labor so that some cells grow one vital molecule while other cells grow a different essential compound, so these cells do better together than apart, an idea supported by recent experiments with bacteria.Ratcheting can also explain the symbiosis between ancient microbes that led to symbionts living inside cells, such as the mitochondria and chloroplasts that respectively help their hosts make use of oxygen and sunlight. The single-celled organisms known as Paramecia do poorly when experimentally deprived of photosynthetic symbionts, and in turn symbionts typically lose genes that are required for life outside their hosts.These ratcheting mechanisms can lead to seemingly nonsensical results. For instance, apoptosis, or programmed cell death, is a process by which a cell essentially undergoes suicide. However, experiments show that higher rates of apoptosis can actually have benefits. In large clusters of yeast cells, apoptotic cells act like weak links whose death allows small clumps of yeast cells to break free and go on to spread elsewhere where they might have more room and nutrients to grow.A fossil of a 600 million-year-old multicellular organism displays unexpected evidence of complexity. Credit: Virginia Tech"This advantage does not work for single cells, which meant that any cell that abandoned the group would suffer a disadvantage," Libby said. "This work shows that a cell living in a group can experience a fundamentally different environment than a cell living on its own. The environment can be so different that traits disastrous for a solitary organism, like increased rates of death, can become advantageous for cells in a group."When it comes to what these findings mean in the search for alien life, Libby said this research suggests that extraterrestrial behavior might appear odd until one better understands that an organism may be a member of a group."Organisms in communities can adopt behaviors that would appear bizarre or counterintuitive without proper consideration of their communal context," Libby said. "It is essentially a reminder that a puzzle piece is a puzzle until you know how it fits into a larger context."Libby and his colleagues plan to identify other ratcheting mechanisms."We also have some experiments in the works to calculate the stability provided by some possible ratcheting traits," Libby said.NASA Astrobiology Mailing ListSign-up to get the latest in news, events, and opportunities from the NASA Astrobiology Program.Sign up Any reference in this website to any person, or organization, or activities, products, or services related to such person or organization, or any linkages from this web site to the web site of another party, do not constitute or imply the endorsement, recommendation, or favoring of the U.S. Government, NASA, or any of its employees or contractors acting on its behalf. External LinksScience Mission DirectorateNASABack to Top The difference between unicellular and multicellular organisms is primarily due to cell composition, function, and arrangement. Unicellular organisms exist as an individual cell, whereas multicellular organisms possess a group of specialized cells. Unicellular organisms mediate all their cellular activities by a single cell itself, while multicellular organisms perform specific cell activities through their specialized or distinct group of cells. The cell arrangement is much simpler in unicellular organisms, whereas multicellular organisms have a complex cell arrangement. Both unicellular and multicellular organisms are the two major categories of the cell type, depending on cell number, shape, and size. In this post, we will study the key differences and similarities between the unicellular and multicellular organisms, along with the definition of the two. Content: Unicellular vs Multicellular Organisms Comparison Chart Definition Key Differences Similarities Conclusion Comparison Chart PropertiesUnicellular OrganismsMulticellular Organisms Cell numberSingle cellMultiple cells Cell sizeSmallComparatively large Cell shapeIrregularDefinite Cell organizationSimpleComplex NatureMicroscopicMacroscopic Cell typeThey include organisms of both prokaryotic and eukaryotic cell typeThey include organisms of only eukaryotic cell type Cell differentiationGenerally absent, but unicellular yeasts may undergo differentiationSpecialized cell differentiation occurs Life spanShortLonger Division of labourLimited to the organelle levelSpecified to cellular, tissue and organ system level Operational efficiencyLowHigh Regeneration abilityGreater tendency to regenerateLow regeneration ability Reproduction methodsBudding and binary fissionGamete fusion Transport mechanismThe transport mechanism for food and water occurs through simple diffusionThe transport mechanism for food and water occurs by the diffusion, active and passive transport methods ExamplesBacteria, Protozoans, unicellular amoeba etc.Humans, animals, plants etc. Definition of Unicellular Organisms They refer to the living organisms, which possess a single cell only to perform different life processes or cellular activities in the cytoplasm. It includes prokaryotic organisms like bacteria and archaea and eukaryotic organisms like protozoa, unicellular algae and yeasts. One of the most common features of unicellular organisms is their microscopic nature, i.e. unobservable through the naked eye. They commonly reproduce via asexual methods like budding, fragmentation and binary fission. But a few reproduce sexually via conjugation (like bacteria and protists). Because of single-cell composition, the cell arrangement is quite simple. They can thrive in extreme heat, acidity, salinity, and other environmental stresses. Definition of Multicellular Organisms They refer to living organisms, which possess multiple cells with distinct cell organelles that perform separate cellular activities or different life processes within a body. It only includes eukaryotic organisms like insects, animals, birds, human etc. One of the most common features of a multicellular organism is its macroscopic nature, i.e. easily noticeable through the open eye. They commonly reproduce via sexual methods (by the formation of a zygote). But, few members can grow via asexual means like budding and spore formation. Because of multiple cell composition, it has a composite cell arrangement. Organism's size increases as the cell number increases. Unicellular organisms appear small and single-celled, whereas multicellular organisms are large-sized, containing multiple cells. The cell arrangement of unicellular organisms is incomplex than the multicellular organisms. Unicellular organisms are microscopic, i.e. only evident under the microscope, whereas multicellular organisms are macroscopic, i.e. detectable with the naked eye. Unicellular organisms include microorganisms of both prokaryotic (bacteria, archaea, etc.) and eukaryotic (protozoa, unicellular algae, unicellular fungi, etc.) cell type. In contrast, human, animal, higher and lower plants have a multicellular eukaryotic cell type. The division of labour in unicellular organisms is limited to the organelle level, while it is specified to cellular, tissue, and organ system levels in multicellular organisms. Due to single-cell and high workload, the unicellular organisms have a shorter life span and lower operational efficiency than the multicellular species. Unicellular organisms generally do not undergo cell differentiation, except unicellular yeasts. Oppositely, multicellular organisms undergo specific cell division to form differentiated cells, mediating particular tasks within a living organism. The members with multiple cell-type lose the regeneration ability over a period of cell growth and differentiation or cell ageing. Oppositely, unicellular organisms are immortal, as they have a considerable tendency of regenerating themselves. Similarities Both single and multi-celled organisms originate from a functional unit of life, known as "Cells". The presence of plasma membrane and cytoplasm occurs in both types. Both the organisms share a similar feature by containing DNA and ribosomes for gene expression. The process of cell division typically occurs in both types, commonly through mitosis or meiosis. Both organisms need cellular energy to function. Conclusion Therefore, we can conclude that a cell can be unicellular and multicellular type, which undergoes the same life processes like respiration, digestion, excretion etc., to sustain life. A significant difference is in a cell number that creates a significant difference in cellular function, work efficiency, cell arrangement etc., of the unicellular and multicellular organisms. The unicellular organisms have a single cell due to which their function is fully dependent on a single cell only, which eventually reduces the working efficiency and life span of the organisms due to heavy workload. In contrast, multicellular species possess multiple cells to perform distinct tasks by coordinating different cells and eventually promotes high working efficiency and a long life span due to the division of cell labour. Organism that consists of more than one cell The nematode Caenorhabditis elegans stained to highlight the nuclei of its cells A multicellular organism is an organism that consists of more than one cell, unlike unicellular organisms.[1] All species of animals, land plants and most fungi are multicellular, as are many algae, whereas a few organisms are partially uni- and partially multicellular, like slime molds and social amoebae such as the genus Dictyostelium.[2][3] Multicellular organisms arise in various ways, for example by cell division or by aggregation of many single cells.[4][3] Colonial organisms are the result of many identical individuals joining together to form a colony. However, it can often be hard to separate colonial protists from true multicellular organisms, because the two concepts are not distinct; colonial protists have been dubbed "pluricellular" rather than "multicellular".[5][6] There are also macroscopic organisms that are multinucleate though technically unicellular, such as the Xenophyophorea that can reach 20 cm. Multicellularity has evolved independently at least 25 times in eukaryotes,[7][8] and also in some prokaryotes, like cyanobacteria, myxobacteria, actinomycetes, Magnetoglobus multicellularis or Methanosarcina.[3] However, complex multicellular organisms evolved only in six eukaryotic groups: animals, symbiomycotan fungi, brown algae, red algae, green algae, and land plants.[9] It evolved repeatedly for Chloroplastida (green algae and land plants), once for animals, once for brown algae, three times in the fungi (chytrids, ascomycetes, and basidiomycetes)[10] and perhaps several times for slime molds and red algae.[11] To reproduce, true multicellular organisms must solve the problem of regenerating a whole organism from germ cells (i.e., sperm and egg cells), an issue that is studied in evolutionary developmental biology. Animals have evolved a considerable diversity of cell types in a multicellular body (100–150 different cell types), compared with 10–20 in plants and fungi.[12] The first evidence of multicellular organization, which is when unicellular organisms coordinate behaviors and may be an evolutionary precursor to true multicellularity, is from cyanobacteria-like organisms that lived 3.0–3.5 billion years ago.[7] Decimeter-scale multicellular fossils have been found as early as 1.56 Ga.[13] Loss of multicellularity occurred in some groups.[14] Fungi are predominantly multicellular, though early diverging lineages are largely unicellular (e.g., Microsporidia) and there have been numerous reversions to unicellularity across fungi (e.g., Saccharomycotina, Cryptococcus, and other yeasts).[15][16] It may also have occurred in some red algae (e.g., Porphyridium), but they may be primitively unicellular.[17] Loss of multicellularity is also considered probable in some green algae (e.g., Chlorella vulgaris and some Ulvophyceae).[18][19] In other groups, generally parasites, a reduction of multicellularity occurred, in the number or types of cells (e.g., the myxozoans, multicellular organisms, earlier thought to be unicellular, are probably extremely reduced cnidarians).[20] Multicellular organisms, especially long-living animals, face the challenge of cancer, which occurs when cells fail to regulate their growth within the normal program of development. Changes in tissue morphology can be observed during this process. Cancer in animals (metazoans) has often been described as a loss of multicellularity and an atavistic reversion towards a unicellular-like state.[21] Many genes responsible for the establishment of multicellularity that originated around the appearance of metazoans are deregulated in cancer cells, including genes that control cell differentiation, adhesion and cell-to-cell communication.[22][23] There is a discussion about the possibility of existence of cancer in other multicellular organisms[24][25] or even in protozoa.[26] For example, plant galls have been characterized as tumors,[27] but some authors argue that plants do not develop cancer.[28] In some multicellular groups, which are called Weismannists, a separation between a sterile somatic cell line and a germ cell line evolved. However, Weismannist development is relatively rare (e.g., vertebrates, arthropods, Volvox), as a great part of species have the capacity for somatic embryogenesis (e.g., land plants, most algae, many invertebrates).[29][10] Tetrabaena socialis consists of four cells. One hypothesis for the origin of multicellularity is that a group of function-specific cells aggregated into a slug-like mass called a grex, which moved as a multicellular unit. This is essentially what slime molds do. Another hypothesis is that a primitive cell underwent nucleus division, thereby becoming a coenocyte. A membrane would then form around each nucleus (and the cellular space and organelles occupied in the space), thereby resulting in a group of connected cells in one organism (this mechanism is observable in Drosophila). A third hypothesis is that as a unicellular organism divided, the daughter cells failed to separate, resulting in a conglomeration of identical cells in one organism, which could later develop specialized tissues. This is what plant and animal embryos do as well as colonial choanoflagellates.[30][31] Because the first multicellular organisms were simple, soft organisms lacking bone, shell, or other hard body parts, they are not well preserved in the fossil record.[32] One exception may be the demosponge, which may have left a chemical signature in ancient rocks. The earliest fossils of multicellular organisms include the contested Grypania spiralis and the fossils of the black shales of the Palaeoproterozoic Francevillian Group Fossil B Formation in Gabon (Gabonionta).[33] The Doushantuo Formation has yielded 600 million year old microfossils with evidence of multicellular traits.[34] Until recently, phylogenetic reconstruction has been through anatomical (particularly embryological) similarities. This is inexact, as living multicellular organisms such as animals and plants are more than 500 million years removed from their single-cell ancestors. Such a passage of time allows both divergent and convergent evolution time to mimic similarities and accumulate differences between groups of modern and extinct ancestral species. Modern phylogenetics uses sophisticated techniques such as alloenzymes, satellite DNA and other molecular markers to describe traits that are shared between distantly related lineages.[citation needed] The evolution of multicellularity could have occurred in several different ways, some of which are described below: This theory suggests that the first multicellular organisms occurred from symbiosis (cooperation) of different species of single-cell organisms, each with different roles. Over time these organisms would become so dependent on each other that they would not be able to survive independently, eventually leading to the incorporation of their genomes into one multicellular organism.[35] Each respective organism would become a separate lineage of differentiated cells within the newly created species.[citation needed] This kind of severely co-dependent symbiosis can be seen frequently, such as in the relationship between clown fish and Riterri sea anemones. In these cases, it is extremely doubtful whether either species would survive very long if the other became extinct. However, the problem with this theory is that it is still not known how each organism's DNA could be incorporated into one single genome to constitute them as a single species. Although such symbiosis is theorized to have occurred (e.g., mitochondria and chloroplasts in animal and plant cells—endosymbiosis), it has happened only extremely rarely and, even then, the genomes of the endosymbionts have retained an element of distinction, separately replicating their DNA during mitosis of the host species. For instance, the two or three symbiotic organisms forming the composite lichen, although dependent on each other for survival, have to separately reproduce and then re-form to create one individual organism once more.[citation needed] This theory states that a single unicellular organism, with multiple nuclei, could have developed internal membrane partitions around each of its nuclei.[36] Many protists such as the ciliates or slime molds can have several nuclei, lending support to this hypothesis. However, the simple presence of multiple nuclei is not enough to support the theory. Multiple nuclei of ciliates are dissimilar and have clear differentiated functions. The macronucleus serves the organism's needs, whereas the micronucleus is used for sexual reproduction with exchange of genetic material. Slime molds syncitia form from individual amoeboid cells, like syncitial tissues of some multicellular organisms, not the other way round. To be deemed valid, this theory needs a demonstrable example and mechanism of generation of a multicellular organism from a pre-existing syncytium.[citation needed] The colonial theory of Haeckel, 1874, proposes that the symbiosis of many organisms of the same species (unlike the symbiotic theory, which suggests the symbiosis of different species) led to a multicellular organism. At least some - it is presumed land-evolved - multicellularity occurs by cells separating and then rejoining (e.g., cellular slime molds) whereas for the majority of multicellular types (those that evolved within aquatic environments), multicellularity occurs as a consequence of cells failing to separate following division.[37] The mechanism of this latter colony formation can be as simple as incomplete cytokinesis, though multicellularity is also typically considered to involve cellular differentiation.[38] The advantage of the Colonial Theory hypothesis is that it has been seen to occur independently in 16 different protoctistan phyla. For instance, during food shortages the amoeba Dictyostelium groups together in a colony that moves as one to a new location. Some of these amoeba then slightly differentiate from each other. Other examples of colonial organisation in protista are Volvocaceae, such as Eudorina and Volvox, the latter of which consists of up to 500–50,000 cells (depending on the species), only a fraction of which reproduce.[39] For example, in one species 25–35 cells reproduce, 8 asexually and around 15–25 sexually. However, it can often be hard to separate colonial protists from true multicellular organisms, as the two concepts are not distinct; colonial protists have been dubbed "pluricellular" rather than "multicellular".[5] Some authors suggest that the origin of multicellularity, at least in Metazoa, occurred due to a transition from temporal to spatial cell differentiation, rather than through a gradual evolution of cell differentiation, as affirmed in Haeckel's gastraea theory.[40] About 800 million years ago,[41] a minor genetic change in a single molecule called guanylate kinase protein-interaction domain (GK-PID) may have allowed organisms to go from a single cell organism to one of many cells.[42] Genes borrowed from viruses and mobile genetic elements (MGEs) have recently been identified as playing a crucial role in the differentiation of multicellular tissues and organs and even in sexual reproduction, in the fusion of egg cells and sperm.[43][44] Such fused cells are also involved in metazoan membranes such as those that prevent chemicals from crossing the placenta and the brain body separation.[43] Two viral components have been identified. The first is syncytin, which came from a virus.[45] The second identified in 2002 is called EFF-1,[46] which helps form the skin of Caenorhabditis elegans, part of a whole family of FF proteins. Felix Rey, of the Pasteur Institute in Paris, has constructed the 3D structure of the EFF-1 protein[47] and shown it does the work of linking one cell to another, in viral infections. The fact that all known cell fusion molecules are viral in origin suggests that they have been vitally important to the inter-cellular communication systems that enabled multicellularity. Without the ability of cellular fusion, colonies could have formed, but anything even as complex as a sponge would not have been possible.[48] This theory suggests that the oxygen available in the atmosphere of early Earth could have been the limiting factor for the emergence of multicellular life.[49] This hypothesis is based on the correlation between the emergence of multicellular life and the increase of oxygen levels during this time. This would have taken place after the Great Oxidation Event but before the most recent rise in oxygen. Mills[50] concludes that the amount of oxygen present during the Ediacaran is not necessary for complex life and therefore is unlikely to have been the driving factor for the origin of multicellularity.[citation needed] A snowball Earth is a geological event where the entire surface of the Earth is covered in snow and ice. The term can either refer to individual events (of which there were at least two) or to the larger geologic period during which all the known total glaciations occurred. The most recent snowball Earth took place during the Cryogenian period and consisted of two global glaciation events known as the Sturtian and Marinoan glaciations. Xiao et al.[51] suggest that between the period of time known as the "Boring Billion" and the snowball Earth, simple life could have had time to innovate and evolve, which could later lead to the evolution of multicellularity. The snowball Earth hypothesis in regards to multicellularity proposes that the Cryogenian period in Earth's history could have been the catalyst for the evolution of complex multicellular life. Brocks[52] suggests that the time between the Sturtian Glacian and the more recent Marinoan Glacian allowed for planktonic algae to dominate the seas making way for rapid diversity of life for both plant and animal lineages. Complex life quickly emerged and diversified in what is known as the Cambrian explosion shortly after the Marinoan.[citation needed] The predation hypothesis suggests that to avoid being eaten by predators, simple single-celled organisms evolved multicellularity to make it harder to be consumed as prey. Herron et al.[53] performed laboratory evolution experiments on the single-celled green alga, Chlamydomonas reinhardtii, using paramecium as a predator. They found that in the presence of this predator, C. reinhardtii does indeed evolve simple multicellular features.[citation needed] It is impossible to know what happened when single cells evolved into multicellular organisms hundreds of millions of years ago. However, we can identify mutations that can turn single-celled organisms into multicellular ones. This would demonstrate the possibility of such an event. Unicellular species can relatively easily acquire mutations that make them attach to each other—the first step towards multicellularity. Multiple normally unicellular species have been evolved to exhibit such early steps: yeast are long known to exhibit flocculation. One of the first yeast genes found to cause this phenotype is FLO1.[54] A more strikingly clumped phenotype is called "snowflake", caused by the loss of a single transcription factor Ace2. "Snowflake" yeast grow into multicellular clusters that sediment quickly; they were identified by directed evolution.[55] More recently (2024), snowflake yeast were subject to over 3,000 generations of further directed evolution, forming macroscopic assemblies on the scale of millimeters. Changes in multiple genes were identified. In addition, the authors reported that only anaerobic cultures of snowflake yeast evolved this trait, while the aerobic ones did not.[56] A range of green algae species have been experimentally evolved to form larger clumps. When Chlorella vulgaris is grown with a predator Ochromonas vallescia, it starts forming small colonies, which are harder to ingest due to the larger size. The same is true for Chlamydomonas reinhardtii under predation by Brachionus calyciflorus and Paramecium tetraurelia. C. reinhartii normally starts as a motile single-celled propagule; this single cell asexually reproduces by undergoing 2–5 rounds of mitosis as a small clump of non-motile cells, then all cells become single-celled propagules and the clump dissolves. With a few generations under Paramecium predation, the "clump" becomes a persistent structure: only some cells become propagules. Some populations go further and evolved multi-celled propagules: instead of peeling off single cells from the clump, the clump now reproduces by peeling off smaller clumps.[53] Multicellularity allows an organism to exceed the size limits normally imposed by diffusion: single cells with increased size have a decreased surface-to-volume ratio and have difficulty absorbing sufficient nutrients and transporting them throughout the cell. Multicellular organisms thus have the competitive advantages of an increase in size without its limitations. They can have longer lifespans as they can continue living when individual cells die. Multicellularity also permits increasing complexity by allowing differentiation of cell types within one organism.[citation needed] Whether all of these can be seen as advantages however is debatable: The vast majority of living organisms are single celled, and even in terms of biomass, single celled organisms are far more successful than animals, although not plants.[57] Rather than seeing traits such as longer lifespans and greater size as an advantage, many biologists see these only as examples of diversity, with associated tradeoffs.[citation needed] During the evolutionary transition from unicellular organisms to multicellular organisms, the expression of genes associated with reproduction and survival likely changed.[58] In the unicellular state, genes associated with reproduction and survival are expressed in a way that enhances the fitness of individual cells, but after the transition to multicellularity, the pattern of expression of these genes must have substantially changed so that individual cells become more specialized in their function relative to reproduction and survival.[58] As the multicellular organism emerged, gene expression patterns became compartmentalized between cells that specialized in reproduction (germline cells) and those that specialized in survival (somatic cells). 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