International Journal of Chemical and Biological Sciences 2023; 5(1): 49-54

E-ISSN: 2664-6773
P-ISSN: 2664-6765
Impact Factor: RJIF 5.6
IJCBS 2023; 5(1): 49-54
www.chemicaljournal.org
Received: 12-12-2022
Accepted: 23-01-2023

Dr. VDS Kumari Perumalla
Department of Microbiology, MVR Degree College (UG & PG), Gajuwaka, Visakhapatnam, Andhra Pradesh, India

Gopi Garata
Department of Microbiology, MVR Degree College (UG & PG), Gajuwaka, Visakhapatnam, Andhra Pradesh, India

Manoj Krishna Talari
Department of Microbiology, MVR Degree College (UG & PG), Gajuwaka, Visakhapatnam, Andhra Pradesh, India

Corresponding Author:
Dr. VDS Kumari Perumalla
Department of Microbiology, MVR Degree College (UG & PG), Gajuwaka, Visakhapatnam, Andhra Pradesh, India

Glimpses of weird and wonderful world of microbes

Dr. VDS Kumari Perumalla, Gopi Garata and Manoj Krishna Talari

DOI: https://doi.org/10.33545/26646765.2023.v5.i1a.61

Abstract
Microorganisms can be seen with the help of microscope. Microorganisms include Bacteria, Archaea, Viruses, Fungi, Protist, Protozoa and algae etc. Microbes are omnipresent in the biosphere and their presence invariably affects the environment in which they grow. The effects of microbes on the environment can be beneficial or harmful or in apparent with regards to human measure or observation. The most significant effect of microbes on the Earth is their ability to recycle the primary elements that make up all living systems, especially carbon, oxygen, nitrogen. This article mainly focuses on beneficial and harmful impact of microbes on environment and their role to maintain quality, health and sustainability of environment. Some microorganisms are beneficial while some are non-beneficial for human beings. Some microbes spread different disease in the world and make the world polluted but some clean the pollution of the World.

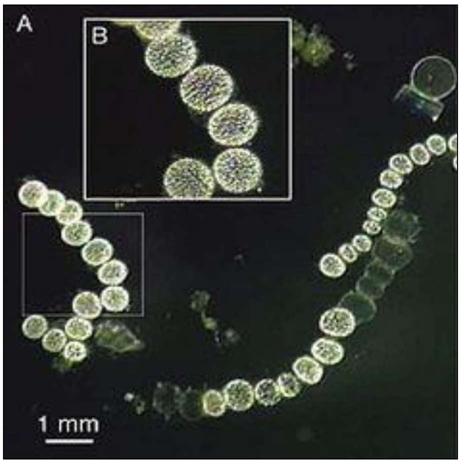
Keywords: Bacteria, archaea, viruses, fungi, protist, protozoa, carbon, nitrogen, oxygen

Introduction
"We live on the planet of the microbes, but it's largely unexplored", "we're entirely dependent on this microbial population for our well-being".
Mi-cro-or-gan-ism (mi'kro-or'geniz'm), is a living creature too small to be seen without a microscope. Some (protozoa) are animals; some are simple forms of plant life (algae, yeasts, moulds, etc.); some (bacteria) hold an intermediate place between the animals and plant kingdom; and some (viruses) are too primitive to be classified as plant or animals. Countless trillions of microbes inhabit every cranny of the globe. They reshape their environment, make life possible and sometimes destroy. Despite their minuscule size, these creatures also have had an enormous effect on land, water and air. Micro-organism manufacture oxygen, convert nitrogen into forms that plants can eat and drive the cycles of carbon, sulfur, iron and other elements essential to life. Microbes are responsible for generating at least half the oxygen we breathe. Microbes plays a key role in the transformation of Earth to a habitable planet. Microbes out-number all other species and make up about ~60% of the Earth's biomass. Less than 0.5% of the estimated 2 to 3 billion microbial species have been identified.
Microbes are roots of life's family tree. An understanding of their genomes will help us understand how more complex genomes developed. Microbial genomes are modest in size and relatively easy to study (usually no more than 10 million DNA bases, compared with some 3 billion in the human and mouse genomes). Microbial communities are excellent models for understanding biological interactions and evolution.
Microbes comes in a number of shapes and sizes, but most of these shapes are rather uncomplicated. The easiest shapes for a microbe are a sphere, like a soap bubble. The cell membranes of microbes tend to naturally form this simple structure due to forces such as surface tension.
Some rare microbes form radically unique shapes. Using high-powered microscopes, the scientist captured images that show star-shaped cells with four to nine points. It's unique structure for a microbe and one that has not been witnessed before (Fig 1) [7].

(Courtesy: Wagner *et al*.)

Fig 1: Star shaped cells

The cell membrane of the bacterium twists and turns to provide its unique shape. The colossus among bacteria is a single celled giant that lives in the ocean and is named *Thiomargarita namibiensis*, which means "sulfur pearl of Namibia" (fig 2). It was found in the ocean floor of the coast of Namibia in Africa. *T. namibiensis's* ball-shaped cells can grow to almost 1 millimetre or 1/25th of an inch in diameter. *T. namibiensis* "eats" sulfur and "breathes" nitrate. It stores these molecules in bubble-like compartment in its cell called vacuoles. These vacuoles take up 97% of the space inside the cell and give the bacterium a pearly, blue-green colour [15].



(Courtesy: H.N. Schulz)

Fig 2: *Thiomargarita namibiensis*

The largest bacterium is *Epulopiscium fischelsoni* (fig. 3) that have been discovered in the guts of a fish found in the warm water of the Red sea. It measures 200-700 micrometres. Viewed through powerful electron microscopes, it looks like fuzzy tangles of threads. It is polymorphic and lacks cells wall components [2].

(Courtesy: Bresler *et al*.)

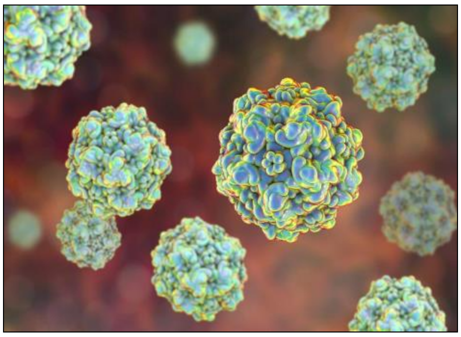
Fig 3: *Epulopiscium fishelsoni*

Did you ever wonder what the world's largest organism is? Maybe you'd pick an elephant or a giant whale. Well, those choices would be wrong; this organism is actually a soil fungus, *Armellaria bulbosa* (fig. 4) found in a northern Michigan hardwood forest. It is most likely one of the world's oldest organisms as well, exceeding 1,500 years and weighing over 100 tons. It is actually a plant pathogen, whose hyphae pierce the root of aspen trees and absorbs nutrients from them. They are also referred to as 'honey mushrooms' [10].

(Courtesy: Internet)

Fig 4: *Armellaria bulbosa*

The smallest of the small are the viruses. The smallest of all are members of a group called the parvoviruses. Some of these spherical viruses can be as little as 18 nano meters in diameter (fig. 5) [13].



(Courtesy: Wadsworth centre, New York State Department of Health)

Fig 5: Parvovirus

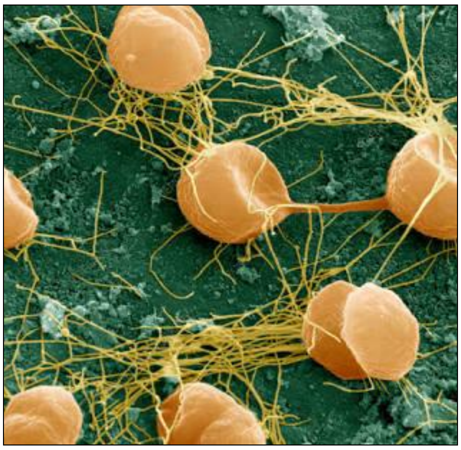
Mycoplasmas are the smallest "known" free-living microorganism about 300nm in diameter (fig. 6) [11].

(Courtesy: Duncan Krause)

Fig 6: *Mycoplasma pneumoniae*

Microorganisms are "omnipresent". They are found in air, water, soil, animals, plants, rocks or even polar region. Microbes thrives in an amazing diversity of habitats in extremes of heat, cold, radiation, pressure, salinity, acidity, darkness and often where no other life forms could exist. They also survive different extreme environmental conditions. Certain bacteria grow very well in the cold. Researchers have reported findings of large populations of bacteria in surface snow collected from South Pole. They found 200 to 5,000 bacterial cells per millilitre (there are 5 millilitres in a teaspoon) in the surface snow. These organisms are so tough that they are able to make protein and DNA at temperatures as low as 17 degrees Fahrenheit. If an organism can make proteins and DNA, it can grow and make divided too.

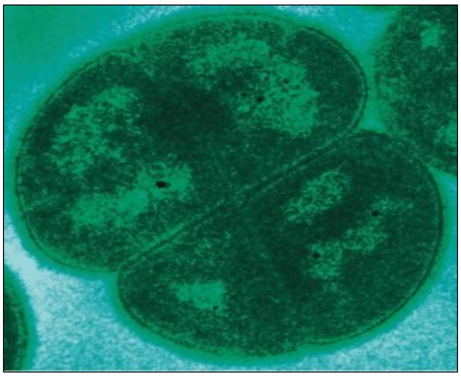
Archaebacteria or primitive bacteria are found in undersea hot vents, where there is no sunlight and the pressure is around 200 atoms, in addition to the extremely high temperature. Some bacteria that thrive well in boiling water temperature (100 °C) are called "hyperthermophiles". It freezes to death at temperatures below 70 °C. Another exciting feature of these bacteria is that they do not use oxygen; instead, they use sulphur and release hydrogen sulphide. Over 3 billion years ago, ancient Earth was probably streaming hot with little oxygen and plenty of sulfur, a comfortable place for *Pyrococcus furiosus* (fig. 7) to swim and enjoy life. But perhaps one of the most unusual microbial superhero is the bacteria that are highly resistant to absolutely lethal radiation levels [8].



(Courtesy: Henry Aldrich)

Fig 7: *Pyrococcus furiosus*

Deinococcus radioduran (fig.8) is very remarkable for its ability to with stand radiation levels overs 1000 times higher than that which would completely debilitate any human on Earth. It is one of the most radio resistant bacteria which can survive cold, dehydration, vacuum and acid and is therefore known as a polyextremophile. This has been listed as the world's toughest bacterium. Its resistance characteristics are being exploited in the development of bioremediation processes for clean-up of highly radioactive waste sites, and in the development of radio protectors [5].



(Courtesy: Michael Daly)

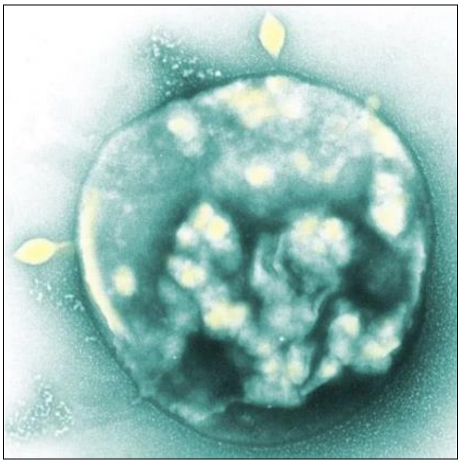
Fig 8: *Deinococcus radioduran*

Yet another archaeon which grows in environment of extremely high salinity is *Halobacterium* (fig. 9). Halobacteria can be found in highly saline lakes such as the Great Salt Lake Magadi. On an interesting note, however, *Halobacteria* are a candidate for a life form present on Mars. One of the problems associated with the survival on Mars is the destructive ultraviolet light. *Holobacteria* have an advantage here. These microorganisms develop a thin crust of salt that can moderate some of the ultraviolet light. Sodium chloride is the most common salt and chloride salts are opaque to short wave ultraviolet. Their photosynthetic pigment, bacteriorhodopsin is actually opaque to the longer wave length ultra violet radiations [16].

(Courtesy: Internet)

Fig 9: *Halobacterium*

There are some interesting *archeabacteria* called *Sulfolobus solfataricus* (fig. 10) which can survive without sunlight or organic carbon as food is. It works in some of nature's hardest volcanic conditions. It lives on sulfur, hydrogen and other materials which normal organism can't metabolize. It has ADH (alcohol dehydrogenase) which can survive up to 88 °C and responsible for the conversion of alcohols. When biomolecules extracted from these volcanic microbes are stored at room temperature, they undergo deep freeze condition compared to their shelf life and stability for commercial use [3].



(Courtesy: Brock, Belly and Weiss)

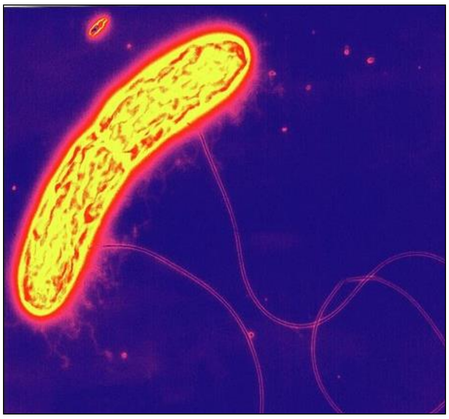
Fig 10: *Sulfolobus solfataricus*

There is another interesting bacterium that contains fixed magnets that force the bacteria into alignment – even dead cells align, just like a compass needle. When placed near a magnet, they are attracted to the magnet's northern pole because the bacteria make magnetic particles which contain iron. It is the built in compass that enables the bacteria to find its way down to the deep, oxygen free parts of its aquatic habitat. These bacteria are called magnetotactic bacteria (fig. 11) [6].

(Courtesy: R. Frankel)

Fig 11: Magnetotactic bacteria

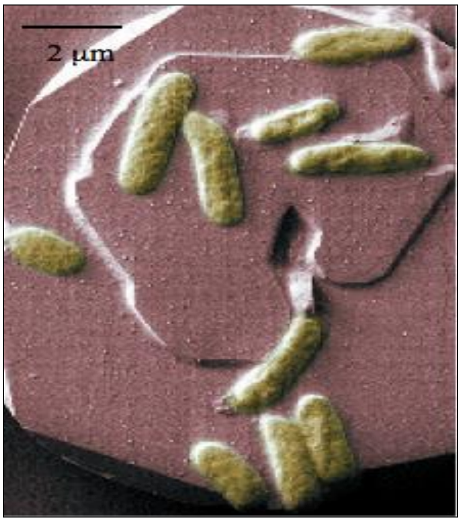
Miles below the Earth's crust microbes survive without oxygen or sunlight by feeding on metals like iron and manganese. One of these microorganisms, *Geobacter metallireducens* (fig. 12), has an unusual survival tactic for life in the underworld: it uses a senor to 'sniff out' metals. If metal is not nearby, *G. metallireducens* can spontaneously grow flagella - whip-like cellular propellers – to find new energy sources. In addition to using iron, the organism will use metals such as plutonium and uranium to metabolize food [4].



(Courtesy: Childers, Ciufo and Lovley)

Fig 12: *Geobacter metallireducens*

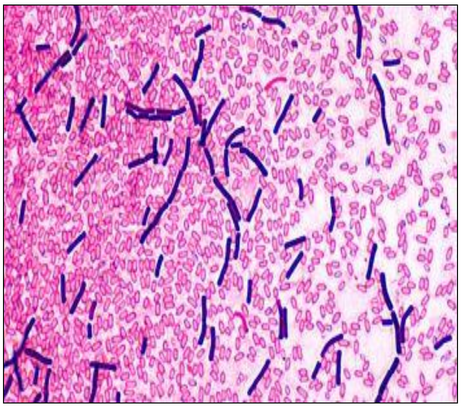
G. metallireducens consumers these radioactive elements. In the case of uranium, microbes change the metals from a soluble to an insoluble form. The insoluble uranium drops out of the groundwater, thus decontaminating streams and drinking water. It remains in the soil and could then be extracted. For *Shewanella oneidensis* (fig.13) a microbe that modifies uranium chemistry, the pieces are coming together, and they resemble pearls that measure precisely 5 nanometres across enmeshed in a carpet of slime secreted by the bacteria. *Shewanella* also metabolizes toxic radioactive metal to inert substances, a much more economical solution. Science has only just begun to study the world's microorganisms. Just 0.1% of all microbes have been cultured, and who knows what other kinds of unique and essential properties we'll find when we start looking [18].



(Courtesy: Oak Ridge National Laboratory)

Fig 13: *Shewanella oneidensis*

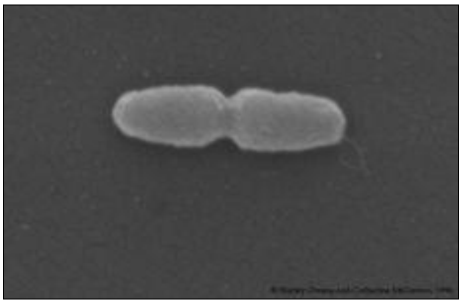
Microbes can help in degrading explosives too. Trinitrotoluene, TNT is a problematic explosive that contaminates the soil in areas where ammunition is kept. Bacteria named *Clostridium bifermentans* (fig.14) is able to break down this contaminant [1].



(Courtesy: Internet)

Fig 14: *Clostridium bifermentans*

When provided with starch as energy source, the bacteria can break down the TNT through cometabolism as a source of carbon. Toluene is one of the most toxic components of gasoline. Anaerobic bacteria *Azoarcus tolulyticus* (fig. 15) that degrade toluene are begin studied as a possible way to bioremediate (clean up) such contaminated water supplies [17].



(Courtesy: Shirley Owens and Catherine McGowan)

Fig 15: *Azoarcus tolulyticus*

Pseudomonas is also one of the biggest contributors to cleaning up the environment. Scientists found that by feeding the contaminated area with oxygen and waste water, the bacteria present there were provided with the nutrients needed to flourish, thereby encouraging the breakdown of hydrocarbons within crude oil by *Pseudomonas*. The hydrocarbons that the bacterium feasts on are converted to carbon dioxide and water.

Carbon, the main components of most diamond, usually contains an isotope of light carbon (12C), which is utilized by some living organism. Therefore, eclogitic diamonds with large amount of the isotope 12C are believed to have an organic origin. These were formed from carbon near hydrothermal vents which was also utilized by the bacterial communities near the vents. Thus, through time, heat and pressure they were able to turn the carbon along with the bacterial colonies into diamonds. It could be possible that those sparklers of your diamond may just be clumps of billion-year-old bacteria corpse.

Bacteria may form microbial ‘jugnu’ that emit visible light. Bacteria produce light basically the same process called bioluminescence. ‘Luciferase’ – uses molecular oxygen and a protein that has a particular vitamin FMNH2 (reduced from of flavin mononucleotide) attached to it. ‘Luciferase’ causes oxidation reduction to occur between oxygen and vitamin leading to the conversion from FMNH2 to FMN. As this occurs, luciferase emits visible light. The colour of light (orange, yellow, yellow-green or blue-green) depend on the kind of luciferase and amount of oxidation of the vitamin attached to the luciferase.

Microbes are our great helpers ranging from domestic, industrial, social and environmental. Bacteria can keep vegetables fresher. Even vegetables that are kept in airtight containers are prone to spoilage by psychrotrophs like *E. coli* and *Listeria*. Latic acid bacteria are an alternative solution to this problem by producing natural acids like lactic acid and bacteriocin that prevent pathogenic bacteria like Listeria from growing in foods.

Bacteria are the best candidates to make chocolates. Chocolates comes from the seeds of the Cacao tree. The seeds come in pods and the only way to retrieve the seeds are to be ferment them with yeasts and *lactobacillus* and *Acetobacter*. The *lactobacillus* secretes an acid to help break apart the pod.

Alcaligenes eutrophus (fig. 16) is a useful bacterium having the capability of making plastics. The bacterium is able to accomplish this feat because it has granules that are made of a fat-like polymer and not starch, like the granules of other bacteria. The plastics can be readily degraded and hopefully will pose less environmental threat [9].

(Courtesy: SCIMAT 2001)

Fig 16: *Alcaligenes eutrophus*

In a novel study, researchers from University of Gothenburg have found that the cellulose produced by bacteria could be used to develop artificial blood vessels. They say that bacterial cellulose carries a lower risk of blood clots than the synthetic materials. Currently used for bypass operations. Produced by a bacterium known as *Acetobacter xylinum* (fig.17), the cellulose is strong enough to cope with blood pressure and works well with the body’s own tissue. This bacterial cellulose works very well in contact with the blood and is a very interesting alternative for artificial blood vessels [12].

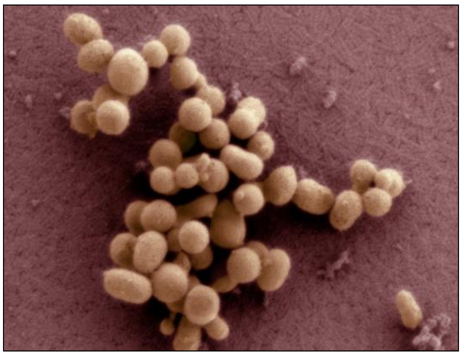
(Courtesy: Leonardo da Silva *et al*.)

Fig 17: *Acetobacter xylinum*

Microorganisms are also being used for producing electricity from biomass. The microbial fuel cell (MFC) can take common sources of organic waste such as human sewage, animals waste or agricultural runoff and convert them into electricity. In the microbial fuel cell, bacteria form a biofilm, a living community that is attached to the electrodes by a sticky sugar and protein coated biofilm matrix. When grow without oxygen, the by-products of bacterial metabolism of waste include carbon dioxide, electrons and hydrogen ions. Electrons produced by the bacteria are shuttled onto the electrode by the biofilm matrix, creating a thriving ecosystem called the biofilm anode and generating electricity.

Microorganisms were the first living creature to start natural life on Earth. Micro palaeontologists discovered layers of sedimentary rocks, wave like stromatolites in Great Lakes that are believed to contain microbial fossils. Some fossils are 3.5-billion-year-old, formed only one billion years after the creation of the Earth indicating that microbes are the earliest forms of life on Earth.

Recently, scientists at the Craig Venter Institute (JCVI) in Rockville Maryland has come up with artificial organisms that might one day produce new fuels, clean polluted water or speed vaccine production. Americans have named it as “Synthia”. The creature is a bacterium named *Mycoplasma mycoides* JCVI-syn 1.0 (fig. 18) and importantly, it reproduces on its own. This synthetic cell has its genome that was designed in the computer and brought to life through chemical synthesis, without using any pieces of natural DNA [14].



(Courtesy: Craig Venter Institute)

Fig 18: *M. mycoides* JCVI-syn 1.0- The JCVI

We should never underestimate the power of a microorganism. They are just like that God cannot be seen through naked eye but we can feel their impact on us in various ways. Well, this is a world of microbes where we are living under their democracy.

References

1. Bergey, *et al*. *Clostridium bifermentans*: (Weinberg and Séguin 1918). National Center for Biotechnology Information (NCBI); c1923.
2. Bresler V, Yanko V. Chemical ecology: a new approach to the study of living benthic epiphytic foraminifera. J Foraminifer Res. 1995;25:267–279.
3. Brock TD, Brock KM, Belly RT, Weiss RL. Sulfolobus: a new genus of sulfur-oxidizing bacteria living at low pH and high temperature. Archiv für Mikrobiologie. 1972;84(1):5468. doi:10.1007/bf00408082. PMID 45597 03. S2CID 9204044.
4. Childers SE, Ciufo S, Lovley DR. *Geobacter metallireducens* accesses insoluble Fe(III) oxide by chemotaxis. Nature. 2020 Apr;416(6882):767–769. Bibcode:2002Natur.416..767C. doi:10.1038/416767 a. PMID 11961561. S2CID 2967856.
5. Cox, Michael M, John R Battista. *Deinococcus radiodurans* – the consummate survivor (PDF). Nature Reviews. Microbiology. 2005 Nov;3(11):882–892. doi:10.1038/nrmicro1264. PMID 16261171. S2CID 20680425. Archived from the original (PDF) on 2011-10-08. Retrieved 2008-02-01.
6. Frankel RB, Blakemore RP, De Araujo FF, Esquivel DMS, Danon J. Magnetotactic bacteria at the geomagnetic equator. Science. 1981;212:1269-1270. [PubMed] [Google Scholar]
7. Wanger G, Onstott TC, Southam G. Stars of the terrestrial deep subsurface: A novel 'star-shaped' bacterial morphotype from a South African platinum mine, Geobiology. 2008 Jun;6(3):325-30.
8. Henry Aldrich, ifasufledu. https://www.voanews.com/a/scientists-coax-microbe-to-produce-biofuel-from-co2/1630726.html
9. Janes B, Hollar J, Dennis D. Molecular Characterization of the Poly-β-Hydroxybutyrate Biosynthetic Pathway of *Alcaligenes eutrophus* H16. In New Biosynthetic Biodegradable Polymers of Industrial Interest From Microorganisms; Kluwer Publishers: Amsterdam; c1990. p. 175–190. [Crossref], [Google Scholar]
10. Kim MS, Klopfenstein NB, Hanna JW, McDonald GI. Characterization of North American Armillaria species: genetic relationships determined by ribosomal DNA sequences and AFLP markers (PDF). Forest Pathology. 2006;36(3):145–64. doi:10.1111/j.1439-0329.2006.00441.x. Archived from the original (PDF) on 2011-07-21.
11. Krause, Duncan C, *et al*. Identification of Mycoplasma pneumoniae Proteins Associated with Hemadsorption and Virulence Infection and Immunity. 1982 Mar;35(3):809-817.
12. Leonardo da Silva. Experimental study of the tissue reaction caused by the presence of cellulose produced. Braz J Otorhinolaryngol. 2009 Mar-Apr;75(2):200–207. Published online 2015 Oct 19. doi: 10.1016/S1808-8694(15)30779-5
13. Patel MK, Goodson JL, Alexander JrJP, *et al*. Progress toward regional measles elimination-worldwide. MMWR Morb Mortal Wkly Rep. 2000-2019;69(45):1700–1705, 2020. doi: 10.15585/mmwr.mm6945a6.
14. Roy D Sleator. The story of Mycoplasma mycoides JCVI-syn1.0 Bioeng Bugs. 2010 Jul-Aug;1(4):229–230. Published online 2010 May 24. doi: 10.4161/bbug.1.4.12465.
15. Schulz HN, Brinkhoff T, Ferdelman TG, Mariné MH, Teske A, Jorgensen BB. Dense populations of a giant sulfur bacterium in Namibian shelf sediments, Science. 1999 Apr;284(5413):493–5. Bibcode: 1999 Sci. 284. 493S, doi:10.1126/science.284.5413.493, PMID 10205058, S2 CID 32571118.
16. See the NCBI webpage on *Halobacterium*. Data extracted from the NCBI taxonomy resources. National Center for Biotechnology Information. Retrieved; c2007. p. 03-19.
17. Shirley Owens, Catherine McGowan; c1996. https://commtechlab.msu.edu/sites/dlc-me/zoo/zqq0386.html
18. Venkateswaran K, Moser DP, Dollhopf ME, Lies DP, Saffarini DA, MacGregor BJ, *et al*. Polyphasic taxonomy of the genus Shewanella and description of *Shewanella oneidensis* sp. nov. International Journal of Systematic Bacteriology. 1999;49(2):705–724. doi:10.1099/00207713-49-2-705. ISSN 0020-7713. PMID 10319494.