

## Economic, Ecological and Human Outcomes of Bacteria

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**Abstract:** - This paper deals with the role played by bacteria in our life. There is a popular myth that bacteria are always harmful. But it is not the whole story about bacteria. Bacteria have numerous beneficial roles in human life and also in the stability of environment. They are the most robust unicellular and ultra-microscopic organisms. They play important role in agriculture, medicine human health and are also said to be the basis of many industrial products. Some are beneficial to humans directly or indirectly, others are very harmful as they cause various plants, animal and human diseases. It has been established by researches that bacteria are useful for the ecology, economy and human health. For example they are used to produce a number of food items, drugs and also for agricultural purposes. They are also useful in fiber retting, human and animal digestion, and biological control of pests.

**Keywords:-** Human, Economic, Environment, Bacteria, Outcomes, Good & Bad bacteria.

### Introduction

It has been revealed in studies that bacteria play so many important roles and thus exert effects on human life and environmental stability. Bacteria are single cell (unicellular) organisms and cannot be seen with naked eye. They vary in sizes, measure approximately 0.1 to 10.0  $\mu\text{m}$ . There is no particular method of cell division, they simply divide by binary fission in which cell divides into two daughter cells [2].

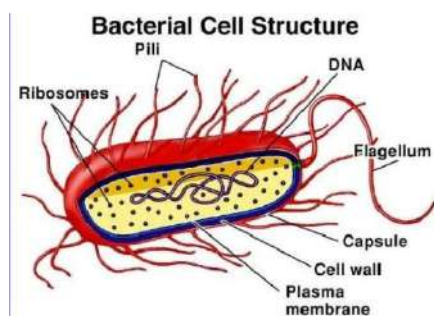


Figure1: Some parts of the bacteria

They do not have proper nucleus within the cell but the genetic material is attached to the cell membrane in an irregular form [25]. They are found everywhere like top of the mountains, rivers, on land and in ice form [1]. Bacteria have the property of living in extreme weathers like extreme cold and extreme heat. They are able to live long because they become inactive for a long period of time [23]. Their cells are prokaryotic, i.e., they lack a membrane-bound nucleus and many of the cell parts of

eukaryotes. Some of the parts of bacteria are shown in figure-1. Bacteria may have a number of shapes however three more common shapes are presented in figure2- round, rod and spiral shapes.



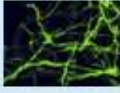
Shape of bacteria	Description
	Coccus, Plr. Cocci Exemple- Staphylococcies epidermidis
	Bacillus, Plr. Bacilli Example- Escherichia coli
	Spirillum, Plr. Spirilla Exemple- Treponema pallidum

Figure2: Some of the common shapes of bacteria

The researchers are of the view that organic carbon present in the environment in the form of dead organisms might eat up all the carbon dioxide from the atmosphere if there were no decomposers present on earth [5, 7]. One can imagine the situation if there were no carbon dioxide in the atmosphere. There would have been no photosynthesis in the plants and as a result of it no food would have been produced by plants. Decomposers or bacteria help in cycling of minerals like carbon and sulfur [3, 9, 13]. Thus, bacteria are considered as our friends and foes both, because of their beneficial and harmful effects.

### Soil microorganisms

It has been established in studies that bacteria are more dominant group of microorganisms in the soil and equal to one half of the microbial biomass in soil [18]. Its population ranges from 100,000 to several hundred millions for gram of soil - autochthonous - zymogenous groups. The majority are heterotrophs (common soil bacteria are arthrobacter, bacillus, clostridium, micrococcus).

**Actinomycetes** – It is the intermediate group between bacteria and fungi. Numerous and widely distributed in soil. Abundance is next to bacteria. 104 - 108/g soil. 70% of soil actinomycetes are Streptomyces. Many of them are known to produce antibiotics. Its population increases with depth of soil.

**Fungi:** Fungi are more numerous in surface layers of well-aerated and cultivated soils-dominant in acid soils.

Common genera in soil are aspergillus, mucor, penicillium trichoderma, alternaria, rhizopus. Algae – found in most of the soils in number ranges from 100 to 10,000 per g.

**Protozoa:** These are unicellular and their population ranges from 10,000 to 100,000 per g of soil. Most of the soil forms are flagellates, amoebae or ciliates. They derive their nutrition by devouring soil bacteria, abundant in upper larger of the soil. They regulate biological equilibrium in soil and thus very important.

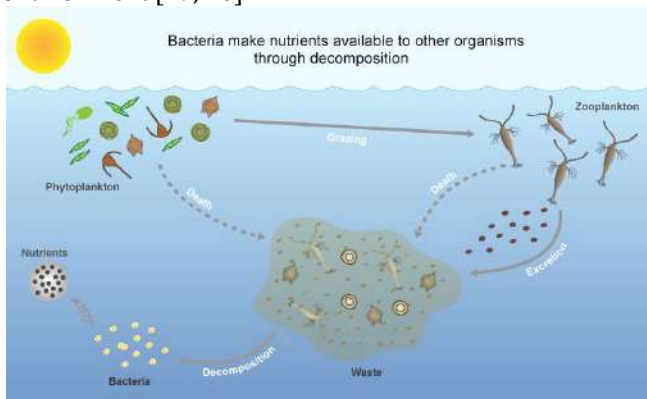
**Effects of Bacteria**

Bacteria are said to be both, the friend and foes of human beings, plants and the environment also. Their role may be classified into two categories [14, 17].

**Beneficial effects:** There are so many evidences that bacteria synthesize a number of compounds which have a number of commercial applications [1]. The role played by the bacteria may be underlined as agriculture, industrial and medicinal functions.

**Role in Agriculture:** The activities of bacteria are very important in agriculture in the following from the following points of views.

**1. Decaying of organic substance:** Bacteria play a very crucial role of silently getting the nature rid of the dead matter through the decomposition of dead organic matter by the microbes (Figure3). According to Rangaswami, they help the plants to get nutrients from the dead matter in different forms, such as, ammonia, hydrogen sulphide, phosphates, nitrates and CO<sub>2</sub> water etc. [18]. They, do not only decompose the organic compounds but also remove the harmful waste from the earth and thus function as scavengers for the environment [19, 20].



**Figure3:** Bacteria make available the nutrients to other organisms through decomposition

**2. Fertility of the soil:** According to Garrity, some bacteria maintain and others increase the fertility of the soil. Such bacteria are useful as they convert the insoluble materials into the soluble materials and are thus engaged in changing physical and chemical composition of the soil [8]. It is because of the functions that they are called ammonifying, nitrifying and the nitrogen fixing bacteria.

**(i).Ammonifying Bacteria:** This group of bacteria is responsible for ammonification, that is why they are called ammonifying bacteria (e.g., Bacillus ramosus, B. vulgaris) as they decompose the proteinous compounds to convert into amino acids,

**(ii).Nitrifying Bacteria:** The Nitrobacter and Nitrosomonas are the specific examples of this group of bacteria, in which Nitrosomonas performs the task of oxidizing the ammonium salts into nitrous acid and the Nitrobacter then converts the nitrites into nitrates-called nitrification [27, 29].

**(iii).Nitrogen Fixation:** The health and growth of plants depend upon soil for the supply of nitrogen. Through the process of nitrogen fixation, nitrogen from the atmosphere becomes available to the plants. They make available the nitrogen for plants from the environment. It is known as nitrogen fixation. There are two types of nitrogen-fixing bacteria. First- Azotobacter and Clostridium- They live freely in the soil and fix nitrogen of the air in their bodies in the form of nitrogenous organic compounds. Second- Nodule bacteria and Bacillus- The location of the rhizobium is the root of leguminous plants where they live as symbiont and absorb free nitrogen from the bacterial cells. Thus they increase the fertility of the soil. They are particularly known for involvement in nutrient transformation process, decomposition of resistant components of plant and animal tissue and microbial antagonism

**3. Role in Industry and Medicine:** Bacteria play very important roles in various industrial products. The products obtained as a result of bacterial activities cannot be chemically prepared [26, 29]. For example, ethyl alcohol and butyl alcohol are manufactured by the bacterial activities in the sugar solution, e.g., clostridium acetobutylicum. Vinegar is prepared by the activities of Acetobacter aceti in the sugarcane juice. The preparation of butter, cheese etc. is also done by bacteria. The Lactobacillus lactis is responsible for souring of milk resulting in curd preparation. Bacterial activities also impart the typical flavors. Typical types of bacteria are cultured for this purpose, e.g., micrococcus. Fibers from the hemp are isolated after rotting the stems by activity of bacteria (e.g., clostridium butyricum). The hairs and fats are removed from the skin by the action of bacteria in the leather industry. According to Sir Alexander Fleming, the growth of harmful staphylococci is checked by penicillium natatum. This has led to the production of various types of antibiotics being used in treatment.

**Bioremediation:** Bioremediation refers to the process of depletion/degradation of toxic compounds present in the natural environment by living organisms. Bacteria are one of the key players in bioremediation. For example, oil spills due to oil digging operations or accidents on oil transport channels in the ocean or on the soil, are important determinant of healthy environment, i.e., Pseudomonas play important role in degradation of oil

spills on oceans/soils. Besides this, heavy metal uptake/compound metabolism are maintained by bacteria like *Alcaligenes faecalis* (Arsenic), *Pseudomonas fluorescens* and *Enterobacter clocae* (Chromium)

**Harmful effects:** As previously mentioned, bacteria are harmful also directly or indirectly. They cause various diseases in plants, human beings or domestic animals. The harmful bacteria are of four types - animal pathogenic bacteria, plant pathogenic bacteria, food destroying bacteria and soil fertility destroying bacteria [4, 15].

**(i). Pathogenic Bacteria:** There are a large number of parasitic bacteria, which cause various serious diseases in man and domestic animals, sometimes in epidemic form. They are invisible enemies [27]. Table-1 shows some of the common human diseases producing bacteria.

**Table-1:** Some of the bacteria causing human diseases.

SN.	Bacteria	Disease
1	<i>Mycobacterium tuberculosis</i>	Tuberculosis
2	<i>Eberthela typhosa</i>	Typhoid,
3	<i>Clostridium tetani</i>	Tetanus
4	<i>Shigella dysenteriae</i>	Dysentery,
5	<i>Hemophilous influenzae</i>	Influenza.
6	<i>Corynebacteriaum diphtiteriea</i>	Diphtheria
7	<i>Diplococats pneumonias</i>	Pneumonia.
8	<i>Vibrio cholerae</i>	Cholera.
9	<i>Streptococcus</i>	Blood poisoning
10	<i>Treponema pallidum</i>	Syphilis
11	<i>Gonococcus</i>	Gonorrhoea
12	<i>Bacillus pestis</i>	Plague

Similarly, in domestic animals also, various diseases are caused by bacteria, e.g., anthrax, pneumonia, tuberculosis, cholera, glanders and so on.

**(ii) Plant Pathogenic Bacteria:** Some bacteria have been identified as being responsible for diseases in crops such as citrus canker, fire blight of pear, cotton root rot, walnut blight, potato rot, pineapple rot etc [29, 4]. The black spots on some vegetable are caused by such bacteria (e.g., carrot, cabbage, potato, and tomato).

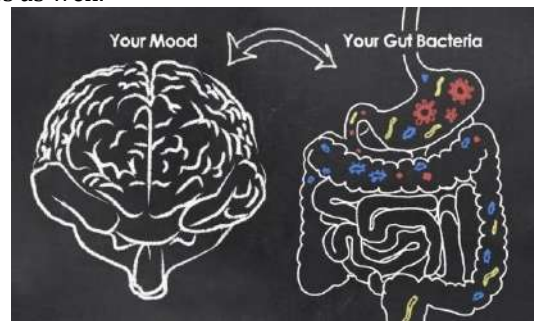
**(iii) Food destroying Bacteria:** The bacteria like staphylococcus and clostridium botulinum cause food poisoning when rotten food is eaten. They spoil food stuffs and make them poisonous, (meat, milk, vegetables, fruits etc).

**(iv) Soil Fertility destroying Bacteria:** This group of bacteria (e.g., *Bacillus denitrificans*) is involved in denitrification, and thus fertility of the soil decreased. They are abundant in the soil which is not properly drained and is mixed with heavy amount of manure [2, 7, 14].

### Human Health and Bacteria

Bacteria in our body are found everywhere. However, they are more concentrated in three places- the mouth, skin and gut (Figure4). It is estimated that 3/4 activity relating to immune system occurs in our gut and

digestive tract that is why recently attention has been refocused on the gastrointestinal system, which is particularly related to our health status. It is also strongly believed that the bacteria in your gut can even affect our metabolism, hormonal levels, and the mood states as well.



**Figure 4:** The Gut-Brain Connection (Photo Credit: T. L. Furrer / Fotolia)

**Oral Bacteria** - Bacteria in the mouth is largely the result of what we eat (or rather, what we eat and leave between our teeth). The 'good' bacteria help us maintain health (e.g., *S. sanguinis*, *Actinomyces naeslundii* and *Veillonella dispar*) whereas 'bad' bacteria play impairing roles (e.g., *Streptococcus mutans*, *Porphyromonas gingivalis*, and *Tannerella forsythia*). Again, as previously mentioned, a bacterial balance must be struck for optimal health [5].

**Skin Bacteria** The skin is the body's largest organ and is the barrier between external pathogens and the body. It is believed that skin has about 1,000 bacteria which can be categorized as 'good' and 'bad' bacteria. 'Good' bacteria on the skin (*Staphylococcal epidermis*) help in preventing bacterial infections from occurring by protecting the surface area of the skin from outside bacterium [10]. They prevent colonization of bacteria causing infections on the skin [9].

### Bacteria and the Digestive System

The bacteria in human gut are found in huge quantity and survive there very easily as the internal conditions are very much comfortable for them [16, 29]. The benefits of bacteria in our digestive system are incredibly important. Without them, we would be unable to digest our food, synthesize certain essential vitamins, absorb water, and fend off the dangerous bacteria which often try to attack our gut [5, 24]. Some of the most important 'good' gut bacteria include *Lactobacilli*, *Bifidobacterium* and *Caulobacter*, whereas *Salmonella*, *Clostridium*, and *E. coli* are 'bad' bacteria found in the gut. The dominance of 'good' bacteria is obviously helpful in maintaining immunity and recovering quickly [6, 28].

### Synthesizing Vitamins

Some bacteria also synthesize vitamins. *Lactobacillus acidophilus* manufactures vitamin K. Lactic acid bacteria

produce some B-complex vitamins, while enteric bacteria produce vitamin B-12.

### Bacteria and Immune System: Good vs. Bad Bacteria

According to Hill et al., 'good bacteria' play a powerful role in supporting the immune system [12]. 'Good' bacteria increase white blood cells called T-cells, which aid in the immune system's response to harmful bacteria. Some examples of good and bad bacteria are shown in figure- 5. The beneficial bacteria found in the digestive system are called probiotic bacteria, and there are also a number of foods that contain probiotics to improve our bacterial balance [12, 20]. Probiotics are lactic-acid producing microorganisms that are often used to make certain food products, such as fermented milk, yogurt, kombucha, sauerkraut, miso and soy. An increase of the amount of probiotics in our diet (and gut) can neutralize harmful bacteria and reduce symptoms of diarrhea, inflammation, nutrient deficiency, cramps, constipation and bloating, as well as more serious stomach conditions and diseases [16].

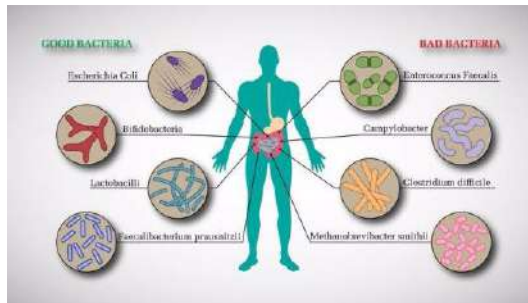


Figure 5: 'Good' vs. 'Bad' Bacteria (Photo Credit: Chombosan / Fotolia)

During the past few decades, we have become an increasingly "sterilized" society. In modern day society, medical practitioners often prescribe antibiotics for the treatments of various types of infections. The medical reports have made it unambiguous that antibiotics damage our immune system. So, it is advisable that administering antibiotics on the patients should be avoided as far as possible.

### Conclusion

After having reviewed the role played by bacteria, it may be concluded that there are numerous beneficial effects of bacteria in human life, economy of the farmers and stability of our environment. So, bacteria are our friends due to their beneficial implications and enemies due to their harmful outcomes. Yet, beneficial effects of the bacteria outweigh their harmful effects. The harmful activities can be controlled. However, their beneficial activities cannot be replaced by artificial processes. Their beneficial effects are much more important for the human beings, economy and the environment.

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