

**COURSE CODE: PGD004**

**COURSE NAME: POST GRADUATE DIPLOMA IN HUMAN NUTRITION**

**ASSIGNEMENT 6**

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**AIPMS/226/002/2019**

**SUBMISSION DATE: 31st OCTOBER 2019**

**Question One.**

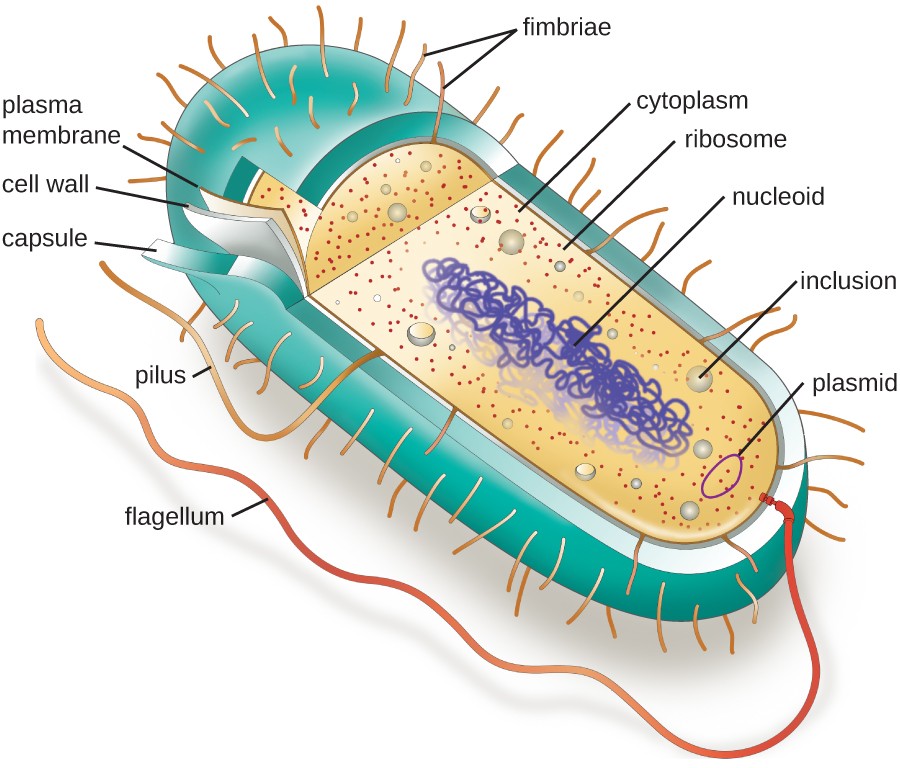
**State the main difference between bacteria cell and typical prokaryotic cells.**

Cell theory states that the cell is the fundamental unit of life. However, cells vary significantly in size, shape, structure, and function. At the simplest level of construction, all cells possess a few fundamental components. These include **cytoplasm** (a gel-like substance composed of water and dissolved chemicals needed for growth), which is contained within a plasma membrane (also called a cell membrane or cytoplasmic membrane); one or more chromosomes, which contain the genetic blueprints of the cell; and **ribosomes**, organelles used for the production of proteins.

Beyond these basic components, cells can vary greatly between organisms, and even within the same multicellular organism. The two largest categories of cells—**prokaryotic cells** and **eukaryotic cells**—are defined by major differences in several cell structures. Prokaryotic cells lack a nucleus surrounded by a complex nuclear membrane and generally have a single, circular chromosome located in a nucleoid. Eukaryotic cells have a nucleus surrounded by a complex nuclear membrane that contains multiple, rod-shaped chromosomes Y.-H.M. Chan, W.F. Marshall. 2010)

All plant cells and animal cells are eukaryotic. Some microorganisms are composed of prokaryotic cells, whereas others are composed of eukaryotic cells. Prokaryotic microorganisms are classified within the domains Archaea and Bacteria, whereas eukaryotic organisms are classified within the domain Eukarya.

The structures inside a cell are analogous to the organs inside a human body, with unique structures suited to specific functions. Some of the structures found in prokaryotic cells are similar to those found in some eukaryotic cells; others are unique to prokaryotes. Although there are some exceptions, eukaryotic cells tend to be larger than prokaryotic cells. The comparatively larger size of eukaryotic cells dictates the need to compartmentalize various chemical processes within different areas of the cell, using complex membrane-bound organelles. In contrast, prokaryotic cells generally lack membrane-bound organelles; however, they often contain inclusions that compartmentalize their cytoplasm. Figure below illustrates structures typically associated with prokaryotic cells.

*Figure 1. A typical prokaryotic cell contains a cell membrane, chromosomal DNA that is concentrated in a nucleoid, ribosomes, and a cell wall. Some prokaryotic cells may also possess flagella, pili, fimbriae, and capsules.*

**Prokaryotes** are microscopic organisms belonging to the domains Bacteria and Archaea, which are two out of the three major domains of life. (Eukarya, the third, contains all **eukaryotes**, including animals, plants, and fungi.) Bacteria and archaea are single-celled, while most eukaryotes are multicellular.

Prokaryotic cells do not have a true nucleus that contains their genetic material as eukaryotic cells do. **Instead, prokaryotic cells have a** [nucleoid region](https://en.wikipedia.org/wiki/Nucleoid)**, which is an irregularly-shaped region that contains the cell’s DNA and is not surrounded by a nuclear envelope.** Some other parts of prokaryotic cells are similar to those in eukaryotic cells, such as a cell wall surrounding the cell (which is also found in [plant](https://biologydictionary.net/plant/) cells, although it has a different composition)

A prokaryote is a simple, single-celled (unicellular) organism that lacks an organized nucleus or any other membrane-bound organelle. Prokaryotic DNA is found in a central part of the cell: the nucleoid. Most prokaryotes have a peptidoglycan cell wall and many have a polysaccharide capsule. The cell wall acts as an extra layer of protection, helps the cell maintain its shape, and prevents dehydration. The capsule enables the cell to attach to surfaces in its environment. Some prokaryotes have flagella, pili, or fimbriae. Flagella are used for locomotion. Pili are used to exchange genetic material during a type of reproduction called conjugation. Fimbriae are used by bacteria to attach to a host cell.

Bacteria are prokaryotes, lacking well-defined nuclei and membrane-bound organelles, and with chromosomes composed of a single closed DNA circle. They come in many shapes and sizes, from minute spheres, cylinders and spiral threads, to flagellated rods, and filamentous chains. They are found practically everywhere on Earth and live in some of the most unusual and seemingly inhospitable places

**Question Two.**

**State the functions of the Cytoplasmic membrane in a bacterial cell.**

The [plasma membrane](https://en.wikipedia.org/wiki/Cell_membrane) or bacterial cytoplasmic membrane is composed of a [phospholipid bilayer](https://en.wikipedia.org/wiki/Phospholipid_bilayer) and thus has all of the general functions of a [cell membrane](https://en.wikipedia.org/wiki/Cell_membrane) such as acting as a permeability barrier for most molecules and serving as the location for the transport of molecules into the cell. In addition to these functions, [prokaryotic](https://en.wikipedia.org/wiki/Prokaryotic) membranes also function in energy conservation as the location about which a [proton motive force](https://en.wikipedia.org/wiki/Proton_motive_force) is generated. Unlike [eukaryotes](https://en.wikipedia.org/wiki/Eukaryote), bacterial membranes (with some exceptions e.g. [*Mycoplasma*](https://en.wikipedia.org/wiki/Mycoplasma) and [methanotrophs](https://en.wikipedia.org/wiki/Methanotrophic)) generally do not contain [sterols](https://en.wikipedia.org/wiki/Sterol). However, many microbes do contain structurally related compounds called [hopanoids](https://en.wikipedia.org/wiki/Hopanoid) which likely fulfill the same function. Unlike [eukaryotes](https://en.wikipedia.org/wiki/Eukaryote), [bacteria](https://en.wikipedia.org/wiki/Bacteria) can have a wide variety of [fatty acids](https://en.wikipedia.org/wiki/Fatty_acid) within their membranes. Along with typical saturated and unsaturated [fatty acids](https://en.wikipedia.org/wiki/Fatty_acid), bacteria can contain fatty acids with additional [methyl](https://en.wikipedia.org/wiki/Methyl), [hydroxy](https://en.wikipedia.org/wiki/Hydroxyl) or even cyclic groups. The relative proportions of these fatty acids can be modulated by the bacterium to maintain the optimum fluidity of the membrane (e.g. following temperature change).

As a [phospholipid bilayer](https://en.wikipedia.org/wiki/Phospholipid_bilayer), the lipid portion of the outer membrane is impermeable to charged molecules. However, channels called [porins](https://en.wikipedia.org/wiki/Porin_(protein)) are present in the outer membrane that allow for [passive transport](https://en.wikipedia.org/wiki/Passive_transport) of many [ions](https://en.wikipedia.org/wiki/Ion), [sugars](https://en.wikipedia.org/wiki/Sugar) and [amino acids](https://en.wikipedia.org/wiki/Amino_acid) across the outer membrane. These molecules are therefore present in the [periplasm](https://en.wikipedia.org/wiki/Periplasm), the region between the cytoplasmic and outer membranes. The [periplasm](https://en.wikipedia.org/wiki/Periplasm) contains the peptidoglycan layer and many proteins responsible for substrate binding or [hydrolysis](https://en.wikipedia.org/wiki/Hydrolysis) and reception of extracellular signals. The periplasm is thought to exist in a gel-like state rather than a liquid due to the high concentration of proteins and [peptidoglycan](https://en.wikipedia.org/wiki/Peptidoglycan) found within it. Because of its location between the cytoplasmic and outer membranes, signals received and substrates bound are available to be transported across the [cytoplasmic membrane](https://en.wikipedia.org/wiki/Cytoplasmic_membrane) using transport and signaling proteins imbedded there.

The plasma membrane, also called the cytoplasmic membrane, is the most dynamic structure of a procaryotic cell. Its main function is a s a selective permeability barrier that regulates the passage of substances into and out of the cell. The plasma membrane is the definitive structure of a cell since it sequesters the molecules of life in a unit, separating it from the environment. The bacterial membrane allows passage of water and uncharged molecules up to mw of about 100 daltons but does not allow passage of larger molecules or any charged substances except by means special membrane transport processes and transport systems (Demchick, P; Koch, AL 1996).

Since procaryotes lack any intracellular organelles for processes such as respiration or photosynthesis or secretion, the plasma membrane subsumes these processes for the cell and consequently has a variety of functions in energy generation, and biosynthesis. For example, the electron transport system that couples aerobic respiration and ATP synthesis is found in the procaryotic membrane. The photosynthetic chromophores that harvest light energy for conversion into chemical energy are located in the membrane. Hence, the plasma membrane is the site of oxidative phosphorylation and photophosphorylation in procaryotes, analogous to the functions of mitochondria and chloroplasts in eukaryotic cells. Besides transport proteins that selectively mediate the passage of substances into and out of the cell, procaryotic membranes may contain sensing proteins that measure concentrations of molecules in the environment or binding proteins that translocate signals to genetic and metabolic machinery in the cytoplasm. Membranes also contain enzymes involved in many metabolic processes such as cell wall synthesis, septum formation, membrane synthesis, DNA replication, CO2 fixation and ammonia oxidation. The predominant functions of procaryotic membranes are listed in Table 7 and discussed below.

1. Osmotic or permeability barrier
2. Location of transport systems for specific solutes (nutrients and ions)
3. Energy generating functions, involving respiratory and photosynthetic electron transport systems, establishment of proton motive force, and transmembranous, ATP-synthesizing ATPase
4. Synthesis of membrane lipids (including lipopolysaccharide in Gram-negative cells)
5. Synthesis of murein (cell wall peptidoglycan)
6. Assembly and secretion of extracytoplasmic proteins
7. Coordination of DNA replication and segregation with septum formation and cell division
8. Chemotaxis (both motility per se and sensing functions)
9. Location of specialized enzyme system
10. It helps to distribute water, oxygen as other substances throughout the cell.
11. Literally, all the cellular content including nucleus, and other cell organelle are floating in cytoplasm.

**Question Three.**

**Name three members of enterobacteriacea. This group of micro-organisms are also known as the “hygiene” group of micro-organisms. Explain why.**

Enterobacteriaceae are Gram-negative, short rods, non-sporulating, facultative anaerobes. The family Enterobacteriaceae is a large [family](https://en.wikipedia.org/wiki/Family_(biology)) of [Gram-negative bacteria](https://en.wikipedia.org/wiki/Gram-negative_bacteria). It was first proposed by Rahn in 1936. Its classification above the level of family is still a subject of debate, but one classification places it in the order Enterobacteriales of the class [Gammaproteobacteria](https://en.wikipedia.org/wiki/Gammaproteobacteria) in the phylum [Proteobacteria](https://en.wikipedia.org/wiki/Proteobacteria) (Don J. Brenner; Noel R. Krieg; James T. Staley *et*, al. 2005)

Taxonomically, the bacterial family Enterobacteriaceae currently has 53 genera (and over 170 named species) and they include Arsenophonus, Biostraticola, Brenneria, Buchnera, Budvicia, Buttiauxella, Calymmatobacterium, Cedecea, Citrobacter, Cosenzaea, Cronobacter, Dickeya, Edwardsiella, Enterobacter, Erwinia, Escherichia, Ewingella, Gibbsiella, Hafnia, Klebsiella, Kluyvera, Leclercia, Leminorella, Levinea, Lonsdalea, Mangrovibacter, Moellerella, Morganella, Obesumbacterium, Pantoea, Pectobacterium, Phaseolibacter, Photorhabdus, Plesiomonas, Pragia, Proteus, Providencia, Rahnella, Raoultella, Saccharobacter, Salmonella, Samsonia, Serratia, Shigella, Shimwellia, Sodalis, Tatumella, Thorsellia, Trabulsiella, Wigglesworthia, Xenorhabdus, Yersinia and Yokenella. Of these, 26 genera are known to be associated with infections in humans. The nomenclature of the Enterobacteriaceae is complicated and has been based on biochemical and antigenic characteristics. Recently, the application of new technologies such as DNA hybridisation has resulted in numerous changes in classification of the Enterobacteriaceae (Hong Nhung P, Ohkusu K, Mishima N, Noda M, Monir Shah M, Sun X, et al. 2007)

The family Enterobacteriaceae consists of a number of species that are gram-negative bacilli (GNB). Most of the other Enterobacteriaceae cause a wide variety of extra-intestinal infections. Edwardsiella tardi can cause both extra-intestinal and intestinal infection. Klebsiella causes extra-intestinal infection, but a hemorrhagic colitis has been associated with Klebsiella oxytoca. Members of this group are becoming highly resistant to antimicrobials, and some members are professional pathogens capable of infecting both healthy and compromised hosts.

In fact, Enterobacteriaceae family contains a large number of genera that are biochemically and genetically related to one another. This group of organisms includes several that cause primary infections of the human gastrointestinal tract. Members of this family are major causes of opportunistic infection (including septicemia, pneumonia, meningitis and urinary tract infections). Examples of genera that cause opportunistic infections are: Citrobacter, Enterobacter, Escherichia, Hafnia, Morganella, Providencia and Serratia.

***Escherichia coli****.* Escherichia coli, a Gram-negative bacillus, stained according to Gram stain protocol, the small rods characteristic of this organism. Escherichia coli live in the human gut and are usually harmless, but some are pathogenic causing diarrhea and other symptoms as a result of ingestion of contaminated food or water. Enteropathogenic E. coli (EPEC). Certain serotypes are commonly found associated with infant diarrhea. Enterotoxigenic E. coli (ETEC) produce diarrhea resembling cholera but much milder in degree. They also cause "travelers' diarrhea". Enteroinvasive E. coli (EIEC) produce a dysentery (indistinguishable clinically from shigellosis, see bacillary dysentery). Enterohemorrhagic E. coli (EHEC). These are usually serotype O157:H7. These organisms can produce a hemorrhagic colitis (characterized by bloody and copious diarrhea with few leukocytes in afebrile patients). The organisms can disseminate into the bloodstream producing systemic hemolytic-uremic syndrome (hemolytic anemia, thrombocytopenia and kidney failure) which is often fatal. The commonest community acquired ("ascending") urinary tract infection is caused by E. coli.

***Shigella*** (4 species; S. flexneri, S. boydii, S. sonnei, S. dysenteriae), all cause bacillary dysentery or shigellosis, (bloody feces associated with intestinal pain). The organism invades the epithelial lining layer but does not penetrate. Usually within 2 to 3 days, dysentery results from bacteria damaging the epithelial layers lining the intestine, often with release of mucus and blood (found in the feces) and attraction of leukocytes (also found in the feces as "pus"). However, watery diarrhea is frequently observed with no evidence of dysentery. Shiga toxin (chromosomally-encoded), which is neurotoxic, enterotoxic and cytotoxic, plays a role. Shigella is Gram-negative, nonmotile, nonspore forming, rod-shaped bacteria closely related to Escherichia coli and Salmonella. The causative agent of human shigellosis, Shigella causes disease in primates, but not in other mammals. It is only naturally found in humans and apes. During infection, it typically causes dysentery.

***Salmonella Typhi*** are motile by means of peritrichous flagella. Salmonella typhi lives only in humans. Persons with typhoid fever carry the bacteria in their bloodstream and intestinal tract. In addition, a small number of persons, called carriers, recover from typhoid fever but continue to carry the bacteria. Both ill persons and carriers shed Salmonella Typhi in their feces (stool). *Salmonella* infections most often cause vomiting or diarrhea, sometimes severe. In rare cases, Salmonella illness can lead to severe and life-threatening bloodstream infections. Salmonellosis, the common salmonella infection, is caused by a variety of serotypes (most commonly S. enteritidis) and is transmitted from contaminated food (such as poultry and eggs). It does not have a human reservoir and usually presents as a gastroenteritis (nausea, vomiting and non-bloody stools). The disease is usually self-limiting (2 - 5 days). Like Shigella, these organisms invade the epithelium and do not produce systemic infection. Salmonella typhi is transmitted from a human reservoir or in the water supply (if sanitary conditions are poor) or in contaminated food. It initially invades the intestinal epithelium. The organisms penetrate (usually within the first week) and passes into the bloodstream where it is disseminated in macrophages. Typical features of a systemic bacterial infection are seen. The Vi (capsular) antigen plays a role in the pathogenesis of typhoid. Antibiotic therapy is essential.

***Yersinia entercolitica*** - the organisms are invasive (usually without systemic spread). Typically, the infection is characterized by diarrhea, fever and abdominal pain. Y. enterocolitica infections are seen most often in young children. Y. enterocolitica can be transmitted by fecal contamination of water or milk by domestic animals or from eating meat products. Yersinia enterocolitica is a species of gram-negative coccobacillus-shaped bacterium, belonging to the family *Enterobacteriaceae. Y*. enterocolitica infection causes the disease yersiniosis which is a zoonotic disease occurring in humans as well as a wide array of animals such as cattle, deer, pigs, and birds.

***Klebsiella pneumoniae*** is often involved in respiratory infections. The organism has a prominent capsule aiding pathogenicity. Klebsiella pneumoniae is a Gram-negative, non-motile, encapsulated rod-shaped bacterium found in the normal flora of the mouth, skin, and intestines

***Proteus*** is another common cause of urinary tract infection; the organism produces a urease that degrades urea producing an alkaline urine. *Proteus vulgaris* is Gram-negative bacterium that inhabits the intestinal tracts of humans and animals. It can be found in soil, water, and fecal matter. It is known to cause wound infections and other species of its genera are known to cause urinary tract infections.

*Enterobacteriaceae* are usually considered by food manufacturers as hygiene indicators and therefore used to monitor the effectiveness of implemented preventive pre-requisite measures such as [Good Manufacturing Practices](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/good-manufacturing-practices) and Good Hygiene Practices (GMP/GHP) (Cox et al., 1988). This is also reflected in numerous national and international standards or criteria where Enterobacteriaceae or coliforms are included as hygiene indicators with 3- class sampling plans, thus with some tolerance values as reflected by the limits m and M of such specifications. Enterobacteriaceae are hardly ever identified as significant hazards in HACCP studies and thus no specific control measures are defined either. However, the specific control measures implemented to control recognized significant hazards such as [*Salmonella*](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/salmonella) are suitable and effective as well to control members of this family. The characteristics of both the pathogen and the hygiene indicator are indeed very similar in terms, for example, of sensitivity to heat-treatments or other killing steps.

The presence of low levels of Enterobacteriaceae in foods is accepted and does not represent a direct safety concern. These levels (m and M of sampling plans) may vary depending on the type of food and consumer. The presence of high levels in [foods prepared](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/prepared-foods) or handled in kitchens, however, is almost invariably due to an additional contamination during handling, to inappropriate conditions such as prolonged storage at elevated temperature and further handling or a combination of the two factors. This can be addressed through the appropriate information and training of food handlers in Good Hygiene Practices.

The establishment of specific control measures for members of the Enterobacteriaceae is thus not very frequent, a significant exception being E. sakazakii in powdered formulae for prematures and infants during the first week of life. As outlined in the FAO/WHO report (2004) E. sakazakii can only be controlled through the implementation of a combination of control measures. Amongst the measures discussed in the above report, some can be applied during production and others during preparation and handling of the prepared bottles.

Members of Enterobacteriaceae is considered as hygiene group of microorganisms because they have been associated with the [spoilage](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/spoilage) of a range of other foods and drinks, although many of these have not been extensively studied and their exact role in the spoilage of these products remains unclear. Examples include [beer](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/beers) spoilage by Obesumbacterium proteus, spoilage of [maple syrup](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/maple-syrup) by various members of the Enterobacteriaceae, spoilage of fresh cream desserts by [*Serratia*](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/serratia) spp. and other members of the Enterobacteriaceae, which is characterised by clotting cream (from acid production) and gas production (Sutherland et al., 1986). In shell eggs Enterobacteriaceae are responsible for bacterial rots, with [*Enterobacter*](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/enterobacter) and [*Proteus*](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/proteus) associated with causing black rots and Serratia with red rots (ICMSF, 1998).

**Question Four.**

**Define mycotoxins. Giving examples explain why they are of concern in the food industry.**

The term mycotoxin was coined in 1962 in the aftermath of an unusual veterinary crisis near London, England, during which approximately 100,000 turkey poults died (Bennett, I, 1997). **Forgacs, J.** (1962**).** When this mysterious turkey X disease was linked to a peanut (groundnut) meal contaminated with secondary metabolites from Aspergillus flavus (aflatoxins), it sensitized scientists to the possibility that other occult mold metabolites might be deadly. Soon, the mycotoxin rubric was extended to include a number of previously known fungal toxins (e.g., the ergot alkaloids), some compounds that had originally been isolated as antibiotics (e.g., patulin), and a number of new secondary metabolites revealed in screens targeted at mycotoxin discovery (e.g., ochratoxin A)

Mycotoxins are toxic secondary metabolic products of molds present on almost all agricultural commodities worldwide. Unlike primary metabolites (sugars, amino acids and other substances), secondary metabolites are not essential in the normal metabolic function of the fungus. Other known secondary metabolites are phytotoxins and antibiotics. In other words mycotoxins are toxic secondary metabolite produced by organisms of the [fungus](https://en.wikipedia.org/wiki/Fungus) kingdom (Richard JL, 2007). And is capable of causing disease and death in both humans and other animals (Bennett, J. W.; Klich, M, 2003). The term 'mycotoxin' is usually reserved for the toxic chemical products produced by fungi that readily colonize crops (Turner NW, Subrahmanyam S, Piletsky SA, 2009).

Currently there are around 400 mycotoxins reported. These compounds occur under natural conditions in feed as well as in food. Some of the most common mycotoxins include: aflatoxins, trichothecenes, fumonisins, zearalenone, ochratoxin and ergot alkaloids (Grenier, B., & Oswald, I. P, 2011). Mycotoxins are produced by different strains of fungi and each strain can produce more than one mycotoxin

The effects of some food-borne mycotoxins are acute with symptoms of severe illness appearing quickly after consumption of food products contaminated with mycotoxins. Other mycotoxins occurring in food have been linked to long-term effects on health, including the induction of cancers and immune deficiency. Of the several hundred mycotoxins identified so far, about a dozen have gained the most attention due to their severe effects on human health and their occurrences in food. These may include but not limited to the following

**Aflatoxins:** Aflatoxins are amongst the most poisonous mycotoxins and are produced by certain molds (Aspergillus flavus and Aspergillus parasiticus) which grow in soil, decaying vegetation, hay, and grains. Crops that are frequently affected by Aspergillus spp. include cereals (corn, sorghum, wheat and rice), oilseeds (soybean, peanut, sunflower and cotton seeds), spices (chili peppers, black pepper, coriander, turmeric and ginger) and tree nuts (pistachio, almond, walnut, coconut and Brazil nut). The toxins can also be found in the milk of animals that are fed contaminated feed, in the form of aflatoxin M1. Large doses of aflatoxins can lead to acute poisoning (aflatoxicosis) and can be life threatening, usually through damage to the liver. Aflatoxins have also been shown to be genotoxic, meaning they can damage DNA and cause cancer in animal species. There is also evidence that they can cause liver cancer in humans.

**Ochratoxin A:** Ochratoxin A is produced by several species of Aspergillus and Penicillium and is a common food-contaminating mycotoxin. Contamination of food commodities, such as cereals and cereal products, coffee beans, dry vine fruits, wine and grape juice, spices and liquor ice, occurs worldwide. Ochratoxin A is formed during the storage of crops and is known to cause a number of toxic effects in animal species. The most sensitive and notable effect is kidney damage, but the toxin may also have effects on fetal development and on the immune system. Contrary to the clear evidence of kidney toxicity and kidney cancer due to ochratoxin A exposure in animals, this association in humans is unclear, however effects on kidney have been demonstrated.

**Patulin:** Patulin is a mycotoxin produced by a variety of molds, particularly Aspergillus, Penicillium and [*Byssochlamys*](https://en.wikipedia.org/wiki/Byssochlamys)*.* Often found in rotting [apples](https://en.wikipedia.org/wiki/Apples) and apple products, patulin can also occur in various moldy fruits, grains and other foods. Major human dietary sources of patulin are apples and apple juice made from affected fruit. The acute symptoms in animals include liver, spleen and kidney damage and toxicity to the immune system. For humans, nausea, gastrointestinal disturbances and vomiting have been reported. Patulin is considered to be genotoxic however a carcinogenic potential has not been demonstrated yet.

**Fusarium fungi:** Fusarium fungi are common to the soil and produce a range of different toxins, including trichothecenes such as deoxynivalenol (DON), nivalenol (NIV) and T-2 and HT-2 toxins, as well as zearalenone (ZEN) and fumonisins. The formation of the molds and toxins occur on a variety of different cereal crops. Different fusarium toxins are associated with certain types of cereal. For example, both DON and ZEN are often associated with wheat, T-2 and HT-2 toxins with oats, and fumonisins with maize (corn). Trichothecenes can be acutely toxic to humans, causing rapid irritation to the skin or intestinal mucosa and lead to diarrhoea. Reported chronic effects in animals include suppression of the immune system. ZEN has been shown to have hormonal, estrogenic effects and can cause infertility at high intake levels, particularly in pigs. Fumonisins have been related to oesophageal cancer in humans, and to liver and kidney toxicity in animals.

**Question Five.**

**Explain why bacteriophages is a major concern in the dairy industry**

Bacteriophages or “phages” are viruses that infect bacteria. They are now believed to represent the most abundant biological entities with an estimated range of 1030 to 1032 total phage particles on earth, assuming that they outnumber bacteria about 10-fold (Emond, E., & Moineau, S. 2007). These bacterial viruses are present in ecosystems where bacteria have been found, including man-made ecological niches such as food fermentation vats. The industry has been dealing with this biological phenomenon for many years now and has relied on a variety of practical approaches to control phages, which include adapted factory design, improved sanitation, adequate ventilation, process changes, improved starter medium, and culture rotation (Moineau, S. 1999). Applications of phage resistance in lactic acid bacteria. In *Lactic Acid Bacteria: Genetics, Metabolism and Applications* (pp. 377-382). Springer, Dordrecht. Despite extensive efforts, however, phage infection of starter LAB cultures remains the most common cause of slow or incomplete fermentation in the dairy industry, and both researchers and industrial technologists are aware of regular, although unpublished, cases where phage infections actually cause product downgrading. Thus, the goal of this review is to make the reader aware of the relevance and implication of phage attacks in dairy fermentations, with special emphasis on the daily and practical aspects related to this problem in the dairy fermentative industry.

Phage infection of dairy starter cultures remains the main cause of fermentation failures in the dairy industry. Phage outbreaks can lead to substantial economic losses due to manufacturing delays, waste of ingredients, lower quality product, growth of spoilage and pathogenic microorganisms or even total production loss (Samson, J.E.; Moineau, S. 2013). Close monitoring of entry routes, quick and effective phage detection methods and control measurements are currently applied to reduce the risk of phage propagation within dairy settings

Foodborne diseases continue to be a hurdle for human health and those associated to dairy industries are not an exception. Thus, many pathogenic bacteria can spread along the food chain from “farm to fork”. In this regard, phages can be used as antimicrobials and biocontrol agents in food industries to prevent and control step by step the pathogenic bacterial contamination during food production. The use of phages has some advantages over conventional disinfectants such as their narrow host range, targeting speciﬁcally bacteria from one species or genus, being also effective against bacteria resistant to antibiotics. Moreover, phages have been described as safe for humans, animals, plants and the environment (Bruttin A, [Brüssow H](https://www.ncbi.nlm.nih.gov/pubmed/?term=Br%C3%BCssow%20H%5BAuthor%5D&cauthor=true&cauthor_uid=15980363). 2005). Besides, they do not cause equipment or surface damage or alter the organoleptic properties of food

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