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REVIEW ON FOOD BORNE DISEASES ANDMICROORGANISMS

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ABSTRACT

Food is the most basic piece of daily routine that holds the experiencing creatures alive. Food borne illnesses are brought about by devouring nourishments and beverages tainted with organisms. In excess of 200 illnesses are an aftereffect of burning-through food sullied with microbes, infections, parasites, growths and other compound substances. Food borne illnesses because of microbes are grouped into two classes which are food borne diseases and food borne inebriations. Diseases are brought about by salmonellosis, loose bowels and cholera. Despite the fact that inebriations are brought about by staphylococcus, botulism. Parasites like giardiasis, cryptosporidiosis trichinosis mycotoxins like aflatoxins, ergot, infections like rotavirus, hepatitis an infection, poliovirus are likewise causative specialists of food borne illnesses. Food borne sicknesses are normally analyzed dependent on patient's set of experiences and side effects. Food borne disease counteraction framework will rely upon the degree of sanitation control set up through food creation, preparing and appropriation keeping food clean, detachment of crude and prepared food, guarding food temperature and utilizing safe water and crude materials are significant for the great strength of people. Today with the advances of in different accommodations of life food has abandoned that antiquated life basic cook into assorted mean of cooking that are either as cheap food, canned food or singed and distributed. The boisterous and occupied life has prepared for the cheap food enterprises the world over, with the expansion in inexpensive food and pattern of eating open air, the sauces serve has likewise thrived and developed.

INTRODUCTION:

Food borne illnesses are contracted from tainted food or drinks it is an issue incited by the advancement of a huge scope of food and water with pathogenic microbes, infections, parasites, growths and their poisons, or synthetic compounds. Food contamination is a term used to communicate any kind of sickness, ailment in the wake of burning-through sullied food and the most extreme sort of food contamination is because of microorganisms which might be because of bacterial disease or food intoxication.(A Bhatia S Zahoor 2007) Contamination of food can happen at any phase of food creation on homesteads where yields are developed and creatures raised, in industrial facilities where food is handled, and during food stockpiling and arrangement in shops , cafés and the home. (Robert E, John A, 2010) Biological, physical, compound pollution of food is a startling danger for the wellbeing and monetary development in creating social orders. Infections coming about because of food are more predominant in underdeveloped nations than in creating. Almost one out of ten people overall become sick because of burning-through defiled food every year. However, it doesn't imply that there is a piece of the world which is liberated from such illnesses. Sickness and passing from illness brought about by polluted food are a consistent danger to general wellbeing and a critical obstruction to financial advancement around the world. (Arie H. Havelaar, 2010). It is the significant issue for the food business, prompting food squander, generous financial misfortunes for fabricates and customers. Food borne sicknesses are normal and frequently cause significant dismalness and mortality it is a significant general medical issue around the world.

CAUSES OF FOOD BORNE DISEASE

Food borne sickness generally emerges from ill-advised taking care of and capacity. Great cleanliness rehearses when the readiness of food can diminish the chance of sickness. Lion's share of food borne illness are brought about by microbial microorganisms.

- Viruses
- Bacteria
- Fungi
- Parasites

SYMPTOMS OF FOOD BORNE DISEASE:

There are numerous indications of food related issues yet usually it is analyzed by the breaking down of gastrointestinal lot. Pollution of food causes queasiness, joint/spinal pains, issues, weariness and stomach cramps (Addis and Sisay, 2020). In a couple of cases kidney and liver breaking down can happen which in the end prompts passing. Occurrences of bacterial food borne ailment are normal in summer. Specific foodborne diseases and harming are connected to specific nourishments. Models incorporate un purified apple juice which contains E. coli crude eggs containing salmonella; crude or unpasteurized milk advanced with campylobacter, shellfish containing norovirus; strawberries may spread hepatitis An infection; raspberries containing Cyclospora and prepared to-eat meats may contain Listeria. (Addis and Sisay, 2020) Everybody is in danger of getting food borne ailment, yet some are at more serious danger for Food Born Disease. Those at more serious dangers are little youngsters, new-born children

and older individuals of end of the week invulnerable for example Helps malignancy, diabetes, kidney illness and relocate patients.

EIDEMIOLOGY OF FOOD BORN DISEASE:

Food borne infections episodes are multidisciplinary assignments requiring abilities in the territories of clinical medication, the study of disease transmission, lab medication and food microbiology. Very nearly one out of ten individuals overall become sick in the wake of devouring tainted food adding to more than 420000 passings for each year as per WHO. Youngsters are especially a few influenced. There are seen 125 000 passings for each year in individuals younger than 5. Foodborne sicknesses are firmly identified with destitution in lower-and center pay nations like Pakistan and is a rising general wellbeing concern around the world. Development of urban areas in Pakistan, climatic change, relocation of individuals from rustic zones to metropolitan territories and expanded global travel increase these issues and acquaint individuals with new wellbeing risks. (Buller and Martin 2006) Food and water borne disease including typhoid, irresistible hepatitis A, E. coli, cholera, and paratyphoid fever, gastroenteritis, loose bowels, intestinal worms ,giardiasis, poliomyelitis and rotavirus diarrhea.(WHO) By the acknowledgment of every one of these worries WHO built up a procedure for sanitation (Tantalising, Nantel ET al.2002). while in industrialized world 20-30% populaces experience the ill effects of food borne sicknesses in any one year causing significant ailment influencing the medical services framework (Environmental trends.n.d).In 2010, it was recorded that consistently 31 dangerous specialists causes 77 million populaces experiencing food borne infection consistently, among which 33 million are youngsters younger than 5 years of age makes 9% of the total populace which bore 40% of the cases for tainted food utilization.

- Africa and South East Asia is on the top rundown trouble, 77% of FBD happens in Africa, where 32,000 demise cases are recorded every year, Factors poultry eggs.

- America with second most reduced weight with 9000 demise case yearly, Factors are Campylobacter, salmonella and Norovirus.

- The Eastern Mediterranean Region is on third most noteworthy rundown where 100 million instances of FBD are recorded with 37000 demise cases annually, 32000 are kids under 5 years of age.

- Elements are E. coli Campylobacter, Norovirus, and Non typhoidal salmonella.

- The least weight for FBD is European Region, with 23 million cases with 5000 passings.

- Variables are, Campylobacter, Non typhoidal salmonella, Listeria.

- South East Asia Region is on the second most noteworthy weight list, 150 million cases, and 175000 passings in which 60 million youth with 50000 life undermined yearly.

- Variables are Campylobacter, Norovirus, Non typhoidal salmonella, Pork tapeworm (Taenia salium.

- Western Pacific Region, 125 million FBD cases, with 50000 passings yearly are recorded.

- Variables are Chinese liver accident, Paragonium spp.

- These cases were accounted for after first historically speaking Globe assessment for FBD (Organization 2015).
  Around the world it has been accounted for that intense diarrheal dangers 1.8 million youth life consistently. Also, an ongoing assessment of food related sicknesses was made and it was accounted for that a large portion of the contaminations were brought about by norovirus, went before by non-typhoidal Salmonella species, campylobacter species and clostridium perfringens Most normal reasons for illness in patients which are conceded in clinics were of norovirus, non-typhoidal Salmonella species , Toxoplasma gondii and Campylobacter spp, Major reasons of expanded demise rate were instances of nontyphoidal Salmonella species, at that point comes T. gondii , Listeria monocytogenes and in the last norovirus. The most customary reason for world wellbeing dangerous case is Norovirus, campylobacter specie and food borne passings are non-typhoidal salmonella enterica, salmonella Typhi Taenia solium, hepatitis an infection, aflatoxins. Consistently 1000 for each 100000 individuals go through the sickness for example diarrheal infection one of the most mutual reason for ailment with pace of 550 million report and 230,000 passings and 60,000 demise every year because of non-typhoidal salmonella enterica cause (Ezzati, Lopez ET al.2004).

This worldwide wellbeing danger has stayed still one of the most testing issue. These sicknesses are typically controlled yet some can even now be hazardous as the individual can be as of late immunosuppressed or helpless to extreme assault. Since the globalization of food stock has prompted wide spread of food conveyance, so the microbes can unexpectedly be host to new geological districts. These microbes that cause food borne disease stay unrecognized or unreported, numerous food creating assets offices are there however a couple towards agricultural nations. Furthermore, the development of microorganisms has driven them to be opposition against anti-microbials that has gotten one of the difficult issues. (Painter JA et al. 2016)
In spite of the fact that with every day review of food cleanliness taking care of it has been accounted for with 25% passings of kids under age of 5 years with gastroenteritis. (Sami and Bari 1986). The food can be wellspring of contamination are those that are not cooked appropriately, for example, ground meat, pooled crude eggs, unpasteurized factory for example Milk gathered from changed creatures one of which was in any event transporter of microbes. (Steward and Martin 2006). Staphylococcal inebriation is a main source of food borne inebriation and enterotoxigenic staphylococcus strains have been segregated from nourishments involved in infection cause (Adesiyun 1995) (Cenci-Goga Karama et al.2003).As one of the most well-known

reasons for FBD related with meat and poultry items. Yersinia enterocolitica is a salt open minded, psychotropic bar that is broadly appropriated in the nature in amphibian and creature supply for Human pathogenic strains (Hillers, Medeiros et al, 2003).

E. coli were accounted for by the rate 39.5% presence in milk (Shehu Adesiyun, 1990). The enterotoxigenic Escherichia coli is accounted for FBD from crude or handled food (Wang, Li et al. 2007). Food borne ailment related with salmonella fundamentally communicates through the defiled genital track emissions that has joined to hands subsequent to utilizing latrine or other source and afterward to food during preparing. Salmonella develop at 41-113 F and can be slaughtered at 160 F heat, and stay at fixed stage at refrigeration or edge of freezing over. (Kendall 2012)

The cases is risky issue in created nations that undermines a large number of lives generally youngsters yearly (Scallan, Majoweiz et al.2005).On the other hand it is hard to appraise the specific mean food borne illnesses as all cases are not appropriately answered to general wellbeing specialists. Studies are embraced to detach better information of worldwide general wellbeing specialists and to separate the information for Gastroenteritis and Food borne infections (Flint, Van Duynhoven ET al.2005)

CLASSIFICATION OF FOOD BORNE DISEASES

Food borne diseases are divided into two groups

- Microbial infections
- Diseases due to chemicals

MICROBIAL INFECTIONS:

There are various instances of microbial diseases. Conventional food is a cross breed food that has sustained our predecessors since the beginning. Customary nourishments have expanded the danger of food borne ailment in Pakistan's rising populace because of the improvement of safe enteric bacterial microbes.

BACTERIAL INFECTIONS:

Salmonella

Salmonella is a gram negative, bar formed microscopic organisms. It doesn't frame spores consequently executed by high temperature or ph. It generally enters the body through ingestion of salmonella tainted food. In the small digestive tract microscopic organisms develops and replicates. Beginning of the sickness is typically inside 8-24 hours of eating microscopic organisms stacked food. Signs and indications show up inside 72 hours of passage of microorganisms. The signs and manifestations incorporate greenish, noxious the runs, fever, chills and muscle shortcoming. It is discovered that salmonella is found in half-cooked eggs, half-cooked poultry and meat. It is additionally found in unpasteurized milk. It is most regular food borne related hospitalizations and demise.

Clostridium perfringens

Clostridium perfringeens is a pole formed gram-positive anaerobic bacterium. Since it is spore framing, it can undoubtedly oppose high temperature thus it isn't slaughtered by bubbling. After ingestion of polluted food, microscopic organisms produce spores in the small digestive tract. Indications of contamination by these microorganisms generally happen inside 24 hours of ingestion. The signs and manifestations

incorporate retching, the runs, and serious agony in mid-region and some of the time it is trailed by fever. It is forestalled by dodging half-cooked meat, legitimate Disinfection and sterilization of the compartments containing uncooked meat. Additionally, appropriate capacity and refrigeration of food is an unquestionable requirement. It is found in meals, flavours and stews that have been put at room temperature for quite a while.

Campylobacter

Compylobacter is a gram negative, bar formed microbes. It is microaerophilic which implies it requires little oxygen to develop. Since it is non spore framing it can undoubtedly be pulverized at high temperature and ph. After ingestion of sullied food, microscopic organisms replicate in little and internal organs. Beginning of the sickness is normally inside 5 days of utilization and it ordinarily goes on for 8-10 days. Signs and manifestations incorporate stomach cramps, fever, nausea, influenza and regurgitating. It can undoubtedly be forestalled by legitimate preparing food. Campylobacter is found in uncooked meat and poultry, unsensitized water, crude or unpasteurized milk and debased produce.

Staphylococcus aureus

It is a pole formed gram positive, facultative anaerobic bacterium. Harmful stun disorder and burnt skin condition are a consequence of this bacterial contamination. Beginning of the illness is generally inside of not many long stretches of eating polluted food. Signs and indications incorporate looseness of the bowels, spewing, drying out, sickness and low pulse. It is typically not followed by fever. The wellspring of Staphylococcus aureus are pungent nourishments, for example, cut meats and crude unpasteurized milk. Nourishments which are set up without wearing gloves or come straightforwardly in contact with hands and in which no extra cooking is required are at most elevated danger which incorporates pastry shop items, servings of mixed greens, samosas and shawarma slows down on side of the road.

E. coli

E. coli is a gram negative, pole formed, facultative anaerobic microscopic organisms. Whenever ingested, inside the body it produces poisons in colon. The signs and side effects incorporate regurgitating, watery the runs which can be changed over to wicked faces, sickness, loss of hunger and weariness. E. coli is found in unpasteurized or unfortunate beverages or crude or half-cooked hamburger.

Listeria

Listeria is a bar molded, anaerobic microorganisms. It is non spore shaping consequently can without much of a stretch be devastated by high temperature and ph. Signs and indications normally show up inside 10 days of ingestion of debased food and incorporate chills, fever and muscle throb. Seizures, loss of equilibrium and migraine may likewise happen if the disease spreads to sensory system. Listeria monocytogenes is found in uncooked poultry, meat and ocean bottom, refrigerated, prepared to-eat nourishments, for example, frozen chunks, frozen pizza, unpasteurized or crude milk.

There are numerous media of move of food borne microorganisms. It is difficult to evade them all. Some of them are given underneath some eateries or food merchants utilize modest crude materials to get more benefit. The crude materials utilized are either corrupted or terminated or they are not appropriately put away prompting their initial crumbling. There are numerous cases in Lahore where numerous eateries were utilizing jackass meat as opposed to utilizing hamburger or sheep. Additionally, numerous overviews were done in little ventures where food material was made utilizing unpermitted substance added substances from unapproved sources. Additionally, numerous stores are loaded up with items which are lapsed. Due to absence of mindfulness individuals are generally oblivious of cleanliness in homes just as exterior. Food borne illnesses fundamentally start from kitchens. It is important to prepare the food completely, consistently cover it, store the food appropriately and above all keeping the climate in which food is being made clean. Side of the road slows down are regular in Pakistan. There not just merchants wash their hands prior to making the food they likewise don't wear gloves. Indeed, even the plates where food is served are not washed appropriately. Eating food from side of the road slows down are the main source of hepatitis an and E, typhoid and looseness of the bowels. Likewise, there is air contamination. The smoke from vehicles prompts enhancement of food with weighty metals especially lead. Water is fundamental in making food. It is likewise utilized in washing crude materials and furthermore washing of utensils. In the event that water in not sterilized our food and utensils will be a home to microorganisms. In Pakistan safe water isn't accessible. We need to utilize channels to stay away from pollution in water.

VIRAL INFECTIONS:

Infections cause numerous illnesses in plants, creatures, and people. They are severe intracellular parasites with cell explicitness viral particles can be sent by various courses, for example, tainted food and water. Individuals normally get tainted orally, after ingestion of items sullied during handling or resulting taking care of or planning. (Vet.Med-Czech, 50, 2005)

NORO VIRUS

It is a circular, non-encompassed infection it has numerous strains as the individual get safe to a couple of strains however it is indistinct how long the resistance keeps going. Norovirus, for what was recently called Norwalk like infections. (Matson and Szucus, 2003) Without a contamination model momentum information on Norwalk infection disease and illness is gotten from episodes and volunteer test contemplates. Exploration concentrates in the genera has expanded advances in atomic natural discovery and affirmation systems. (Hutson et al., 2004) The principal perceived Norovirus, Norwalk infection, get its name from an episode of "winter regurgitating illness" in 1968 at a primary school in Norwalk. (Adler and Zickl, 1969). Norovirus are often the reason for inconsistent cases and furthermore episodes of intense gastroenteritis in kids and grown-ups. (Kaplan et al., 1982). Different courses must be communicated Water might be a vector and any food

took care of by a tainted individual. (Dubois et al., 2002). An episode of Norwalk infection gastroenteritis because of utilization of shellfish was portrayed in Australia. (Stafford et al., 1997). 92 of the 97 cases distinguished were affirmed because of the utilization of clams inside three days to building up the sickness. (Kirkland ET al.1996). Have a place with calciviridae family and are exceptionally infectious that cause pandemic nonbacterial gastroenteritis and imitate in human intestinal mucosal cells to deliver gastroenteritis they can endure freezing and high temperatures. The clinical appearance is generally gentle and the indications incorporate, looseness of the bowels, stomach torment, fever, queasiness, retching and lack of hydration.

HEPATITIS A VIRUS (HAV)

Hepatitis A virus occurs as a single antigenic type that differs from other enteroviruses by certain biological characteristics such as marked tropism for liver cells, exceptional thermostability, acid resistance or slow replication without cytopathic effect on the host cell (WHO, 1993; Bednar et al., 1999).

The virus is most commonly transmitted by the fecal orate route either by direct contact with an infected person or by ingestion of HAV contaminated food or water. (Cromeans et al., 1994) Member of s picorna virus family and highly contagious that is found in human intestinal and urinary tract. Multiple features of its capsid structure, genome organization and replication cycle that distinguish it from other viruses. WHO estimates 7134 deaths in 2016 caused by HAV? Food handlers with HAV are frequently identified and the need for immunoprophylaxis and implementation of control measures are a considerable burden on public health resources. HAV contaminated food may be the source for the unknown proportions of person whose source of infection is not identified. (Fiore, 2004).

ROTA VIRUS

Rota virus are segmented double stranded RNA viruses which explains their genetic variability and the presence of mixed infections. According to the group and subgroups specific antigen this genus is antigenically divided into serological groups. (Acha and Szyfres, 2003). The viruses are non-enveloped and have a degree of robustness in the environment outside of a host (Bajolet and Chippaux-Hypolite, 1998).

Rota viruses can survive for weeks in potable and recreational waters and for at least four hours on human hands. The viruses are relatively resistant to commonly used hard surface disinfectants and hygienic hand wash agents. (Ansari *et al*., 1991).Rota virus is transmitted by fecal oral contact and possibly by contaminated surfaces and hands and respiratory spread. Oral fecal transmission is facilitated by deficient sanitary conditions. (Dennehy, 2000; Cool et al., 2004). Belongs to Reoviridae family that having wheel like appearance it is the leading cause of severe diarrhea among infants and children. The virus infects the villi of the small intestine they multiply in the cytoplasm of the enterocytes and damage their transport mechanism.

PARASITIC INFECTIONS

Parasitic food borne diseases are more common. Globalization of the food supply, increased international travel,

increase of the population of highly susceptible person's improved diagnostic tools and communication are some factors associated with the increased diagnosis of food borne parasitic diseases worldwide. (P. Dorny 2009)

CYCLOSPORA

Cyclosporas is a disease caused by *Cyclospora cystinosis* which can cause a watery diarrhea, nausea and vomiting in humans. Almost 1500 cases occurred in United states and Canada in 1996 associated with eating raspberries from Guatemala (Herwaldt and Ackers,1997) other outbreaks are thought to have been spread through lettuce (CDC, 1997) or fresh basil (Hoge *et al*.,1995). Cyclospora organisms have also been isolated from patients suffering with AIDS and chronic diarrhea. It infects the small intestines water diarrhea, loss of appetite, stomach cramps, nausea vomiting fever are common.

TOXOPLASMA

Toxoplasmosis is a disease caused by *Toxoplasma gondii* which are transmitted to humans by accidental ingestion of sporulated oocysts by eating raw or uncooked meat contaminated with tissue cysts. (Han *et al*., 2008; Fallah *et al*., 2008)Toxoplasmosis is generally considered a serious health problem in pregnant women who can pass the infection to the foetus or new born and in immune compromised person. (Kijlstra and Jongert, 2009). They are obligate intracellular parasitic protozoan occurs by ingesting water, soil vegetables in the feces of an infected animal and sexually reproduce only within the intestines of members of the cat family.

TRICHONOSIS

Trichonosis is a disease caused by *Trichinella spiralis* that are one of the most widespread pathogens in the world, infection has been detected in domestic and wild animals of all continents, with the exception of Antarctica (Pozio and Murrel, 2006).Trichinellosis oocurs in humans with the ingestion of Trichinella larvae that are encysted in muscle tissue of domestic or wild animal meat. (Gottstein *et al*., 2009) The occurrence of trichinillosis in humans is strictly related to cultural food practices including the consumption of raw or undercooked meat. Trichniella is a round worm sometimes reffered as pork worm due to it being typically encountered in undercooked pork products.Symptoms are swelling of tissues around the eyes, muscle stiffness, death.

FUNGAL INFECTIONS:

Fungi are the integral part of the natural environment and plays many roles in relation to food some fungi are used in food production, some are food sources themselves and some are agents of food spoilage. Some fungi that contaminate food can also be harmful to human health. (Kaitilin Benedict, Tom M.chiller 2016).

ASPERGILLOSIS

Aspergillosis is a disease caused by *Aspergillus flavus* is the specie which may reflect its significance as the producer of the most important mycotoxins the aflatoxins. It is a saprophytic soil fungus that infects and contaminates seed crops with the carcinogenic secondary metabolite aflatoxin. (Saori Amaike 2011) It is often found growing on dead leaves, stored grain, compost piles, or in other decaying vegetation. It can also be found on marijuana leaves. People with

weakened immune systems or lung diseases are at higher risk of developing health problems due to Aspergillus. It includes health problems caused by Aspergillus are allergic reactions, lung infections and infections in other organs.

AFLATOXINS

Aflatoxins plays an important role in fungal infections that is produced by Aspergillus species they are highly toxic and cause severe contamination to food source it is abundant in warm and humid regions of the world it causes acute poisoning that can be life threatening producing by certain molds which grow in soil.

DUE TO CHEMICALS:

Food additives and preservatives are unnecessarily utilized in Pakistan. There are 330 food added substances which are endorsed by EU enactment even the doses of food added substances are given. In any case, in Pakistan it is a typical practice to utilize unapproved food added substances because of the absence of checking and observation. Numerous little food ventures utilize inordinate number of added substances as opposed to utilizing crude material to profit their economy. In a progression of attacks by Punjab Food Authority from April 2020 to work date in excess of 7000 liters of milk is disposed of because of the presence of synthetics and contaminated water in it. Additionally, unnecessary and unmonitored utilization of pesticides by ranchers in Pakistan in like manner. Pesticides uncontrolled use prompts ataxia, tipsiness, sickness, visual deficiency and demise.

•Containers in which the food is mostly packed

Now and again filter hefty metals. For instance, pineapples are generally stuffed in metallic compartments. When we open the can, we should move the substance of can in another container in any case oxidation will begin prompting improvement of food with hefty metals. The utilization of plastic sacks is additionally practically speaking in Pakistan. Plastic packs when numerous cancer-causing agents in food interacts with hot food discharges.

•**Pesticides** inordinate and unmonitored use in Pakistan and ranchers is normal. Their uncontrolled use prompts ataxia, dazedness, sickness, visual deficiency and demise. In long haul renal and hepatic problems, fruitlessness is seen.

COMMON FOOD BORNE DISEASES.

The most commonly occurring food related diseases are hepatitis, typhoid, animal contact diseases, and influenza. Most of these diseases are a result of food made from polluted or infected water, food standards absence, improper or no sanitation, lack of public awareness and illiteracy information provided by 'The News' has showed that every third patient in Pakistanwho visits the three allied hospitals in the city is suffering from either food or water borne diseases and the number of cases are increasing continuously. Allied hospitals in the city have been treating approximately 4,000 patients with gastroenteritis per week for the last one and a half month. The epidemic of gastroenteritis has already affected many localities in the area and the number of cases is still rising. (Guzman, Borsutzky *ET al*.2006)

A research was conducted in Sindh, Pakistan to determine the prevalence of hepatitis A and hepatitis E virus. It was

found that adolescents and young adults of Hyderabad, Karachi, Sukkar, Mirpurkhas and Larkana is at a much greater risk of getting infected by hepatitis A and E virus because of improper sanitary and unhealthy living conditions. (Saeed Akhtar 2015).

Substantial progress has been made in the developed world to avoid food borne diseases. For instance, typhoid fever which was particularly common in the 20th century in United States is now almost forgotten. In the pre antibiotic era it was overcome by potable water disinfection, waste treatment, milk treatment and pasteurization. While in Pakistan, a study was conducted involving 1036 patients, selected from the clinics of 45 general practitioners from June to October in 2010. According to it 36.1% patients were tested typhoid positive with high percentages of positive cases in Karachi, Rawalpindi and Hyderabad. (Farah Naz Qamar, Muhammad Khalid 2018)

These days food related disease cases are increasing due to consuming fruits, vegetables and fish. There is no doubt that these foods are healthy and nourishes us but they also serve as a career for harmful pollutants and toxins. (An Odeyemi 2019) In Pakistan dumping of wastes from factories in rivers and seas is common. The wastes contains pollutants which are ingested by fish. This polluted water is, when used for watering plants, makes them carrier of pollutants. Also fruits and vegetables can become a carrier if they are not properly treated during processing and harvesting. (Abdullah Sani 2019) They may lead to a variety of diseases including multiple failure of organs, heart diseases, neurological defects, gastroenteritis and arthritis.

In Pakistan take away are becoming common. Most people eat canned foods. No one checks their shelf life. Street food vendors have also become a major health problem of citizens .Due to poor hygienic conditions on stalls of food vendors there is a great chance of microbial entrance. (AK Verma, a Kumar 2013) According to some researches the causes of food related disorders concerningroadside stalls, may be the microbes of the genera Staphylococcus, Bacillus, Vibrio, Clostridium, Campylobacter, Salmonella and Listeria are common. Pakistan Today has observed that in Lahore thousands of roadside stalls sell substandard food items subjected the nose of Punjab Food Authority while putting the lives of millions of citizens at risk. During a survey it was observed that majority of these food points are near schools, hospitals, hostels, markets and private offices where vendors are busy making food items with little or no hygiene leading to cholera, typhoid, hepatitis A and gastroenteritis to name a few. (Muhammad Tahir Yousufzai 2018)

According to a researches from 1990-2018 it was found that consumption of unhygienic food is the main cause of food related disorders. They found that 46 foods illnesses are a result of 12 bacterial pathogens, 7 food related disorders are a result of 3 protozoans and 6 epidemics are responsible for 5 viral infections.Enteric fever has remained one of the healthy problem in developing countries, including Pakistan. Poor Hygiene and sanitation are the main source, mixed salmonella infection has

also been reported at the same time in patient causing bacteremia. Every year 21 million cases is reported and 21,000 deaths from that cases (Ochiai,Acosta *et al*.2008).The diagnosis left behind due to lack of laboratorial investigation and the successive cost of the viral diagnosis and studies has led to problematic issue due to which a gap remains in work of researcher and clinicians analysis. The new development in field of biotechnology brought advancements and evolution in food varieties and circulation throughout the world, the long-distance travel of food that are preserved through different processes canned, sealed, addition of chemicals, artificial savor for long term, thickening and thinning agents to keep the texture and odour long lasting. These all changes also differ on the basis of their preparation by the company or Industries their import export and handling. These transformed foods are well exposure to food borne illness. International food shipping cargo and the trash of port are leading cause of other unexpected pathogens, it demonstrated in the study that the extremes age week Immune persons and child bearing woman suffer more frequently morbidity and mortality the illness is shown fatal case greater than threefold annually (Javed 2016).

Basic reasons for food borne illness includes contamination of food by pathogenic microorganisms and occurrence of food borne illness are:

- Poor hygiene
- Unsanitary conditions
- Improper handling and transportation
- Cross contamination
- Unsafe preparation
- Inadequate storage

FOOD BORN INFECTION:

Food borne illness (also called food borne disease and colloquially referred to as food poisoning) is illness resulting from the consumption of contaminated food or beverages. Food borne diseases are mainly Campylobacter bacteria, Salmonella, E.coli or Listeria. The intoxication occurs when ingested agents starts producing toxins but not the bacteria itself. Different food items like chicken eggs, egg grounded foods, poultry, Beef, pork, meats pies, fish, cream desserts, chicken burger, chicken rolls etc. these food are mainly contaminated with such bacteria due to their long time preservation in unhygienic environment that cause illness after 8 to 72 hours ingestion and the poisonous chemicals or other harmful substances can cause food borne diseases if present in food.

Disease caused by food have different sign and symptoms ,like acute gastroenteritis that was conducted in 2001,2002,2003 and 2006-2007 in which 11% In 2000 and 15% population in 2007 were included (Scallan, Griffin *et al*.2011). Food is chemically complex matrix that contain sufficient nutrients that support microbial growth Several factors encourage prevent or limit the bacterial growth in food, most important factor are availability of pH, temperature (Bryan 1980)

FOOD BORNE ILLNES IN PAKISTAN

Food borne illness remain responsible for high levels of morbidity and mortality in Pakistan, But particularly at risks are infants and young children, the elderly and the immunocompromised (Siraj, M., 2004). This is confirmed by national institute of health (Islamabad)

studies on epidemics and outbreaks, indicating that the highest number of outbreaks (approx.43%) are food borne in origin (WHO, 2009).

The busy and hectic life schedule has paved the way for fast food industries around the globe.

The traditional and conventional way of cooking is over and the fast food joints are visible everywhere. With changing life style fast foods have become increasingly popular among all segments of the society, Street food joint(SFJs) cater to the demand of reasonable priced foods for many poor urban homes and serves as a source off livelihood (Codjia,2000). Microorganisms in fast food and traditional fast foods are responsible for many human diseases (Anguilla*et al*., 2000, Chandler *et al*., 2000, Mead, 2000.

FOOD SAFETY

Unsafe food is a global health threat which is a danger to every single person particularly infants, pregnant women and older people. 220 million children contact diarrhea around the world per year and among them 96000 die (Wit *et al*., 2001)). Food choice is often influenced more by the psychological interpretation of product properties than the physical properties of product. (Rozin *et al.,* 1986) Everyone from government to a simple citizen must play the role to prevent such illnesses. It is the responsibility of government to keep in check the quality of products in supermarkets. Substandard and adulterated products should immediately be discarded and the people making such products should be granted punishments. (Ruth MW yeung, Joe Morris 2001) Simple citizen must use disinfected and sanitized water for cooking and washing. They must check the shelf life of foods before buying. Perishable foods must be stored in refrigerators. And most importantly the environment in which the food is being prepared must be clean. With the aid of advancements in science, these days every country is trying to lower food related health disorders by enhancing healthy and hygienic conditions and environment either of food which is to be presented to the customer or by spreading awareness among the population about safe and nutritious food.(Mead *et al*.,1999) According to a WHO report 110 billion dollars are spent per year in productivity and medical expenses which are a result of unhealthy food in third world countries like Pakistan. Food poisoning may be eliminated significantly by cooking the food properly, keeping the environment clean, separating cooked and raw foods, storing foods at a safe temperature, using safe and unpolluted water for washing or cooking the food. Nutritious food promises healthier and longer lives and cheaper health care, as well as a more efficient food industry it also decreases aging. In this review a small effort has been made to highlight the major food borne diseases their sources, transmission routes and ways of prevention. (WHO 2001)

CONCLUSION

There are no food safety agendas in developing countries like Pakistan. Pakistanis are so much busy in trying to grow the economy, gaining profit out of everything that they have ignored the health and safety of people. This negligence has led to an increase in the number of E.coli, staphylococcus,

cholera, listeria infection cases. It is high time that we prioritize the health of people as health is wealth. Assessment and monitoring of food in restaurants and roadside stalls is necessary to check the quality of food. It is the responsibility of government and policy makers to ensure that the food sold in cafes, markets, superstores is of high quality. People selling substandard foods must be condemned. A strong check over production, packaging, storage and transportation of food is the need of the day.

REFERENCES:

1. Adams M, Moss M (2008) Food microbiology.
2. Bean NH, Griffins PM (1990) Foodborne Disease Outbreaks in the United States, 1973-1987: Pathogens, Vehicles, and Trends. J Food Microbiology.
3. Bryan FL (1994) Microbiological food hazards based on epidemiological information:
4. Le Minor, Popoff MP (1987) Designation of salmonella enteric species, nom, rev., as the type and only species of the genus salmonella.
5. Gracey LF, Collins DS (1992) Food poisoning salmonella surveillance in meat hygiene. Bailliere, Tindal, London.
6. Kalpelmecher K (1993) the role of salmonella in food borne diseases: In microbiological quality of foods. New York Academic press.
7. Jay JM (2000) Modern food microbiology, Aspen Publications, Gaithersburg, Maryland.
8. Abdulhussein, H.H., Al-Awsi, G.R.L.2019.
9. Akhtar, S., Sarker, M.R., Hossain, A.2014. Microbiological food safety: a dilemma of developing societies.CriticalReviewsinMicrobiology,
10. Al-Awsi, G. R. L., Al-Garawi, E. D. C., Abdulhussein, H.H.2019.
11. Aung, M. M., Chang, Y. S. 2014. Temperature management for the quality assurance of a perishable food supply chain.
12. Chalap, E. D., Al-Awsi, G. R. L. 2019. A general overview of the genetic effects of extracellular polymers For Enterococcus faecium in cancer cells. International Journal of Research in Pharmaceutical Sciences.
13. Ahmad, J. (1995), Food irradiation facts anssd fiction, Nutrition and food science.Mintel (1997) food safety Mintel, August.
14. Anonymous, 1997. Multidrug-resistant Salmonella serotype typhimurium—United States, 1996. MMWR Morb. Mort. Wkly. Rep. 46, 308–310.
15. Anonymous, 2000a. Preliminary FoodNet data on the incidence of foodborne illnesses-selected sites, United States, 1999. MMWR Morb. Mort. Wkly. Rep. 49 (10), 201–205 (Mar 17).
16. Anonymous, 2000b. WHO Surveillance Programme for Control of Foodborne Infections and Intoxications in Europe, 7th Report 1993–1998. BGVV FAO/WHO Collaborating Centre for Research and Training in Food Hygiene and Zoonoses, Berlin, Germany.
17. Anonymous, 2000c. Annual Report on Zoonosis in Denmark. Ministry of Food, Agriculture and Fisheries, Denmark.
18. Buchanan, R.L., Edelson, S.G., 1999. PH-dependent stationaryphase acid resistance response of enterohemorrhagic Escherichia coli in the presence of various acidulants. Journal of Food Protection 62 (3), 211–218.

19. Butzby, J.C., Roberts, T., 1997. Guillain-Barre´ syndrome increases foodborne diseases costs. Food Review 20 (3), 36–42.
20. Chae, M.S., Schraft, H., 2000. Comparative evaluation of adhesion and biofilm formation of different Listeria monocytogenes strains. International Journal of Food Microbiology 62 (1–2), 103–111.
21. Colwell, R.R., Brayton, P.R., Grimes, D.J., Roszak, D.B., Huq, S.A., Palmer, L.M., 1985. Viable but nonculturable Vibrio cholerae and related pathogens in the environment: implications for release of genetically engineered microorganisms. Bio/Technology 3, 817–820.
22. Dauphin, G., Ragimbeau, C., Malle, P., 2001. Use of PFGE typing for tracing contamination with Listeria monocytogenes in three cold-smoked salmon processing plants. International Journal of Food Microbiology 64 (1–2), 51–61.
23. Davis, M.A., Hancock, D.D., Besser, T.E., Rice, D.H., Gay, J.M., Gay, C., Gearhart, L., DiGiacomo, R., 1999. Changes in antimicrobial resistance among Salmonella enterica serovar typhimurium isolates from humans and cattle in the northwestern United States, 1982–1997. Emerging Infectious Diseases 6,
24. 802–806.
25. FAO, 2001. Risk characterization of Salmonella spp. In eggs and broiler chickens and Listeria monocytogenes in ready-to-eat foods. Report of a Joint FAO/WHO Expert Consultation on Risk Assessment of Microbiological Hazards in Foods, Rome, Italy, 30 April–4 May. FAO, Rome.
26. Hood, S.K., Zottola, E.A., 1997. Adherence to stainless steel by foodborne microorganisms during growth in model food systems. International Journal of Food Microbiology 37 (2–3), 145–153.
27. Jackson, L.A., Wenger, J.D., 1993. Listeriosis: a foodborne disease. Infections in Medicine 10, 61–66.
28. Ka¨ferstein, F., Abdussalam, M., 1999.Foodsafetyin the21stcentury. Bulletin of the World Health Organisation 77 (4), 347–351.
29. LeChevallier, M.W., Cawthon, C.D., Lee, R.G., 1988. Factors promoting survival of bacteria in chlorinated water supplies. Applied and Environmental Microbiology, 649–654.
30. Alicata, J.E., 1991. The discovery of Angiostrongylus cantonensis as a cause of human eosinophilic meningitis. Parasitol. Today 7, 151–153.
31. Antoniou, M., Tzouvali, H., Sifakis, S., Galanakis, E., Georgopoulou, E., Tselentis, Y., 2007. Toxoplasmosis in pregnant women in Crete. Parasitologia 49, 231–233.
32. Audicana, M.T., Ansotegui, I.J., de Corres, L.F., Kennedy, M.W., 2002. Anisakis simplex: dangerous—dead and alive? Trends Parasitol. 18, 20–25.
33. Audicana, M.T., Kennedy, M.W., 2008. Anisakis simplex: from obscure Infectious worm to inducer of immune hypersensitivity. Clin. Microbiol. Rev. 21, 360–379.
34. Boone, I., Thys, E., Marcotty, T., de Borchgrave, J., Ducheyne, E., Dorny, P., 2007. Distribution and risk factors of bovine cysticercosis in Belgian dairy and mixed herds. Prev. Vet. Med. 82, 1–11.
35. Cabaret, J., Geerts, S., Madeline, M., Bellandonne, C., Barbier, D., 2002. The use of urban sludge on pastures: the cysticercosis threat. Vet. Res. 33, 575–597.

36. Casemore, D.P., 1990. Foodborne protozoal infection. Lancet 336, 1427–1432.
37. Cavalcante, G.T., Aguilar, D.M., Camargo, L.M., Labruna, M.B., de Andrade, H.F., Meireles, L.R., Dubey, J.P., Thulliez, P., Dias, R.A., Gennari, S.M., 2006. Seroprevalence of Toxoplasma gondii antibodies in humans from rural Western Amazon, Brazil. J. Parasitol. 92, 647–649.
38. CDC, 1997. Update: outbreaks of cyclosporiasis—United States and Canada, 1997. Morb. Mortal. Wkly. Rep. 46, 521–523.
39. Chai, J.Y., Murrell, K.D., Lymbery, A.J., 2005. Fish-borne parasitic zoonoses: status and issues. Int. J. Parasitol. 35, 1233–1254.
40. Cook, A.J., Gilbert, R.E., Buffolano, W., Zufferey, J., Petersen, E., Jenum, P.A., Foulon, W., Semprini, A.E., Dunn, D.T., 2000. Sources of Toxoplasma infection in pregnant women: European multicentre case–control study. European Research Network on Congenital Toxoplasmosis. BMJ 321, 142–147.
41. Curtale, F., Hassanein, Y.A., Savioli, L., 2005. Control of human fascioliasis by selective chemotherapy: design, cost and effect of the first public health, school-based intervention implemented in endemic areas of the Nile Delta, Egypt. Trans. R. Soc. Trop. Med. Hyg. 99, 599–609.
42. De, N.V., Murrell, K.D., Cong, le.D., Cam, P.D., Chau, le.V., Toan, N.D., Dalsgaard, A., 2003. The food-borne trematode zoonoses of Vietnam. Southeast Asian J. Trop. Med. Public Health 34 (S1), 12–34.
43. Dick, T.A., Nelson, P.A., Choudhury, A., 2001. Diphyllobothriasis: update on human cases, foci, patterns and sources of human infections and future considerations. Southeast Asian J. Trop. Med. Public Health 32 (S2), 59–76.
44. Dorny, P., Vercammen, F., Brandt, J., Vansteenkiste, W., Berkvens, D., Geerts, S., 2000. Sero-epidemiological study of Taenia saginata cysticercosis in Belgian cattle. Vet. Parasitol. 88, 43–49.
45. Dubey, J.P., Hill, D.E., Jones, J.L., Hightower, A.W., Kirkland, E., Roberts, J.M., Marcet, P.L., Lehmann, T., Vianna, M.C., Miska, K., Sreekumar, C., Kwok, O.C., Shen, S.K., Gamble, H.R., 2005. Prevalence of viable Toxoplasma gondii in beef, chicken, and pork from retail meat stores in the United States: risk assessment to consumers. J. Parasitol. 91, 1082–1093.
46. Dung, T.D., De, V.N., Waikagul, J., Dalsgaard, A., Chai, J.Y., Sohn, W.M., Murrell, K.D., 2007. Fishborne zoonotic intestinal trematodes, Vietnam. Emerg. Infect. Dis. 13, 1828–1833.
47. Dupouy-Camet, J., Peduzzi, R., 2004. Current situation of human diphyllobothriasis in Europe. Euro Surveill. 9, 31–35.
48. Eckert, J., Deplazes, P., 2004. Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern. Clin. Microbiol. Rev. 17, 107–135.
49. EFSA, 2009. The community summary report on trends and sources of zoonoses and zoonotic agents in the European Union in 2007. EFSA J. 223.
50. Eom, K., Rim, H.J., 2001. Epidemiological understanding of Taenia tapeworm infections with special reference to Taenia asiatica in Korea. Korean J. Parasitol. 39, 267–283.
51. Esteban, J.G., Gonzalez, C., Curtale, F., Mun˜oz-Antoli, C., Valero, M.A., Bargues, M.D., el-Sayed, M., el-Wakeel, A.A., Abdel-Wahab, Y., Montresor, A., Engels, D., Savioli, L., Mas-Coma, S., 2003. Hyperendemic fascioliasis associated with

schistosomiasis in villages in the Nile Delta of Egypt. Am. J. Trop. Med. Hyg. 69, 429–437.
52. Falca˜o, H., Lunet, N., Neves, E., Igle´sias, I., Barros, H., 2008. Anisakis simplex as a risk factor for relapsing acute urticaria: a case–control study. J. Epidemiol. Comm. Health 62, 634–637.
53. Fallah, M., Rabiee, S., Matini, M., Taherkhani, H., 2008. Seroepidemiology of toxoplasmosis in primigravida women in Hamadan, Islamic Republic of Iran, 2004. East Medit. Health J. 14, 163–171.
54. Flisser, A., Correa, D., Avilla, G., Marvilla, P., 2005. Biology of Taenia solium, Taenia saginata and Taenia saginata asiatica. In: Murrell, K.D. (Ed.), WHO/FAO/OIE Guidelines for the Surveillance, Prevention and Control of Taeniosis/Cysticercosis. World Health Organisation for Animal Health (OIE), Paris, pp. 1–9.
55. Garcı´a, H.H., Gonzalez, A.E., Evans, C.A., Gilman, R.H., Cysticercosis Working Group in Peru, 2003. Taenia solium cysticercosis. Lancet 362, 547– 556.
56. Geerts, S., Kumar, V., Aerts, N., Ceulemans, F., 1981. Comparative evaluation of immunoelectrophoresis, counterimmunoelectrophoresis and ELISA for the diagnosis of Taenia saginata cysticercosis. Vet. Parasitol. 8, 299–307.
57. Giesecke, W.H., 1997. Prevalence and economic implications of taeniasis/ cysticercosis in South Africa. In: Cysticercosis. Report on a Workshop held at the Onderstepoort Veterinary Institute, Onderstepoort, South Africa, 18–19 August 1997, and pp. 19–70.
58. Gonzales, A.E., Garcia, H.H., Gilman, R.H., Gavidia, C.M., Tsang, V.C., Bernal, T., Falcon, N., Romero, M., Lopez-Urbina, M.T., 1996. Effective, singledose treatment or porcine cysticercosis with oxfendazole. Am. J. Trop. Med. Hyg. 54, 391–394.
59. Gottstein, B., Pozio, E., No¨ckler, K., 2009. Epidemiology, diagnosis, treatment, and control of trichinellosis. Clin. Microbiol. Rev. 22, 127–145.
60. Hale, D.C., Blumberg, L., Frean, J., 2003. Case report: Gnathostomiasis in two travellers to Zambia. Am. J. Trop. Med. Hyg. 68, 707–709.
61. Hall, S.M., Pandit, A., Golwilkar, A., Williams, T.S., 1999. How do Jains get Toxoplasma infection? Lancet 354, 486–487.
62. Han, K., Shin, D.W., Lee, T.Y., Lee, Y.H., 2008. Seroprevalence of Toxoplasma gondii infection and risk factors associated with seropositivity of pregnant women in Korea. J. Parasitol. 94, 963–965.
63. Heath, D.D., Jensen, O., Lightowlers, M.W., 2003. Progress in control of echinococcosis using vaccination—a review of formulation and delivery of the vaccine and recommendations for practical use in control programs. Acta Trop. 83, 133–143.
64. Herwaldt, B.L., Ackers, M.L., Cyclospora Working Group, 1997. An outbreak in 1996 of cyclosporiasis associated with imported raspberries. N. Engl. J. Med. 336, 1548–1556.
65. Hoge, C.W., Schlim, D.R., Ghimire, M., Rabold, J.G., Pandey, P., Walch, A., Rajah, R., Gaudio, P., Echeverria, P., 1995. Placebo-controlled trial of co-trimoxazole for cyclospora infections among travellers and foreign residents in Nepal. Lancet 345, 691–693.
66. Liu, D. Molecular Detection of Human Fungal Pathogens; CRC Press: Boca Raton, FL, USA, 2011.
67. Brown, G.D.; Denning, D.W.; Gow, N.A.R.; Levitz, S.M.; Netea, M.G.; White, T.C.

Hidden killers: Human fungal infections. Sci. Transl. Med. 2012, 4, 165rv13. [CrossRef] [PubMed]
68. Armstrong-James, D.; Bicanic, T.; Brown, G.D.; Hoving, J.C.; Meintjes, G.; Nielsen, K. AIDS-related mycoses:
69. Current progress in the field and future priorities. Trends Microbiol. 2017, 25, 428–430. [CrossRef] [PubMed]
70. Paterson, R.R.M.; Lima, N. Molecular Biology of Food and Water Borne Mycotoxigenic and Mycotic Fungi; CRC Press: Boca Raton, FL, USA, 2015.
71. Bouakline, A.; Lacroix, C.; Roux, N.; Gangneux, J.P.; Derouin, F. Fungal contamination of food in hematology units. J. Clin. Microbiol. 2000, 38, 4272–4273. [PubMed]
72. Marr, K.A.; Bow, E.; Chiller, T.; Maschmeyer, G.; Ribaud, P.; Segal, B.; Steinbach, W.; Wingard, J.R.; Nucci, M.
73. Fungal infection prevention after hematopoietic cell transplantation. Bone Marrow Transplant. 2009, 44, 483–487. [CrossRef] [PubMed]
74. Sipsas, N.V.; Kontoyiannis, D.P. Occupation, lifestyle, diet, and invasive fungal infections. Infection 2008, 36,
75. 515–525. [CrossRef] [PubMed]
76. Brenier-Pinchart, M.P.; Faure, O.; Garban, F.; Fricker-Hidalgo, H.; Mallaret, M.R.; Trens, A.; Lebeau, B.; Pelloux, H.; Grillot, R. Ten-year surveillance of fungal contamination of food within a protected haematological unit. Mycoses 2006, 49, 421–425. [CrossRef] [PubMed]
77. Ariza-Heredia, E.J.; Kontoyiannis, D.P. Our recommendations for avoiding exposure to fungi outside the hospital for patients with haematological cancers. Mycoses 2014, 57, 336–341. [CrossRef] [PubMed]
78. Richardson, M.D.; Richardson, R. Aspergillus and aspergillosis. In Molecular Biology of Food and Water Borne Mycotoxigenic and Mycotic Fungi; Paterson, R.R.M., Lima, N., Eds.; CRC Press: Boca Raton, FL, USA, 2015; pp. 151–164.
79. Arendrup, M.C.; Zhao, Y.; Perlin, D.S. Aspergillus. In Molecular Detection of Human Fungal Pathogens; Liu, D., Ed.; CRC Press: Boca Raton, FL, USA, 2011; pp. 171–187.
80. Bretagne, S.; Cabaret, O.; Costa, J.-M. Recommendations for quantitative PCR Aspergillus assays. In Molecular Biology of Food and Water Borne Mycotoxigenic and Mycotic Fungi; Paterson, R.R.M., Lima, N., Eds.; CRC Press: Boca Raton, FL, USA, 2015; pp. 103–114.
81. Zaror, L.; Godoy-Martínez, P.; Álvarez, E. Mucormycosis. In Molecular Biology of Food and Water Borne Mycotoxigenic and Mycotic Fungi; Paterson, R.R.M., Lima, N., Eds.; CRC Press: Boca Raton, FL, USA, 2015; pp. 387–400.
82. Iwen, P.C. Mucor. In Molecular Detection of Human Fungal Pathogens; Liu, D., Ed.; CRC Press: Boca Raton, FL, USA, 2011; pp. 759–771.
83. Lee, S.C.; Billmyre, R.B.; Li, A.; Carson, S.; Sykes, S.M.; Huh, E.Y.; Mieczkowski, P. Analysis of a food-borne fungal pathogen outbreak: Virulence and genome of a Mucor circinelloides isolate from yogurt. MBio 2014, 5, e01390-14. [CrossRef] [PubMed]
84. Oliver, M.R.; Van Voorhis, W.C.; Boeckh, M.; Mattson, D.; Bowden, R.A. Hepatic Mucormycosis in a bone marrow transplant recipient who ingested naturopathic medicine. Clin. Infect. Dis. 1996, 22, 521–524. [CrossRef] [PubMed]
85. Manikandan, P.; Galgóczy, L.; Selvam, K.P.; Shobana, C.S.; Kocsubé, S.; Vágvölgyi, C.; Narendran, V. Fusarium. In Molecular Detection of Human Fungal

Pathogens; Liu, D., Ed.; CRC Press: Boca Raton, FL, USA, 2011; pp. 417–433.
86. Hoffman, K.; Voigt, K. Lichtheimia (Absidia-like fungi). In Molecular Detection of Human Fungal Pathogens; Liu, D., Ed.; CRC Press: Boca Raton, FL, USA, 2011; pp. 735–748.
87. Schwartze, V.U.; Kaerger, K. Lichtheimia (ex Absidia). In Molecular Biology of Food and Water Borne Mycotoxigenic and Mycotic Fungi; Paterson, R.R.M., Lima, N., Eds.; CRC Press: Boca Raton, FL, USA, 2015; pp. 355–374.
88. Schuetz, A.N. Curvularia. In Molecular Detection of Human Fungal Pathogens; Liu, D., Ed.; CRC Press: Boca Raton, FL, USA, 2011; pp. 71–82.