Benefits of bacteria and microbiology

- NURFATHINISSA MD ROSLAN

Is Bacteria Our Friend?

Bacteria are relatively simple, single-celled (unicellular) organisms. Bacterial cells are called prokaryotes, (from Greek words meaning prenucleus), because their genetic material is not enclosed in a special nuclear membrane. Bacterial cells generally appear in one of more than one shapes. Bacillus (rodlike), coccus (spherical or ovoid) and spiral (corkscrew or curved) are among the most common one, but there are some bacteria are star-shaped or square. Individual bacteria may appear pairs, chains, cluster, or other groupings which such formations are usually characteristic of a certain genus or species of bacteria. Bacteria are enclosed by cell walls that are mainly composed of a carbohydrate and protein complex known as peptidoglycan. Bacteria are reproduce by dividing into two identical cells, where this process is called binary fission. In the meaning of nutrition, most of bacteria use organic chemicals, which in nature can be obtained from either dead or living organisms. Some bacteria can create their own food by photosynthesis, and others can derive nutrition from inorganic substances. Many bacteria can ‘ swim’ by using moving appendages known as flagella.

We tend to relate these small organisms only with small population of disease such as AIDS, uncomfortable infections, or such any other inconvenience factors such as spoiled food. However, the most of bacteria make big contribution by helping to maintain the balance of living organisms and chemicals in our environment. Human and any other animals rely on the bacteria in their intestines for digestion and the synthesis or production of some vitamins that their bodies need, including some B vitamins for metabolism and vitamin K for blood clotting. The population of the large intestine is composed mostly of anaerobes and facultative anaerobes. Majority of these bacteria help in the enzymatic breakdown of foods, especially many polysaccharides, or else would be indigestible. Some of them synthesize useful vitamins.

Our society's creating awareness of the need to take care the environment has made people more conscious of the responsibility to recycle our water and avoid the pollution of both rivers and oceans. The most pollutant is sewage, which composed of human excrement, industrial and water wastes, and surface runoff. Sewage is about 99. 9% water, with a few hundredths of 1% suspended solids. The remainder is a variety of dissolved materials. The plants treatment sewage separated the unwanted materials and harmful microorganisms. Combination of various physical processes together with the action of beneficial bacteria is actually how the treatment works. Large solids such as paper, wood, glass, gravel and plastic are removed from sewage, only liquid and organic materials are left behind that bacteria convert into such by-products as carbon dioxide, nitrates, phosphates, sulfates, ammonia, hydrogen sulfide, and methane.

Other than that, bacteria also can act as Biosensors that detect pollutants and pathogens. Every year in the United States, industrial plants produce 265 million metric tons of hazardous waste, 80% of which create their way into landfill. Burying these chemicals does not destroy them from the ecosystem, but, it just transfers them to other places, where they may still find their way into bodies of water. Traditional chemical analyses to place these chemicals are cost a lot and cannot distinguish chemicals that affect biological system from those that lie inert in the environment. Due to this problem, scientists are creating biosensors, which bacteria that can locate biologically active pollutants. Biosensors do not cost a lot in chemicals or equipment, and they work so fast within minutes. In order to do work, bacteria biosensors need both a receptor that is activated in the presence of pollutants and a reporter that will make such a change apparent. Biosensors use the lux operon from Vibrio or Photobacterium as a reporter. This operon contains inducer and structural genes for the enzyme luciferase. In the presence of coenzyme called $FMNH_2$, luciferase reacts with the molecule in such a way that the enzyme-substrate complex emits blue-green light, which oxidizes the $FMNH_2$ to produce FMN. Therefore, a bacterium containing the lux operon will produce visible light when the receptor is activated.

In the nineteenth century, bacteria that used in the production of food were grown in pure culture for the first time. This achievement quickly bring to an improved understanding of the correlation between specific microbes and their products and activities. This period can be considered the beginning of industrial food microbiology. Cheese is one of the example of food production that need certain bacteria to produce them. In the production of cheese, it requires the formation of a curd, which can get form the separation of main liquid fraction, or whey. The curd is made up by protein, casein, and is usually produced by the action of an enzyme, rennin, which is controlled by acidic conditions provided by certain lactic acid-producing bacteria. These inoculated lactic acid bacteria also give the characteristic flavors and aromas of fermented dairy products during the ripening process, except for a few unripened cheeses, such as ricotta and cottage cheese. A

Propionebacterium species release carbon dioxide, which cause the holes in Swiss cheese.

Xanthomonas campestris is a gram-negative rod that leads to a disease known as black rot in plants. The bacteria use the glucose transported in those tissues to produce a sticky, gumlike substance, after gaining access to a plant’s vascular tissues. This substance build up to create gumlike mases, which actually block the plant’s transport of nutrients. The gum that makes up these masses, xanthan, consist a high-molecular-weight polymer of mannose. Eventhough it gives effects in plants, xanthan has no adverse effects when ingested by humans. In the other hand, xanthan is useful as a thickener in foods, such as dairy products and salad dressings, and in cosmetics such as cold creams and shampoos.

In order to control leaf-eating insect larvae, gardeners have used the insect pathogen Bacillus thuringiensis for many years. This bacterium release a toxin (Bt-toxin) that destroy certain moths, beetles, and flies when ingested by their larvae. B. thuringiensis subspecies israelensis produces Bt-toxin that is specifically active to fight mosquito larvae and is widely used in municipal control programs. Commercial preparations consists Bt-toxin and endospores of B. thuringiensis are presented at almost any gardening supply store.

Denim blue jeans have become very popular ever since Levi Strauss and Jacob Davis first created them for California gold miners in 1873. Today, companies that manufacture blue jeans are turning to microbiology to produce environmentally sound production methods that minimize toxic wastes and the cost associated with treating toxic wastes. Furthermore, microbiological methods can provide abundant, renewable raw materials. Production of cotton requires large tracts of land, pesticides, and fertilizer, and the crop yield rely on the weather. However, bacteria can provide both cotton and polyester with less impact to the environment. Gluconacetobacter xylinus bacteria create cellulose by attaching glucose untis to simple chains in the outer membrane of the bacterial cell wall. The cellulose microfibrils are extruded through pores in the outer membrane, and bundles of microfibrils then twist into ribbons. Chemical synthesis of indigo needs a high PH and releases waste that explodes in contact with water. However, a California biotechnology company, Genencor, has created a method to produce indigo by the help of bacteria. In the Genencor labs, researchers put the gene for conversion of the bacterial by-product indole to indigo from a soil bacterium, Pseudomonas putida, into Escherichia coli bacteria, which then changed to blue. Bacteria can also make plastic zippers and packaging materials for the jeans. More than 25 bacteria make polyhydroxyalkanoate (PHA) inclusion granules as their food reserve. PHAs are equal to the other plastics, and because they are created by bacteria, they are also readily degraded by many bacteria. PHAs could provide a biodegradable alternative to conventional plastic, which is petroleum product.

Other than all above, bacteria also produce a substance that can inhibits other microorganisms or bacteria, which called as antibiotic. Antibiotics are actually rather easy to discover, but few are of medical and also of commercial value. Some are commercially used instead for treating disease, for example, as a supplement in animal feed. More than 50% of our antibiotics are produced by species of Streptomyces, filamentous bacteria that commonly inhabit soil. Small percentages of antibiotics are produced by endospore-forming bacteria such as Bacillus, and the rest are produced by molds, mostly of the genera Penicillium and Cephalosporium. One study screened 400, 000 microbial cultures that yielded only three useful drugs. It is quite interesting to note that practically all antibiotic-producing bacteria have some sort of sporulation process.

The most valuable pharmaceutical product is the hormone insulin, a small protein release by the pancreas that controls the body’s uptake of glucose from blood. For past years before, people with insulin-dependent diabetes have controlled their disease by injecting insulin achieved from the pancreases of slaughtered animals. Getting this insulin is a high cost process, and the insulin from animals is not as effective as what obtained from human. Due to the value of the human insulin and the small size of the protein, producing human insulin by recombinant DNA techniques was an early succes for the pharmaceutical industry. In order to produce the hormone, synthetic genes were first constructed for each of the two short polypeptide chains made it possible to use synthetic genes. Two different E. coli bacterial cultures were used, one to produce each of the insulin polypeptide chain. The polypeptides were then recovered from the bacteria, separated from the β-galactosidase, and chemically joined to produce human insulin.

Some of bacteria can also act as normal flora on our body. Once established, the normal flora can help the host by avoiding the overgrowth of harmful microorganisms. This phenomenon is known as microbial antagonism. One consequences of this competition is that the normal flora protect the host from the colonization by potentially pathogenic microbes by competing for nutrients, producing substances harmful to the pathogens, and affecting conditions such as PH and available oxygen. For example, the normal bacterial flora of the adult human vagina maintains a local PH in about 4. The presence of normal flora prevents the over-growth of the yeast Candida albicans, which can attack when the balance between normal microbiota and pathogens is upset and when PH is disturbed.

Bacteria have always been very beneficial to humankind, even when their unknown existence. Even though bacteria are our friend, still, there are some bacteria that are pathogenic, which are disease-producing bacteria. But for overall, bacteria can still be our friend as it gives more that hundreds useful effects to human especially.