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Contents

- **Message:** from the President of BNHC
- **BNHC Directory: Board of Directors:** Dr. Nadir Sidiqi Ph.D., Mrs. Aziza Sidiqi, Mr. Zalmi Gulzarzada, Mr. Ghaus Siddiqi, Mr. Naveed Siddiqi
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- Agriculture, Environment, Public Health, Technology
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Message: from the President of BioNatural Healing College (BNHC)



Greetings!

First and foremost, I am extremely thankful to Almighty God for granting me this opportunity to present the BioNatural Healing College (BNHC), BNHC E-Magazine to our dear readers. Also, I would like to thank you all, especially the dear readers who send us their valuable feedback and support. The information in this magazine is solely for educational purposes.

We hope this BNHC- E-Magazine will be useful to you based on the contribution and dedication of many other respected researchers and colleagues around the globe. Thanking and wish you all the best health and prosperous life.

Best regards,

Dr. Nadir Sidiqi Ph.D.



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BioNatural Healing College Hope you and your loved ones are staying healthy and safe during this pandemic (COVID-19). What we need to do especially during this uncertain time as follows:

1. Vaccination, Sanitation, and Isolation from Social Interaction.
2. Positive Attitude will Increase the Power of Mind and Immune System.
3. Healthy Diet and Drink Plenty of Water (Honey with green tea, vitamin D₃, vitamin C), and Get Enough Sleep.
4. Exercise (any type of physical activity for 30 minutes daily).
5. A Lot of Prayer to Almighty God (be patient, calm).

May Almighty God bless, guide us all (Humanity) and grant us the ability to find a cure for the elimination of COVID-19.

Understanding Basic Microbiology: In Human Health and Disease By: Dr. Nadir Sidiqi Ph.D.

Introduction

Microorganisms exist everywhere on the planet Earth, even inside the human body, plants, or animals. They exist and interact in their environment. Microorganisms with their powerful ability and impact on all aspects of life, such as the biological, physical, and chemical makeup of our Earth planet depend on them. When do we speak about microorganisms that would be appropriate to ask ourselves, what is microbiology? Microbiology is the study of microscopic living organisms that are too tiny to be visible to the naked eye. Thus, this includes bacteria, viruses (need a powerful electronic microscope to be observed), fungi, nematodes, prions, protozoa, archaea, and algae. Thus, collectively known as microorganisms, which play significant roles in initiating health and disease (in humans, plants, and animals), nutrient cycling, biodegradation/biodeterioration, food spoilage, climate changes, making life-saving drugs, cleaning up pollution, manufacturing of biofuel, and producing/processing food and drink. However, microorganisms exist on the Earth for many million years, but the discovery of the science of microbiology has informed us over the past few centuries. Abu Baker Muhammad Ibn Zakariya (Known in West Rhazes 864-930 C.E.) as far as microbiology is concerned for this study reminds us of his remarkable contribution, when the method of choosing the right spot for the Baghdad main hospital ordered by the King (Adhud Daulah) and asked Rhazes to build a hospital. He recommended that he had pieces of fresh meat placed at posts at various parts of the city of Baghdad and later he checked each post with meat pieces to find out which one was less rotten than the others.

Therefore, he chose the spot of the least rotten pieces of meat a site for a selection of the hospital¹. Similarly, Antoni van Leeuwenhoek in 1673 spent much of his spare time grinding glass lenses to produce simple microscopes and observed, what later other scientists known those tiny, microscopic organisms as protozoa, bacteria, fungi, and viruses². The idea came to the belief that the origin of these microorganisms arises based on spontaneous generation, it means that living organisms could arise from non-living matter. However, this theory has been denied from the remarkable experiment by the Italian Francesco Redi (1626-1697) has proved that the larvae found on putrefying meat arose from eggs deposited by flies, rather than spontaneously because of the decay process.

Afterward, Louis Pasteur (1822-95), a well-known microbiologist, noticed that when lactic acid was produced instead of alcohol in wine, rod-shaped bacteria were always present as well as the expected yeast cells. That brings his attention to spoilage problems in the wine industry. Pasteur concluded that the yeast produced the alcohol, while the bacteria were responsible for the spoilage, and must spread from the environment and had to disprove spontaneous generation to sustain his theory.

In connection to Pasteur's disprove the theory of spontaneous generation, the biogenesis concept arises, that life arises only from already existing life. Pasteur's experiment using the swan-necked flasks demonstrated that if those flasks were covered, dust particles that carried microorganisms on them were kept out, and the contents would remain sterile according to Essential Microbiology (2013). Having said that, Pasteur's notable contribution to the role of microorganisms in wine contamination opened the window for further investigation that certain types of these microorganisms may cause various types of diseases in humans, plants, and animals (such as known pathogens) as well as beneficial aspects.

Many articles stated that this notion was performed thousands of years ago, by the Egyptians in the process of fermentation of bread, beer, vinegar, yogurt, cheese, wine, and other related such as mummies preservation of the dead body from decaying. The Roman philosopher Lucretius (98-55 BC) also supported the notion long before that living creatures were responsible for certain diseases and much later this idea was supported by the physician Girolamo Fracastoro (1478-1553). Essential Microbiology describes that Fracastoro wrote: Contagion is an infection that passes from one thing to another and recognized three forms of transmission: by direct contact, through inanimate objects, and via the air. However, today this mechanism of disease transmission is the same. Similarly, another suggestion from the ancient Unani physicians is that disease is the result of an imbalance between the four senses of humor of the body such as blood, phlegm, yellow bile, and black bile. However, after the great devastation (1845) Irish potato late blight famine due to the fungus-like organism (*Phytophthora infestans*), In 1876 Robert Koch from German demonstrated the relationship between the cattle disease anthrax and a bacillus as recently known as *Bacillus anthracis* (a rod-shaped bacterium, is Gram-positive).

Koch in his first scientific experiment infected healthy mice with blood from diseased cattle and sheep. He observed that the symptoms of the disease appeared in the mice, for this purpose that rod-shaped bacteria could be isolated from their blood (mice). These isolated blood samples could be grown in a culture where they multiplied and produced spores. Injection of healthy mice with these spores (bacilli) with the intention to develop anthrax disease, and once again the bacteria were isolated from their blood and that proved the bacilli was the causal agent for anthrax disease. As a result of that research Koch's criteria have been proposed and known as Koch's postulates as follows:

1. The pathogen must be present in every instance of the disease and absent from healthy individuals.

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2. The microorganism must be capable of being isolated and grown in pure culture.
3. When the microorganism is inoculated into a healthy host, the same disease condition must result.
4. The same microorganism must be re-isolated from the experimentally infected host.

Essential Microbiology describes Koch's postulates value as well as certain limitations. For instance, certain causal disease agents such as viruses, and prions (the name derived from proteinaceous infectious particles) cannot be grown in vitro (a procedure performed outside of the living organism in test tubes) but only in host cells. Therefore, after World War II emerged a Golden Age of Microbiology, the antibiotics were discovered by Alexander Fleming in London (1928). He was examining a culture of *Staphylococcus aureus*, a pathogenic bacterium on which he was doing some research, then, he observed contamination took place during his research; mold began to grow that demonstrated the remarkable ability to halt the growth of bacteria.

In 1945 the Nobel Prize was awarded to Alexander Fleming and his two other colleagues for great work that saved millions of people, animals, and plant lives. However, antibiotic resistance is a hot issue in scientific society in the current era. With the discovery of the electronic microscope and molecular biology for the identification of viruses and viral diseases, the science of microbiology reaches advanced levels, including control of disease-causing microorganisms in consumable water, pharmaceutical products, the use of quality control methods in food and dairy product production, and industrial application of microorganisms. Production of biopesticides is a crucial part of microbiology in the prevention of plant diseases and insect control in the agriculture sector as well as plant growth and production with the help of microbiologists, biotechnologists, and other related field colleagues' collaboration. Let us review in brief microorganisms according to Microbiology: Cliffs Quick Review book for this study.

Bacteria: These are relatively small, microscopic, prokaryotic organisms, whose cells lack a nucleus or nuclear membrane. Bacteria can be found in three shapes such as rods (bacilli), spheres (cocci), or spirals (spirilla or spirochetes). Bacteria reproduce by binary fission, have unique constituents in their cell walls, and exist almost all over the places on our Earth planet. For instance, bacteria live at temperatures ranging from 0 to 100 C (32 to 212 F) and in conditions that are oxygen-rich or oxygen-free.

Fungi: Belong to a eukaryotic group that includes multicellular such as molds and unicellular (single-celled) yeasts. The yeasts are slightly larger than bacteria and are used in alcoholic fermentations and bread making. Certain yeast species such as *Candida albicans* are pathogenic (disease-causing in certain conditions).

Molds: are filamentous, branched fungi that use spores for reproduction. The fungi prefer acidic environments, and most live at room temperature under oxygen-rich conditions. Fungi cause major disease problems in plants as well as some types of diseases in humans, and mushrooms are belonging to fungi.

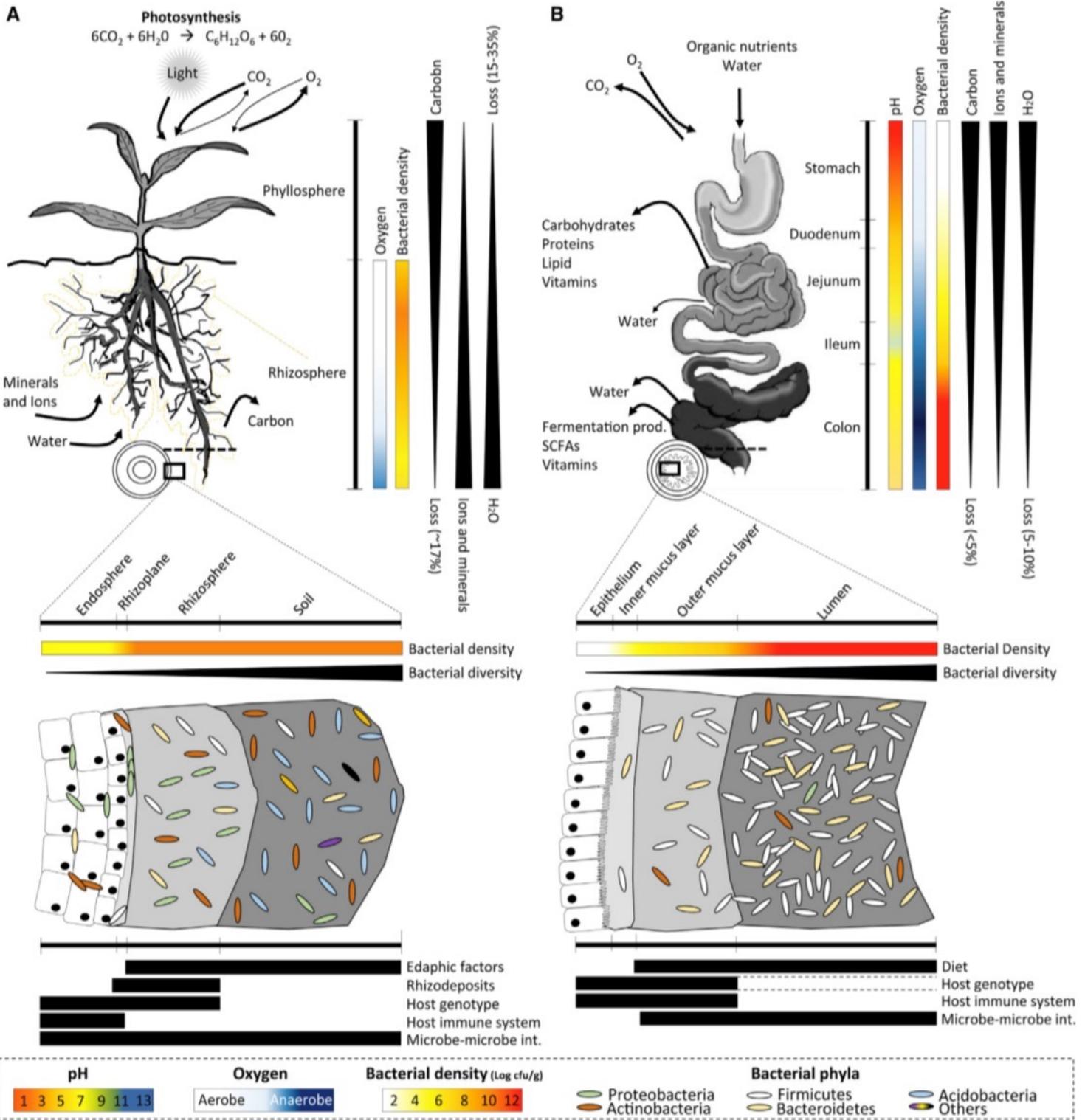
Viruses: These are ultramicroscopic tiny genetic material (DNA or RNA) enclosed in a protein coat and sometimes, a membranous envelope. Viruses multiply only in living cells and use the biochemical machinery of the host cells for their benefit. Viruses are without metabolism; therefore, it is difficult to use drugs to interfere with their structures or activities.

Protozoa: These are eukaryotic, unicellular organisms with a variety of shapes, due lack of cell walls. Motion is a characteristic associated with many species, and the protozoa can be classified according to how they move; some species use flagella, others use cilia, and others use pseudopodia. Protozoa can cause diseases in humans such as malaria, sleeping sickness, dysentery, and toxoplasmosis.

Algae: These are plantlike organisms; however, several types of single-celled algae are important. For example, the diatoms and dinoflagellates that inhabit the oceans are found at the bases of marine food chains. Most algae capture sunlight and transform it into the chemical energy of carbohydrates in the process of photosynthesis. As mentioned earlier about the significance of microorganisms, it would be appropriate to explore microbiota in the sense of vertebrate gut and plant roots.

Microorganisms associated with multiple habitats: The main difference between animal and plants is that an animal is a heterotroph it means rely entirely on the energy originally captured by other living organisms, (e.g., plant, another animal). Plants are autotrophs, producing their food and energy through photosynthesis. Animal guts and plant roots are colonized by diverse microbial classes, such as bacteria, archaea, fungi, oomycetes, as well as viruses.

These communities play important functions in the health and disease of animal guts and plant roots, for instance, the gut microbiota has a major role in host nutrition and health. It contributes nutrients and energy to the host via the fermentation of digestible polysaccharides into short-chain fatty acids in the colon. However, in plant roots, especially the rhizosphere, the microbiota (main phyla *Proteobacteria*, *Actinobacteria*, *Bacteroidetes*) mobilizes and provides nutrients by increasing nutrient uptake from soil to the plant⁴.



Physiological functions of the human gut and plant roots in nutrient uptake. Spatial aspects of microbiota composition, and the factor driving community establishment.

Source: [http://www.cell.com/cell-host-microbe/pdf/S1931-3128\(15\)00167-5.pdf](http://www.cell.com/cell-host-microbe/pdf/S1931-3128(15)00167-5.pdf)

On other hand, some of the microorganisms can be harmful and can cause many health problems, to humans, plants, and animals. Furthermore, it is important to understand how these microbial communities interact, in the context of pathobiome, which represents the pathogenic agents to human health and disease in the broader sense. Food plants have become a source of human pathogens, particularly the emerging ones belonging to the group of Shiga toxin-producing *Escherichia coli* (STEC) strains⁵. The agricultural plant environment is an environment where microbial communities of at least four different ecosystems may come together, namely those from the soil, plants, farm animal digestive track systems (manure), and freshwater source (irrigation)⁶.

As such, this broad issue must be concise to the nature of the causative agent that is atypical for pathogenic for instance, *Escherichia coli* strains commonly occurring in Europe and the USA. The *Escherichia coli* O104: H4 outbreak strain was an entero-aggregative *Escherichia coli* strain that does not have animals, which is often the case for other *Escherichia coli* O type strains, but instead only humans as major reservoir⁷. However, outbreaks caused by this type of pathogen are rare in Western societies, whereas, those caused by *Escherichia coli* O157:H7 and *Salmonella enterica* are more common as below Table.

Examples of large disease outbreaks resulting from contamination of vegetables and sprouts with human pathogenic bacteria.,

Location	Pathogen	Food source	Reference
East Anglia (UK)	<i>E. coli</i> O157:H7	Potato tubers	Morgan et al. (1988)
Osaka (Japan)	<i>E. coli</i> O157:H7	Radish sprouts	Michino et al. (1999)
Connecticut (USA)	<i>E. coli</i> O157:H7	Mesclun lettuce	Hilborn et al. (1999)
Western USA, British Columbia (Canada)	<i>E. coli</i> O157:H7	Unpasteurized apple juice	Cody et al. (1999)
California (USA)	<i>E. coli</i> O157:H7, <i>S. enterica</i>	Alfalfa and clover sprouts	Mohle-Boetani et al. (2001)
Michigan (USA)	<i>E. coli</i> O157:H7	Alfalfa sprouts	Breuer et al. (2001)
Multistate outbreak USA	<i>E. coli</i> O157:H7	Packaged spinach	Wendel et al. (2009)
Hamburg (Germany)	<i>E. coli</i> O104:H4	Fenugreek sprouts	Bielaszewska et al. (2011)

Source: <http://journal.frontiersin.org/article/10.3389/fmicb.2014.00104/full>

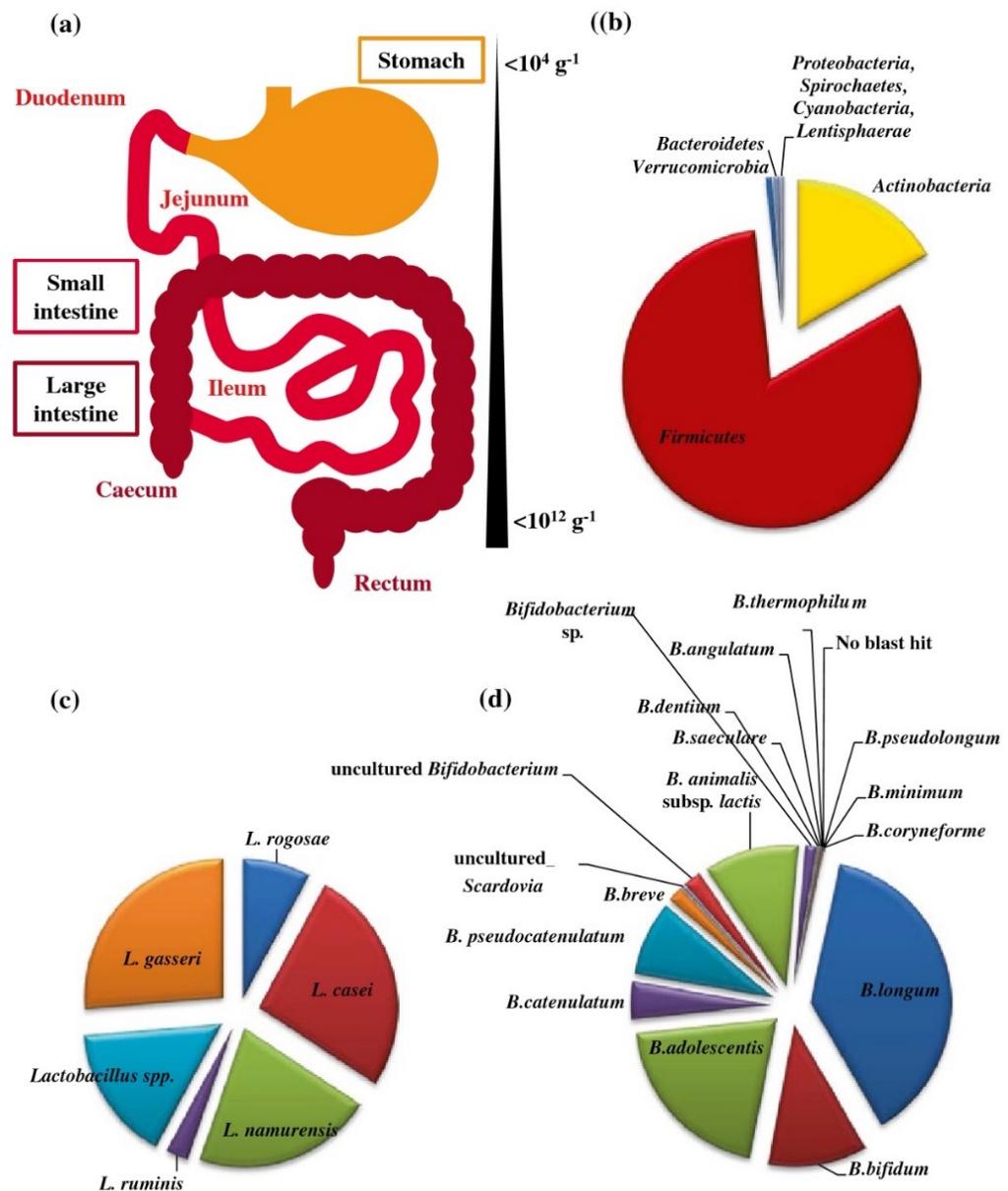
Some remarkable correspondence in the taxonomy of human disease-causing bacteria can be found with typical soil/rhizosphere bacterial species. For instance, cross-domain pathogens belonging to the genera of Burkholderia (e.g., *Burkholderia cepacia*) and *Pseudomonas* (e.g., *Pseudomonas aeruginosa*; Barak and Schroeder, 2012; Kumar et al., 2013). These are opportunistic pathogens in humans and are commonly found in plant and soil habitats. *Escherichia coli* O157:H7 live as commensal species in the digestive tract system of ruminants without causing any visible symptoms to the host (Wells et al., 1991; Chapman et al., 1993). The bacterium is excreted via feces and can survive in manure for a long period. The most important Shiga toxin-producing *Escherichia coli* (STEC) serotypes that cause disease in humans are *E. coli* O157:H7, *E. coli* O26: H11, *E. coli* O103: H2, O145:H28, and O111:H8 (Pearce et al., 2004, 2006).

That is why we hear in the News about these pathogenic bacteria causing health problems as the above table indicated. On the other hand, fungi as human and plant pathogens, for instance, the literature states that of the 5.1 million species of fungi that are believed to exist only a handful cause humans but a wider range of fungi attack in the case of plant infections. Those that do, have a significant impact not only on food security as pathogens of crops and as food spoilage organisms, but also as life-threatening pathogens of humans and animals. As mentioned earlier *Phytophthora* infesting as the etiologic agent of potato late blight disease, the cause of the Irish potato famine, later in the mid-nineteenth century identified by the pioneering work of the Reverend Miles Joseph Berkeley. Since then, the related oomycete (fungus-like organism), *Phytophthora ramorum* has emerged as a devastating pathogen of the oak tree, especially in California. Another, fungus *Magnaporthe oryzae* is the rice blast pathogen that accounts for 10-35 percent loss of the global rice crop annually (Wilson & Talbot, 2009). Similarly, the emerging hyper-virulent strain Ug99 of the wheat stem rust (pathogen: *Puccinia graminis*) capable of causing up to 100 percent crop loss, highlights the threat of fungi to global food security as pointed out by authors Christopher Thomton & Odette Will “Immunodetection of Fungal & Oomycete Pathogens: Established and Emerging Threats to Human Health, Animal Welfare & Global Food Security (2013). However, since the topic of our discussion is more relevant to human health and disease it would be appropriate particularly to explore the human gut and microbiota, to shed some light on this vital issue.

The human gut and microbiota association: The human gut is a diverse habitat and highly complex ecosystem for microorganisms that influence the human physiology, immunology, nutrition, and health status of the host. According to the Food and Agriculture Organization (FAO) of the United Nations and World Health Organization (WHO), criteria, probiotic bacteria are microorganisms that are consumed as live dietary supplements and that confer one or more health benefits to the host^{8,9}.

Most probiotic bacteria that are commercially available belong to two genera, *Bifidobacterium* and *Lactobacillus*, both of which are common inhabitants of the human intestine¹⁰. Probiotic bacteria assist human health in various ways such as strengthening the intestinal barrier, modulation of the immune response, and antagonism of pathogens either by the production of antimicrobial compounds or through competition for mucosal binding sites¹¹. The human gut is a treasure of trillions of commensal bacteria that make up the intestinal that belong to five microbial phyla: Firmicutes, Bacteroidetes, Actinobacteria, Proteobacteria, and Fusobacteria, which are distributed throughout the gut in different numbers, likely as a result of varying microorganisms¹² as below figure illustrated.

Fig. 1 Schematic representation of the human gastrointestinal tract showing its different compartments and the relative abundance of bacteria (a). **b** The relative abundance of the main microbial phyla detected in the adult fecal samples [12]. **c** The aggregate microbiota composition of the genus *Lactobacillus* as determined from adult fecal sample analysis [12]. **d** The aggregate microbiota composition of the genus *Bifidobacterium* as determined from adult fecal sample analysis [12]



Numerous articles indicate that elements of the gut microbiota not only play an important role in the fermentation of indigestible complex plant polysaccharides and host produced glycans (such as mucin), but are also believed to provide protection against pathogenic microorganisms. For instance, for the proper development of the host's immune system, research indicates that the gut microbiota exerts a key role in inducing IgA production as well as maintaining the homeostasis of several T cell populations in different human body compartments including the gut, including regulatory T cells (Treg), and T helper 1 (T_H 17) cells. Another study demonstrated that commensal bacteria of the human gut produce molecules that mediate healthy immune responses and protect the host from inflammatory disease. Furthermore, human gut microbiota plays an important role in the synthesis of vitamins and bile acid biotransformation^{12.13}. Many factors may adversely impact the population of microbiota in the gastrointestinal ecosystem, such as antibiotic treatment, physical injuries, psychological stresses, radiation, altered peristalsis, and dietary shifts based on the study report. Let us describes major advance in intestinal health according to Life Extension Magazine (January 2017) as follows:

The importance of a healthy gut: As we touched briefly on earlier, probiotics and their popularity benefit in the context of health, ingestion of these beneficial bacteria through a natural diet (yogurt) or supplements will produce benefits ranging from alleviating intestinal distress to strengthening immunity. Probiotics with their remarkable beneficial activities can slowly reduce the population of harmful bacteria strains in the intestines.

For instance, studies report that there was an exponential increase in beneficial bacteria with a parallel decrease in unfriendly flora like E. coli. Phage therapy uses bacteriophages (which means bacteria eating) which are submicroscopic packages of DNA or RNA enclosed in a protein envelope that selectively target pathogenic bacteria and can be found almost everywhere, in soil, hot springs, ocean depths, animals, and the human body (such as mouth and skin). A bacteriophage is a promising approach to preventing bacterial illnesses, the bacteriophage attaches itself to a bacterial cell wall and then destroys the host bacteria according to researchers' reports. Bacteriophages with their tremendous ability especially the type that is safe and commonly used for a variety of different applications, from controlling Listeria in cheese and E.coli in meat and on food surfaces to Salmonella in food. There is a potential opportunity that bacteriophages can effectively reduce specific populations of harmful organisms that have taken over the intestinal microbiome. Scientists are at the beginning of their work to understand the importance human gut with an emphasis population of microorganisms that can determine the human body's state of health and illness. It is also important to understand that the overuse or misuse of antibiotics kills both beneficial and harmful bacteria as well. As such, with the rise in antibiotic-resistant bacteria, bacteriophage therapy will be a good tool among the scientific community because of its effectiveness and safety profile. The National Institutes of Health 2015 sponsored a symposium titled: "Bacteriophage Therapy: An Alternative Strategy to Combat Drug Resistance"¹⁴. The aim of this study brings our attention to the science of microbiology which has been mentioned that bacteria, fungi, viruses, and parasites living organisms that are found all around us for good causes and bad causes. Some of them can cause a wide variety of diseases, by infecting any organ in the human body. For instance, bacteria can infect any part of the body, but most of the time cause diarrhea when they invade the digestive tract. The rest of this study in respect to microbiology according to the University Rochester Medical Center article entitled "Viruses, Bacteria, and Parasites in the Digestive Tract"¹⁵ however, it would be useful, to begin with, bacteria that cause diarrhea in humans:

What is diarrhea? Various harmful microorganisms can cause diarrhea such as bacteria, viruses, and parasites. Especially children in developing countries are easily vulnerable due to lack of sanitation, food allergies, or by certain medications (antibiotics). A child has diarrhea when bowel movements are loose and watery, including nausea, vomiting, stomach aches, headache, and possibly fever.

Sources of contact with the pathogens: By eating or drinking contaminated food or water. By touching an object contaminated with pathogens such as dirty diapers (may occur at home or day-care centers). Once viruses, bacteria, and parasites that get inside the digestive tract of a person then cause diarrhea and large amounts of water are lost, causing dehydration, especially children are much quicker susceptible than adults. One of the important concerns is about children and adults with weakened immune systems are at higher risk and need immediate medical attention.

Common bacteria, viruses, and parasites that cause diarrhea:

Bacteria (E. coli): It has been mentioned earlier that there are hundreds of different types or strains, of the bacteria E.coli (Escherichia coli). Most of these are harmless and live in the intestines of healthy people and animals. However, some strains of E. coli make a powerful toxin that causes severe infection. The Centers for Disease Control and Prevention recognizes E. coli as a foodborne illness. Most E. coli illness has been associated with eating undercooked, contaminated ground beef. E. coli bacteria live in the intestines of healthy cattle; however, it is unknown for the number of organisms caused, but is suspected to be very small. Meat during slaughter can become contaminated and E. coli can be thoroughly mixed into beef when it is ground, and contaminated beef looks and smells normal.

Transmission: Many sources could be possible; however, bacteria may transfer from the cow udders or equipment and may get into raw milk. Infection may occur after swimming in or drinking sewage-contaminated water and may occur by drinking unpasteurized juices, (e.g., apple cider).

Prevention: CDC recommendations for the prevention of the infection include:

- Make sure washing hands is very important, especially for people infected particularly children, to wash their hands carefully and frequently with soap to reduce the risk of spreading the infection.

- Cook all ground beef or hamburger thoroughly. Make sure that the cooked meat is gray or brown throughout (not pink), any juices run clear, and the inside is hot.
- Using a digital instant-read meat thermometer, the temperature of the meat should reach a minimum of 160-degree F.
- Avoid serving an undercooked hamburger in a restaurant, if it is not cooked properly send it back.
- Drink only pasteurized milk and milk products. Avoid raw milk.
- Drink clean and fresh water

Salmonella (Bacteria): Over 1 million people are infected by salmonella in the United States every year as reported. This bacterium infects the intestines and causes diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. In most cases, the illness lasts four to seven days, and many people recover without treatment. However, in some cases, diarrhea may be so severe that the patient needs to be hospitalized and required prompt medical attention and antibiotics.

Transmission: Animal feces are the main source of contamination, especially eating raw foods from contaminated animal feces. Most contaminated foods are of animal origin, and usually, look and smell normal. For instance, beef, poultry, milk, eggs, and also some unwashed fruits and vegetables, and peanut butter.

Prevention: The following are recommendations by the CDC:

- Make sure poultry and meat, including hamburgers, are well cooked, not pink in the middle.
- Do not consume raw or unpasteurized milk or other dairy products.
- Thoroughly wash the produce before eating it.
- Avoid cross-contamination of foods. Uncooked meats should be kept separate from produce, cooked foods, and ready-to-eat foods.

- All utensils, including cutting boards, knives, counters, etc., should be thoroughly washed after handling uncooked foods.
- Thoroughly wash hands before handling foods and between handling different food items.
- Thoroughly wash hands after contact with feces.
- Thoroughly wash hands after handling any reptile (such as iguanas and turtles), since reptiles are particularly likely to have Salmonella.

Rotavirus (Viruses): Rotavirus causes severe diarrhea in children, and over 500,000 children die every year worldwide due to rotavirus. Winter is the peak season in the United States for disease occurrence. Annual epidemics occur from December to June. Infants and young children 5 years of age are infected in the United States and around the world. Adults can also be infected with mild severity; however, about two days is the incubation period for rotavirus disease. Symptoms of the disease is characterized by vomiting, and watery diarrhea for three to eight days, and fever and abdominal pain occur frequently.

Transmission: Rotavirus can be spread through ingestion of contaminated food, and water, especially the type of water found in a public swimming pool. An accidentally swallowing the virus picked up from surfaces contaminated with stool from an infected person, for instance, toys, bathroom fixtures, changing tables, and diaper pails.

Prevention: The CDC recommends:

- Adults should wash their hands after using the toilet, after helping a child use the toilet, after diapering a child, and before preparing, serving, or eating food.
- Children should wash their hands after using the toilet, after having their diapers changed (an adult should wash the infant's or small child's hands), and before eating snacks or meals.
- Toys, bathrooms, and food preparation surfaces are disinfected frequently, especially if a sick child has been in the home.
- Use diapers with waterproof outer covers that can contain liquid stool or urine, or use plastic pants.

- Make sure that children wear clothes over diapers.

Giardia (Parasites): Giardia lamblia is a tiny, microscopic parasite that lives in the intestines of people and animals. Giardia has become recognized as one of the most common waterborne diseases in humans in the United States as well as in other parts of the world.

Transmission: Giardia can be found in water, food, and soil, People become infected after accidentally swallowing water from swimming pools, lakes, rivers, springs, ponds, or streams contaminated with sewage or feces from humans or animals. the parasite. Consuming uncooked food contaminated with Giardia as well as toys, bathroom fixtures, changing tables, and diaper pails.

Prevention: The CDC recommends:

- Washing hands with soap and water after using the toilet, changing diapers, and before handling food.
- Wash and peel all raw vegetables and fruit before eating.
- Avoid drinking water from lakes, rivers, springs, ponds, or streams unless it has been filtered and chemically treated.
- Boiling drinking water for one minute to kill the Giardia parasite. This will ensure safe drinking water during community-wide outbreaks caused by contaminated drinking water.
- When camping or traveling in countries where the water supply may be unsafe, avoid drinking unboiled tap water and avoid uncooked foods washed with unboiled tap water. Bottled or canned carbonated beverages, seltzers, pasteurized fruit drinks, and steaming hot coffee and tea, are safe to drink.

Cryptosporidium: Crypto is a short referred to as Cryptosporidium. This tiny parasite can live in the intestines of humans and animals. One of the unique characteristics of Crypto is protected by an outer shell that allows it to survive outside the body for long periods and makes it very resistant to chlorine disinfection.

Transmission: Consuming uncooked contaminated food, and swallowing anything that has come in contact with contaminated water from swimming pools, hot tubs, lakes, rivers, springs, ponds, or streams or feces from humans (diaper pails) or animals.

Prevention: The CDC recommends:

- Every child should wash their hands with soap and water after using the toilet, changing diapers, and before eating or helping prepare food.
- Avoid water or food that may be contaminated.
- Wash and/or peel all raw vegetables and fruits before giving them to your child to eat.
- Avoid drinking water from lakes, rivers, springs, ponds, or streams unless it has been filtered and chemically treated.
- Boiling drinking water for one minute to kill the crypto parasite. This will ensure safe drinking water during community-wide outbreaks caused by contaminated drinking water.
- When camping or traveling in countries where the water supply may be unsafe, avoid drinking unboiled tap water and avoid uncooked foods washed with unboiled tap water.
- Avoid swimming in pools if your child has had cryptosporidium and for at least two weeks after diarrhea stops. Crypto can be passed in the stool and contaminate water for several weeks after your child no longer has symptoms. This has resulted in several outbreaks of crypto among pool users. Crypto can survive in chlorinated pools for several days.

Conclusion: Microorganisms with their diverse tools exist in different sizes, shapes, and physiological and biochemical characteristics and constantly interact in our environment. However, microorganisms have existed on Earth for many millions of years, but the discovery of the science of microbiology has informed us in the past few centuries with tremendous productive outcomes. The human digestive tract and plant roots are good habitats for microorganisms whether they are beneficial or pathogens, this includes bacteria, viruses (electron microscope), fungi, nematodes, prions, protozoa, archaea, and algae, which live in diverse habitats (soil, water, air). Thus, collectively known as microorganisms, which play significant roles in initiating health and disease (in humans, plants, and animals), nutrient cycling, biodegradation/biodeterioration, food spoilage, climate changes, making life-saving drugs, cleaning up pollution, manufacturing of biofuel, and producing/processing food and drink. Interestingly, some of them help humans in the improvement of health and other related life quality issues; however, other types may be the cause of certain diseases in humans, plants, and animals. This gives us the alarm signal which we need to be careful and always protect ourselves and prevent any of these diseases by taking the necessary precautions. Also, require further research to find out many undiscovered harmful and beneficial microorganisms in the prevention of human, plant, and animal diseases.

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