



## The Silent Threat: Understanding Microbial Toxins and Their Global Impacts

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### Abstract:

This abstract looks on to microbial toxins that play important role in shaping the ecosystem and affecting various aspects of human life. These toxic substances are produced by variety of microorganisms such as bacteria, viruses and algae. Understanding their nature and effects is essential for studying global impacts. Bacterial toxins contains strains of different bacterial species such as Escherichia coli, and Clostridium botulinum, have significant implications for human health. They can causes severe diseases from gastrointestinal infections to life threatening conditions. The food borne illness is often related to bacterial toxins. Fungal toxins such as mycotoxins, pose serious threat to crops and food security. The global trade of food makes it easy for mycotoxins to spread and affect human health (such as liver and kidney damage) and crops. Algae toxins, produced by certain species of microalgae, can lead to harmful algae blooms (HABs). These toxins cause mass mortality of marine life and disrupting the aquatic ecosystem. HABs can contaminate sea food and cause diseases to humans through contaminated fish and shell fish. Climate change further complicates the scenario by promoting the prevalence of toxins producing substances. Rising temperature and precipitation patterns create favorable conditions for toxin producing species. Efforts to address this, lies with the collaboration of microbiologists, ecologists and public health experts. Surveillance systems for early detection, regulations on food safety and research strategies. In conclusion, microbial toxins exerts many effects on global health, and ecosystem. Understanding their nature and implementing effective measures is necessary for the sustainability of the planet.

**Key words:** Toxins, microbial toxins, aflatoxins, mycotoxins, domoic acid, cyano toxins, global impact.



## Introduction

A toxin is a toxic substance produced inside residing cells or organisms. Toxins may be small molecules, peptides, or proteins which might be able to inflicting ailment on touch with or absorption with the aid of using frame tissues interacting with organic macromolecules together with enzymes or cell receptors. Microbial pollutants consist of pollutants produced with the aid of using micro-organisms, such as microorganism and fungi [1]. Microbial toxins are the important virulent subunits of numerous pathogenic microorganisms by which cell and molecular mechanisms of immune cells may be evaded. Microbial toxins can also additionally cause deteriorated cell immune response to clean the pathogen challenge. After the primary discovery of Diphtheria toxin in 1888, growing number of such microbial toxins had been identified, characterized and studied by various laboratories all over the world. They are vital factors for many bacteria but still a danger to human health [2].

Over the years, they have gained attention of not only the microbiologists but also from the field of cell biology. Microbial pollutants sell contamination and ailment with the aid of using at once unfavorable host tissues and with the aid of using disabling the immune system. Toxins are also of two types: Endotoxins and Exotoxins. Endotoxins are gram negative, they exert their movement by removing restrictions from host cell function. Exotoxins are proteins that may with ease be grouped into three primary categories. First, inside cell lively molecules, second, molecules that destroy membranes, thirdly, antigen presenting cells [3]. Most of the bacterial toxins are proteins that are coded with chromosomal genes or plasmids. Lysogenic phage's shape a part of chromosome. The toxins are commonly exit from organisms through lists.

However, a few shed their outer membranous proteins in outer vesicles [4]. The manner of toxin binding and entry seems comparable in lots of respects to that with the aid of using the protein hormones and different biologically macromolecules engage with cells. Since it appears not going, as higher vertebrate cells possess "suicide receptors" for bacterial toxins, an affordable opportunity is that those pollution parasitize path methods for molecules generally taken up with the aid of using cells [5]. Bacterial hyaluronidases, collagenases, and phospholipases possess the capability



to damage mobile membranes or matrices. Specific instances of those forms of pollutants consist of the  $\alpha$ -toxin of *Cl.perfurings*, *St.pyogenes*, streptokinase that can convert plasminogen to plasmin and solubilize the clots [6]. Recent studies on bacterial toxins mode of action tells that amount of toxins excreted by bacteria depends on several conditions such as their growth or composition of the culture medium. It is now ensured that toxin production can take place in controlled manner and it can be very with time [7].

Botulinum toxin is a robust neurotoxin induced via means of *Cl. botulinum*. There are 8 sorts of botulinum toxins (A, B, D, E, F, G) which can be immunologically wonderful however produce the identical pharmacological effect: they stop the discharge of acetylcholine from cholinergic nerve endings. Most lines of *Clostridium botulinum* produce best one kind of toxin. All toxin sorts have a comparable molecular weight of about 150,000 and are manufactured as a single polypeptide chain , this is lifted via way of means of endogenous proteases withinside the proteolytic lines (e.g., sorts A and B) and may be nicked via way of means of exogenously delivered proteases withinside the nonproteolytic lines [8].

*S. Aureus* is a main purpose of food-borne disease characterised within 6 hours of taking in of 1 or extra preformed heat-fetid enterotoxins. Some instances also are related to diarrhea. Clinical contamination is imputed to the capability of the organism to provide one or extra serologically different protein exotoxins named A, B, C1 to C3, D, or E. All these toxins are small proteins with comparable organic activities. The genes encoding the staphylococcal enterotoxins can be chromosomal or plasmid related or can be carried through participants of a polymorphic own circle of relatives of temperate bacteriophages. The mechanisms through which those toxins stimulate vomiting and diarrhea aren't virtually understood. The staphylococcal enterotoxins are the maximum powerful T-cells activators acknowledged and are capable of activate lymphocyte growth and cytokine manufacturing. Super antigens may be provided directly (i.e., they do now no longer require processing through an antigen-imparting cells) to the T-cells receptor through cells containing fundamental histocompatibility complicated magnificence II molecules. The fundamental histocompatibility complicated magnificence II molecule is the receptor for those toxins [9].



Mycotoxins are a quiet exceptional group of low weight compounds which are found in foods and have an effect on animals (e.g. humans). They are catalysed by fungi that is filamentous, however, the fungi may not be present in food. It is crucial to recognise that mycotoxins aren't the simplest weapons. For instance, other toxins that belong to fungi, which aren't determined in food, can be extra toxic. Most of the fungi are not pathogens but they may generate toxins [10]. Mycotoxins can affect the GIT microbiota at once via antimicrobial hobby and via secondary mechanisms regarding the discharge of antimicrobial components from mycotoxin-degraded host cells.

Numerous research have delved the effect of mycotoxins on host microbiome in vivo. Contrarily, the microbiota also can affect the biological availability of consumed mycotoxins and their related metabolites. Mycotoxins may be neutralized via biological transformation and bodily segregated with the aid of using direct adsorption on cell wall of microbes which compromise their concentration throughout the gut. Nearly, 300 mycotoxins have been observed. They can show carcinogenic and mutagenic effects. They are found as contaminants of food. The temperature and humidity for mycotoxins vary from fungal growth. Major impact of these is difficulty in transporting food and crops as they contaminate them [11]. The prevalence of mushroom poisoning varies loads over the arena relying on nearby traditions, life-style, dietary factors, weather and the incidence of untamed mushrooms. Remitting mushrooms containing toxins that affect behaviour and mind, consumption of poisonous fungi is nearly perpetually accidental.

Only with the aid of using exception, fungal degrading is of destructive or murderous origin. The scientific size of the hassle is associated with the truth that a few mushrooms include distinctly effective toxins. Thus, a regular mushroom meal can also additionally disclose human beings to a deadly dose of the toxin. Cytolytic proteins and peptide toxins are definitive malignant elements of bacterial pathogens and play a primary function in disease caused by bacteria. Human-pathogenic fungi have been now no longer recognized to own such pollutants till the latest discovery of candidalysin, a peptide toxin secreted with the aid of using *Candida albicans* [12]. *C. Albicans* is typically a benign member of the microbiota [13], however below positive predisposing conditions, it is able to reason superficial mucosal contamination in wholesome people and probably deadly invasive and systemic contamination withinside the



immunocompromised .Although *Candida Albicans* is related to the bulk of mucosal *Candida* infections, candidiasis is likewise as a result of numerous non-*Candida Albicans* species, inclusive of *Candida Dubliniensis* and *Candida Tropicalis*, which set off numerous epithelial replication in vitro and in vivo .

While *Candida. Albicans*, *C. Dubliniensis*, and *C. Tropicalis* showcase variations of their skills to keep hyphae on epithelial cells, all 3 species reason epithelial destruction (even though to specific extents) and promote the discharge of the damage-related cytokine. *Fusicoccum amygdali* Del., it is the pathogen of almond (*Prunus amygdalus* ) and peach (*Prunus persica*) canker, reasons leaves of an inflamed shoot to decay and dehydrated , except inflicting cankers round inflamed buds and nodules. These foliar signs and symptoms had been imputed to toxins that are formed via way of means of the pathogen on the site contamination and transported withinside the vascular system. A toxin, yield in way of life via means of the lively developing mycelium of the pathogen has been uprooted, clarified, and referred to as fusicoccin. It is a glucoside of a tricarbocyclic terpene having mol. weight of 680. When added into the xylem, fusicoccin shows signs and symptoms in almond and peach shoots carefully such as the ones discovered after a contamination of *Fusicoccum amygdali*<sup>2</sup>. Furthermore, if examined on cuttings or indifferent leaves, the toxin influences cuttings from a huge variety of plants [14].

Aflatoxins are each frightfully and continually poisonous to animals, along with man, inflicting severe liver distortion, and formation of nodules in liver, initiation of tumours and malform effects [15]. The 4 principal obviously produced aflatoxins are referred to as aflatoxins B<sub>1</sub>, B<sub>2</sub>, G<sub>1</sub>, and G<sub>2</sub>. 'B' and 'G' talk to the blue and inexperienced fluorescent hues produced via way of means of those compounds below UV mild on skinny layer chromatography. When aflatoxin B<sub>1</sub> and B<sub>2</sub> are consumed via way of means of lactating cows, a proportion (approximately 1.5%7) is hydroxylated and released withinside the milk as aflatoxins M<sub>1</sub> and M<sub>2</sub> components of decrease toxicity than the determine molecules, however full-size due to the tremendous intake of cows' milk via means of infants. Because in their excessive toxicity, low bound for aflatoxins in ingredients and feeds were set via way of means of many countries. Under latest agreements, 15 ug/kg of general aflatoxins is probably to turn out to be the most stage authorised in all meals commodities in global trade.



Severe toxicity of aflatoxins to people has been discovered most effective rarely [16]. In 1974, a deadly disease of hepatitis that contrived four hundred Indian people, of whom one hundred died, nearly without a doubt resulted from aflatoxins [17]. Penicillin may be located in food products has been emphasized lately [18]. The penicillin's also are inherently poisonous as many who've been on a route of the formula will be attested. Again the problem is concentration; publicity to low immersions reasons a number of the defiance problems. Another instance is mycophenolic acid. Determination of mycotoxins is not easy, detection can take place by examining grains or feed for mycotoxins detective. Investigation may include histopathological examination of tissues from contrived species. The toxins produced by algae are called algal toxins. The blue green algae

*Aphanizomenon flos-aquae* present in USA and Canada, is known to produce a neurotoxin. It causes death of aquatic life. Waterborne sicknesses are generally brought about by irresistible microorganisms. In any case, an irregular yet far and wide wellspring of water-based illnesses are the exotoxins delivered by a few marine and freshwater green growth species. Marine algal poisons come from dino flagellates and cyanobacteria (bluegreen growth). Harmful indications of these marine poisons are shifted however include fundamentally neuro- and derma toxicity. A couple of freshwater algal poisons are delivered by dinoflagellates and haptophytes however the greater part are framed by "water sprout"; types of cyanobacteria. Harmful blossoms of these cyanobacteria can be found in a few sorts of water bodies.

Poisons delivered are neurotoxic alkaloids and hepatotoxic peptides. Human poisonings from algal poisons can be from ingestion of defiled shellfish, fish, and drinking water or by contact with the green growth in sporting water supplies. Toxigenic algae frequently come to be severe public fitness problems, while they may be consumed and focused withinside the organs of aquatic animals [19]. Most vital amongst those are the intoxications regarded as "poisoning by mussels" and "poisoning due to shellfish" These are due to intake of molluscs that have consumed poisonous dinoflagellates. In human exhilaration, the molluscs act simply as carrier of the toxin. The intake poison has a tendency to build up withinside the digestive area of mussels or clams, in addition to withinside the gills of the soft-shell clam or the channels of butter clams. The quantity of harmful algae focused and saved through the bivalves may be considerable, even if the density of G.



Catenella within the water is especially low (two hundred consistent with ml) and simply is so at some point of intervals of blooms while densities attain as much as 10<sup>4</sup> to a hundred and five species consistent with ml of seawater. Surviving dinoflagellates in the Class Dinophyceae are microalgae which inhabit a large number of fluid natural surroundings, from earthly snow and Antarctic ice slush to the interstitial seawater spaces between sand grains. Their properties, life cycles history, and record of fossils reflect long stretches of effective variation to an evolving climate. Of the assessed 2000 living dinoflagellate species, around 30 species produce poisons which may cause human ailment from shellfish or fish poisonings.

The poisons and their subordinates have been disengaged from fish like eatable bivalves and fishes, and from creatures of financial significance that have been tentatively initiated to gather poisons through taking care of trials. Shellfish harming (for example diarrhetic shellfish harming (DSP), neurotoxic shellfish harming (NSP), incapacitated shellfish harming (PSP), and potentially venerupin shellfish harming) and ciguatera fish harming are brought about by poisonous dinoflagellates that produce bioactive non proteinaceous compounds. These mixtures can maliciously influence people in more than one way; for instance, they can influence sodium or calcium directs in films by restricting to unmistakable receptor destinations on layers and impeding or opening the channels.

This physiological movement at the layer surface impedes the transmission of nerve driving forces. Notwithstanding the above poisonings which influence people, a few harmful dinoflagellates and other phyto plankters cause the fish to kill and other marine species death. Domoic acid is a neurotoxin generated via way of means of marine diatoms. Originally remote from the pink macro alga (*Chondria armata*) [20], domoic acid became now no longer acknowledged to be catalysed via way of means of microalgae previous to a human shellfish occasion in 1987 on Prince Edward Island, Canada, whilst the toxin became twisted for the very first time in Amnesic Shellfish Poisoning (ASP). After the intake of poisonous blue mussels, 3 humans died, 19 had been hospitalized (12 remained in in depth take care of a time), and greater than a hundred had been taken unwell with various stages of GIT and neurologic illness.

Domoic acid poisoning in mussels became ultimately related to the diatom. The presence of harmful cyanobacteria (blue green growth) on surface of water, utilized for drinking purposes and

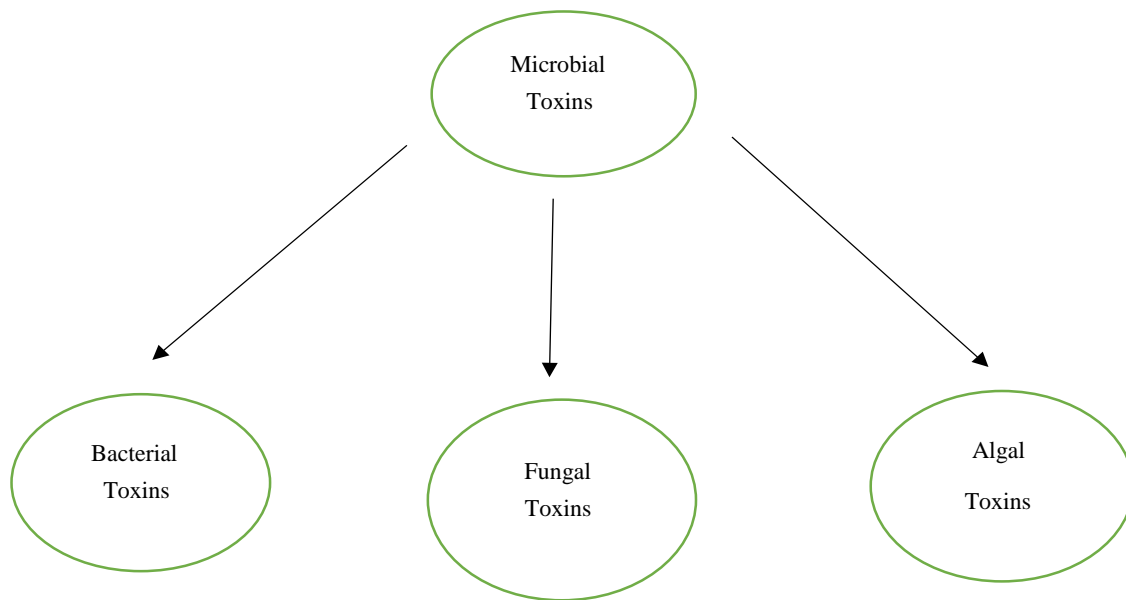


other water sources and entertainment is getting expanding consideration overall as a potential wellbeing concern [21]. Human disease coming about because of openness to blue-green algal poisons, however more uncommon than poisonings of dangerous and domestic creatures [22], has been counted [23]. In 1996, 55 hemodialysis patients kicked the bucket in Brazil when the water of their dialysis became polluted with poisons from the blue-green alga *Microcystis aeruginosa* [24]. Although potential wellbeing takes a chance to algal poisons in surface waters have been generally perceived, likely dangers from openness through one more significant course ingestion of debased dietary enhancements produced using blue green growth (BGA).

The international growth in number and depth of dangerous algal blooms (HABs) has caused greater common prevalence of seafood- borne ailments and negative influences on herbal sources. In concerning this, public fitness businesses global have marshalled to provoke HAB tracking programs. To overcome this requirement, progressive analytical strategies are being evolved that offer speedy and dependable finding of the organisms that are causative and the pollutants produced. Alterations to traditional chromatography and mass spectrometry have significantly stepped forward delicacy and accuracy of those techniques in the direction of obviously happening phyco toxins. Bioassay strategies the use of stay organisms are giving manner to molecular and mobile techniques that degree the toxicologically extensive interest of the toxin molecules. Molecular probes are being carried out to differentiate

Species-unique RNA and DNA sequences for speedy identity of HAB- inflicting organisms. The route of this new generation is to broaden speedy and dependable screening techniques for phyco toxins and offer safety for public fitness, aquaculture, and herbal resources. New techniques are also being evolved for detecting lower quantities of toxin molecules in microenvironments, main to understand the functions of toxins.





**Fig 1: Classification of Microbial Toxins.**

## Global Impact of Microbial Toxins

Microbial toxins have significant impact on various aspects of life including public health, agriculture and environment. Mycotoxins that are found in crops affect the GIT and also cause liver cancer and esophageal cancer, associated with Neural Tube Defect (NTD) and renal problems. Aflatoxin is associated with childhood stunting and is an important public health concern, and is mainly due to high exposure to infectious diseases [25]. NTDs are the damages associated at embryonic stage of brain and spinal cord [26]. Aflatoxin is one of the deadly cancer (liver cancer) causing agent in the world with high mortality rate [27]. Latest studies shows that low levels of aflatoxin exposure in Chinese population cause decrease in age standards rate related to mortality of liver cancer [28]. Consuming food that is contaminated with pathogens or microbial toxins cause serious food borne illness and economic losses [29].

Mostly people that are affected with these are aged people or children or people with low immunity. Therefore it is a serious concern in developing countries. About 91 million people are affected with this issue in Africa according to WHO. It is also reported that 2.2 million children suffer from death every year due to diarrhea and many more children die every day due to



consumption of unhygienic food [30]. Cyanobacteria blooms will have important effects on aquatic environments. Formation of many blooms in lakes have in the long run caused low levels of oxygen withinside the water, ensuing in huge fish kills. Toxins produced with the aid of using cyanobacteria have additionally been connected to death in aquatic large-invertebrates, and different predators [31].

CHABs additionally have high monetary effects on neighborhood communities. Pathogenic blooms lessen commercial enterprise at some stage in usually tourism-loaded weekends and holidays, ensuing in heavy sales losses. The ability public fitness chance because of publicity to CHAB pollutants has been more and more gaining the eye of scientists and authorities agencies, in addition to the media and local public. The principal ways of exposure to cyano toxins are consumption, inhalation, or skin contact. The maximum not unusual place direction is ingestion. In leisure water, publicity to pollutants can arise thru unintentional ingestion of water that contains cyanobacteria cells and dermal contact [32].

Inhalation of aerosols which are toxicogenic ,at some stage in leisure activities which include swimming or boating has been proven to be some other ability direction of publicity [32]. Exposure may additionally arise through ingestion of ingesting water or food (e.g. nutrient expansion) containing cyano toxins. Cyano toxins can also be present in drinking water depending upon its concentration. Areas where adequate water treatment is not available, there may be chances of accumulation of such toxins. Although cyano bacteria are the most common toxin producing specie in aquatic environments, however, there are other species of bacteria as well that produces harmful toxins such as *Vibrio* spp. *Vibrio* is also very common toxin producing bacteria associated with sea-food infections [33].

Aero Mona's hydrophila is also responsible for producing toxins in aquatic environment. Other species include *E.coli*, *Campylobacter* spp that affects not only the marine environment but also human health. The increased infection of agricultural entities via way of means of mycotoxins and their poisonous results on people and animals which eat such substances contribute to a prime difficulty to meals protection and security. These tremendously poisonous meals contaminants are bring about via way of means of diverse fungi species which might be present everywhere in nature, however, beneficial climatic situations with inside the tropics aid their growth in those



regions. Africa, via way of means of distinctive feature of its area alongside the equator makes it tremendously bestowed to proliferation of myco toxicogenic fungi species, as such, it's miles the maximum affected of all of the continents. Other elements consisting of poverty, and weather alternate similarly intricate the mycotoxin scenario at the continent. Economic effect because of mycotoxin infection in Africa is accordingly alarming. Microscopic algae (planktonic) are used as a supply of meals for shellfish usually bivalve.

When planktonic algae multiply, i.e., shape algal blooms, a useful impact for aqua-culture and operations for wild fisheries may be expected. However, those algal blooms can also additionally turn out to be dangerous, affecting the financial system of surrounding regions and inflicting human fitness impacts. From the anticipated 5000 species of aquatic planktons, most effective round three hundred can discolor the floor of the ocean and round forty can produce powerful pollutants that could input the meals chain thru fish and shellfish to humans. The time Period "purple tide" is used while the algae develop in such plenty that they alternate the color of the seawater to purple, brown, or green; however, the time period is deceptive due to the fact now no longer all water discolorations are pathogenic. Therefore, the right time period is "dangerous algal blooms".

The biological effect of Harmful Algal Blooms (HABs) includes fish death, contamination of sea food, human illness as well as water contaminated with shellfish. It results in medical expenses and costs to remove all algae from the water. It also cause decrease in tourism and management cost as well. Various mycotoxins have particular damaging results at the fitness of an individual. The principal mycotoxins encompass aflatoxins, ochratoxin A, patulin and zearalenone. Even little quantities of mycotoxins in ingredients can bounce a giant fitness risk. Aflatoxins have cancer causing abilities and in particular have an effect on the liver, inflicting hepatotoxicity. Ochratoxin A is nephrotoxic and speeds up the development of loose radicals, which can be dangerous to the human body. Patulin toxicity can cause negative gastrointestinal situations and neurotoxicity. Zearalenone has cancer causing and teratogenic activities [34].

Regulatory government in many nations have described the forbidden boundary of mycotoxins in specific food objects. Contaminated water environments containing mixture of Gram positive and Gram negative bacteria along with toxins that cause multiple sclerosis (MS). Among bacterial



toxins, Staphylococcal, nasopharyngeal flora disturbs the normal immunity and lead to the damage of nervous system. Staphylococcal toxins cause demyelinating disease in humans. Certain fungal toxins may also cause myelin degradation and damage vital cells [35].

| TOXINS       | ORGANISMS | DISEASES                                    |
|--------------|-----------|---|
| Enterotoxins | Bacteria  | Food Poisoning, Diarrheal disease           |
| Neurotoxins  | Bacteria  | Neurological disorders, Alzheimer's disease |
| Cytotoxins   | Bacteria  | Gastric ulcer                               |
| Aflatoxins   | Fungi     | Hepatic Failure                             |
| Ochratoxin A | Fungi     | Nephrotoxicity, Renal tumors                |
| Patulin      | Fungi     | Skin tumors, GIT disorders                  |
| Domoic Acid  | Algae     | Amnesic Shellfish Poisoning (ASP)           |
| Ciguatoxins  | Algae     | Ciguatera toxicity                          |

## Conclusion

The harmful effects of Microbial toxins affect not only humans but also aquatic life causing big problems worldwide, and hurt nature and agricultural practices. To deal this, we need to watch out



the early detection of these toxins to find ways to overcome them. It is also important for countries to collaborate and made latest technologies regarding this concern. We should also made researches to know more about these toxins and how to control them or stop their growth. Educating public about these toxins and their mode of action, how to avoid them is also important. Everyone from farmers to consumers, need to know about these toxins in order to protect themselves from any harm. By working together, staying informed, and using new techniques, we can make this world a better or safe place for everyone.

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