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A Review on Recent Diseases Caused by Microbes

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Abstract Microbes are called disease-causing microbes and can make humans, animals and plants sick by causing infection and disease. Disease-causing microbes can also be called pathogens, germs or bugs and are responsible for causing infectious diseases. Microorganisms are very diverse. They include all of the prokaryotes, namely the bacteria and archaea and various forms of eukaryotes, comprising the protozoa, fungi, algae, microscopic plants (green algae), and animals such as rotifers and planarians. Some microbiologists also classify viruses as microorganisms, but others consider these as nonliving. This review deals with the current status of disease causing microbes and the recent diseases which mostly went unnoticed.

Keywords: *microbes, disease causing microorganisms, algae, fungi*

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1. Introduction

Disease and illness are very much related and having similar concepts. The concepts are mainly: patients suffer from 'illnesses' and doctors diagnose and treat 'diseases'. Disease can refer to a combination of signs and symptoms. It can also be referred as a phenomena associated with a disorder of function or structure or illness associated with a specific cause [1]. A disease is an abnormal condition that affects the body of an organism. It is often construed as a medical condition which is associated with specific symptoms and signs. Disease may be caused by factors originally from an external source, such as infectious disease. It may be caused by internal dysfunctions also, such as autoimmune diseases. Diseases are also caused by microbes or microorganisms [1,2,3]. Colonization of the body by various microbes results in the infectious disease. There are many similar disease states that can arise from different causes, i.e., pneumonia can be caused by viruses, many types of bacteria, protozoa, and even fungi [3]. Microbes are single-cell organisms. They are so tiny that, millions can fit into the eye of a needle and cannot be seen with the naked eyes. Microbes are the oldest form of life on earth. They are very small living things and are sometimes termed as micro-organisms. Microbes can only be seen using a microscope [2]. Microbe fossils date back more than 3.5 billion years. Without microbial growth, garbage wouldn't decay and there would be a lot less oxygen to breathe. Microbes are often called "microscopic organisms." These organisms are found almost everywhere on Earth –such as in air, water, soil and rock, and even in plants, animals and the human body. Some live happily in searing heat, while others thrive in freezing cold. Some microbes need oxygen to live, but others do not. These microscopic organisms are found in both plants and animals as well as in the human body [2,3]. Mainly these microbes cause different types of infectious diseases [2,4]. Plenty of researchers are working on many infectious diseases to find their cause, diagnosis, treatments and prevention methods [1,2]. The National Institute of Allergy and Infectious Diseases (NIAID), part of the National Institute of Health (NIH) is the federal government's lead agency for conducting and funding research for these infectious diseases [6]. Biomedical research supported by NIAID provides the tools necessary to develop diagnostic tests, new and improved treatments, vaccines, and other means to combat the microbial threats of today and tomorrow [2,4].

2. Types of Microbes and Resulting Diseases

2.1. Bacteria

Bacteria are often dismissed as "germs" that cause illness. Bacteria are also considered as single-celled microscopic organisms, which do not completely have a nucleus. Bacteria help us in doing an amazing array of useful things, like making vitamins, breaking down of some types of garbage, and maintaining the atmosphere. They "eat" everything from sugar & starch to sunlight, sulfur, Iron. Some bacteria cause disease, but many are useful. Bacteria reproduce very quickly. Two can very quickly become four, then eight and so on. They also constitute a large domain of prokaryotic microorganisms [4]. Microbes belonging to the bacteria group are made up of only one cell. Bacteria look like balls, rods, or spirals when visualized under a microscope. Bacteria are so small in size that a line of 1,000 could fit across the eraser of a

pencil. Life in any form on Earth could not exist without these tiny cells. Bacteria are the smallest and the most numerous organisms. Bacterial cell structure is more complex. It has a secondary membrane like covering outside of their cell wall. It also exhibit considerable diversity in both structure and metabolism. Many serious human diseases are caused by bacteria, some of them responsible for millions of deaths each year.Bacteria multiply rapidly by simple cell division and absorb nutrients from their immediate environment. Bacterial pathogens are also introduced to new sites on contaminated seed or transplants. Once established, bacteria are spread by splashing rain, water runoff, wind-driven rain or mists (aerosols), equipment, insects, and people working around the plants [5]. Bacteria (singular bacterium) are autonomously replicating unicellular organisms lacking both an organized nucleus (which defines the class of cells called prokaryotes) and organized intracellular organelles. They have only a single circular chromosome of double-stranded DNA (dsDNA), some extra chromosomal DNA, and most have a cell wall containing the polymer peptidoglycan.

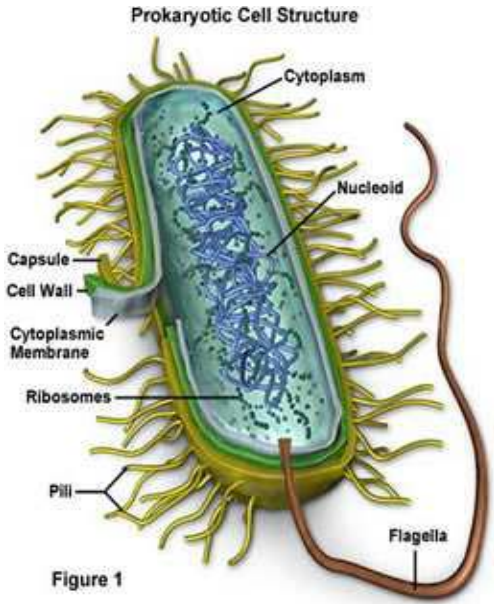

Figure 1. prokaryotic cell structure [6]

Bacterial DNA has no introns and the DNA sequence consists of only codons. If there are base changes, then the bacteria produce different proteins. Such changes are called recombination. Gram positive bacteria (which stain purple following a Gram stain) have a multilayered wall of peptidoglycan. Gram negative bacteria (which stain red under Gram stain) have a thinner layer of this polymer and an additional outer layer of lipopolysaccharide (fat and sugar), LPS, which is often endotoxic (capable of initiating inflammation and cell-mediated immune responses), e.g., *Salmonella*, *Shigella*, and *Escherichia* [4,5]. Bacteria are further classified according to their shape: rod-shaped bacillus, spherical shaped coccus, spiral shaped spirilium, comma-shaped vibrio, ovoid-shaped cocco-bacillus, and other combinations; whether they need oxygen (aerobic) to extract energy from a chemical compound or not (anaerobic); their form of reproduction; genus; and species [5,6]. Bacterial diseases of humans can be discussed according to their mode of acquisition / transmission. Airborne diseases caused by bacteria involve the respiratory system and the direct contact bacterial diseases involve the skin, mucous membranes, or underlying tissues. And also the food-borne and waterborne bacterial diseases are contracted when contaminated food or water is ingested. These diseases are essentially of two types: infections and intoxications [6].

There are many different types of bacteria. Some are helpful and protective to humans. Some flourish naturally in our bodies - particularly in the bowel and vagina - and help to protect the body from infections. However, infections with certain bacteria can cause serious illnesses such as meningitis, pneumonia, tuberculosis, etc. A bacterial infection may be treated with a course of antibiotics [7].

2.1.1. Diseases Caused by Bacteria

2.1.1.1. Inflammatory Bowel Disease (IBD)

It is a group of inflammatory conditions of the colon and small intestine. The major types of IBD are Crohn's disease and ulcerative colitis. Inflammatory bowel diseases are considered autoimmune diseases, in which the body's own immune system attacks the elements of the digestive system [8,9].

Crohn's disease is an illness in which inflammation develops in parts of the gut leading to symptoms such as diarrhea, abdominal pain and tiredness. Crohn's disease is one of the two conditions known as inflammatory bowel diseases (or 'IBD'), the other being ulcerative colitis [9,10]. The disease affects mainly young adults but also can affect teenagers or younger children and can sometimes start later in life. It is thought that Crohn's disease develops as a result of the immune system in the intestine reacting abnormally to bacteria at the surface of the gut. Any part of the gut can get affected in Crohn's disease. The most common area is the last part of the small intestine (terminal ileum) and the first part of the large intestine (or 'colon'), near the appendix [9,10,11]. Crohn's disease (CD) and ulcerative colitis (UC) have features that suggest bacterial involvement, and all genetic models of inflammatory bowel disease (IBD) require the presence of commensal bacteria. CD is associated with innate immune response genes such as *NOD2/CARD15* and the autophagy genes *ATG16L1* and *IRGM*. However, IBD responds to immunosuppressant, suggesting that any bacteria involved are not acting as conventional pathogens [8]. Symptoms are mainly abdominal pain, vomiting, diarrhea, rectal bleeding, severe internal cramps / muscle spasms in the region of the pelvis and weight loss [9]. The most frequent test used to diagnose Crohn's disease is a colonoscopy. This involves the passage of a tube with a video camera at the end around the colon and, where possible, into the last part of the small intestine. Laxative preparation is needed before the examination to clear the bowel and allow good views of the lining of the intestine. Scans such as ultrasound or CT scanning may also be needed, especially if an abscess or problems on the outside of the intestine are suspected [9,10,11]. IBD is a complex disease which arises as a result of the interaction of environmental and genetic factors. Treatment for IBD varies per patient. Some may require medication, which can range from corticosteroids to biologic therapies and antibiotics. Changes in diet, reducing stress, and getting enough rest are universal ways of treating symptoms.

Patients with more serious prognoses may require surgery [9,11]. Medicines used to treat Crohn's disease are mainly directed at the immune system in the intestine. Antibiotics (such as metronidazole) can be helpful, either by reducing the bacteria which 'drive' the inflammation or to treat abscesses. Aminosalicylates are a relative of aspirin and are used to treat milder inflammation or reduce the chances of recurrence (for example, after an operation). Steroids (prednisolone, hydrocortisone) are much stronger drugs used to suppress inflammation when the symptoms are more severe [9,10,11].

2.1.1.2. Bacterial Vaginosis (BV)

Bacterial vaginosis also known as vaginal bacteriosisis, the most common cause of vaginal infection for women of childbearing age mainly caused by bacteria. *Causative agent is Gardnerella vaginalis*. It frequently develops after sexual intercourse with a new partner. BV is more common in women with multiple partners [6,12,13]. The cause for this mainly involves having more than one sex partner or a new sex partner, Smoke and Douche [12,14]. Bacterial vaginosis is considered a sexually transmitted disease. It has a polymicrobic etiology that includes *Gardnerella vaginalis* (a gram-negative to gram-variable, pleomorphic nonmotile rod), *Mobiluncus* spp., *Mycoplasma hominis*, and various anaerobic bacteria. The vaginosis is characterized by a copious, frothy, fishy-smelling discharge without pain or itching [14,17].The most common symptom is a smelly vaginal discharge. It may look grayish white or yellow. A sign of bacterial vaginosis can be a "fishy" smell, which may be worse after sex. About half of women who have bacterial vaginosis do not notice any symptoms [14,15,16,17]. Doctors diagnose bacterial vaginosis by asking about the symptoms, doing a pelvic exam, and taking a sample of the vaginal discharge. The sample can be tested to find out if you have bacterial vaginosis. Diagnosis is based on this fishy odor and the microscopic observation of clue cells in the discharge [14,16,17]. Treatment for bacterial vaginosis is with metronidazole (Flagyl, MetroGel-Vaginal), a drug that kills the anaerobes that are needed for the continuation of the disease. Doctors usually prescribe an antibiotic mainly Metronidazole or Clindamycin, to treat bacterial vaginosis. They come as pills you swallow or as a cream or capsules (called ovules) that you put in your vagina. If you are pregnant, you will need to take pills [14,15,16,17].

2.1.1.3. White Pox Disease

White pox disease (also called *acroporid serratiosis* and "patchy necrosis"), first noted in 1996 on coral reefs near the Florida Keys. It is a coral disease affecting Elkhorn coral (*Acropora palmata*) throughout the Caribbean [18,19]. White pox disease is caused by *Serratia marcescens*, a common Gram-negative bacterium classified as a coliform and a member of the Enterobacteriaceae family. *S. marcescens* is found in the intestines of humans, insects, and other animals, and in fresh water, soil, and plants [18,19,20]. *S. marcescens* is pathogenic to humans, cows, goats, chickens, fishes, insects, and plants. *S. marcescens* is an opportunistic pathogen of humans associated with both waterborne infections in tropical waters and hospital-acquired infections, including urinary tract infections, wound infections, pneumonia, and bacteremia [19,20]. It causes irregular white patches or blotches on the coral that result from the loss of coral tissue. These patches distinguish white pox disease from white band disease which produces a distinctive white band where the coral skeleton has been denuded [19,20]. The pathogen responsible has identified as *Serratia marcescens*, a common fecal intestinal bacterium found in humans and other animals [20]. The causes for the majority of known coral diseases have not been identified. It causes irregular white patches or blotches on the coral that result from the loss of coral tissue [21,22].

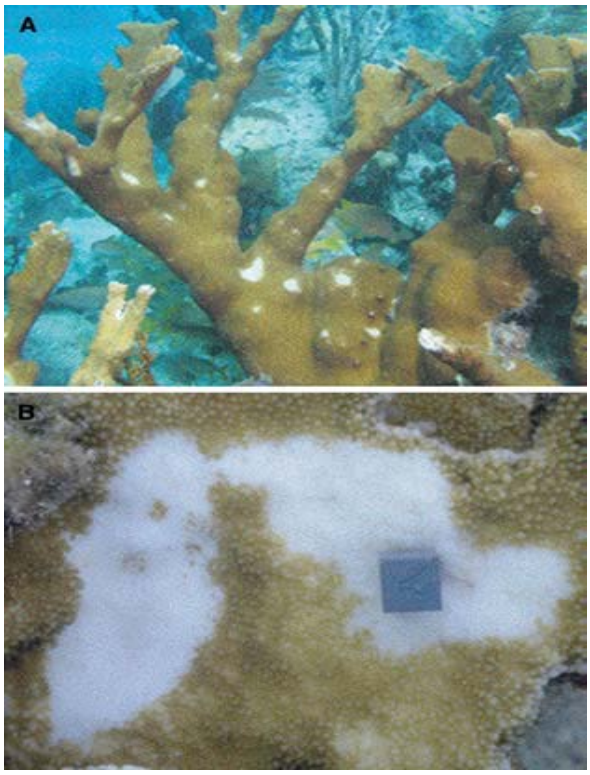

Figure 2. A *Acropora palmata* colony affected with white pox disease.B White pox disease lesions on *A. palmata*. (Photograph by K.P. Sutherland) [19]

2.2. Virus

Viruses have regular and geometric shapes. A virus is a simple organism which does not display all the characteristics of living things. Viruses are made up of a protein coating and some genetic material. Viruses can only grow and reproduce within other living things [2,4]. Viruses are transmitted as organisms much smaller than bacteria and incapable of multiplying outside the host, but often associated with larger particles in the water environment. Nevertheless, they have a clear record of transmission via water and other environmental routes and seem to be quite efficient as waterborne pathogens [23]. A virus is an *obligate intracellular parasite* (meaning that it *must* exist within the cells of its host in order to replicate). A virus is metabolically inert outside a cell. Viruses are not living cells. They cannot provide their own nutrition, nor can they replicate on their own. Viruses have no organized cellular structures but simply a protein coat, called the capsid, surrounding a nucleic acid core, called a genome, of either RNA or DNA, but *never* both. The capsid together with the genome is called the nucleocapsid. The nucleocapsid may be surrounded by an envelope that

is composed of a lipid bilayer containing protein spikes. An entire virus particle is called a virion. Viruses are classified by the categories: DNA or RNA; single strand or double strand; enveloped or non-enveloped [23].

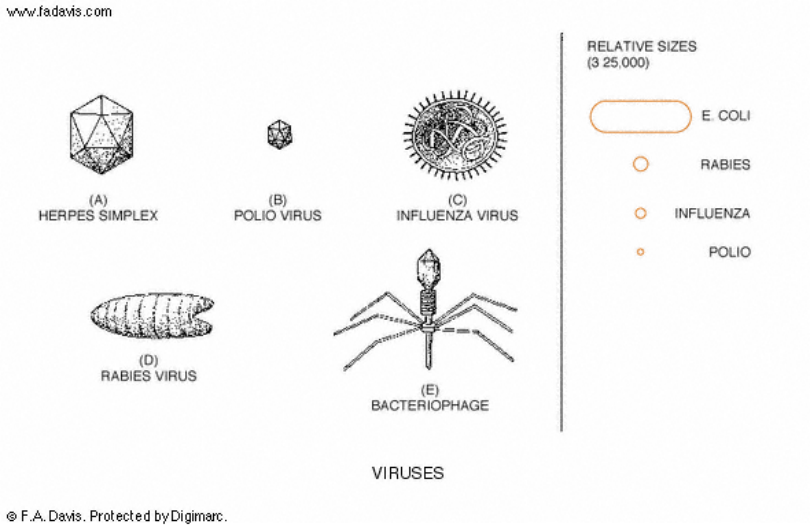

Figure 3. Types Of Virus

Viruses are strange things that straddle the fence between living and non-living. On the one hand, if they're floating around in the air or sitting on a doorknob, they're inert. They're about as alive as a rock. But if they come into contact with a suitable plant, animal or bacterial cell, they spring into action. They infect and take over the cell like pirates hijacking a ship, their only mission to reproduce. Viruses are particles that are smaller than a single cell and not visible through a light microscope. Most viruses are spread by insects, but some are spread mechanically through exposure of plant wounds to infected sap [5]. These are smaller and different to bacteria. Many different types exist. Most of the common 'minor' illnesses are caused by viruses. For example, colds, coughs, sore throats, chickenpox and some other rashes. Most common infections in the community are due to a viral infection.Viral infections are much more common than bacterial and fungal infections. However, some viruses are not fought off and can be very serious. The HIV virus is a good example. There are some antiviral medicines that are used for certain infections - such as antiretroviral medicines used to treat HIV [4].

2.2.1. Diseases Caused by Virus

2.2.1.1. H7N9

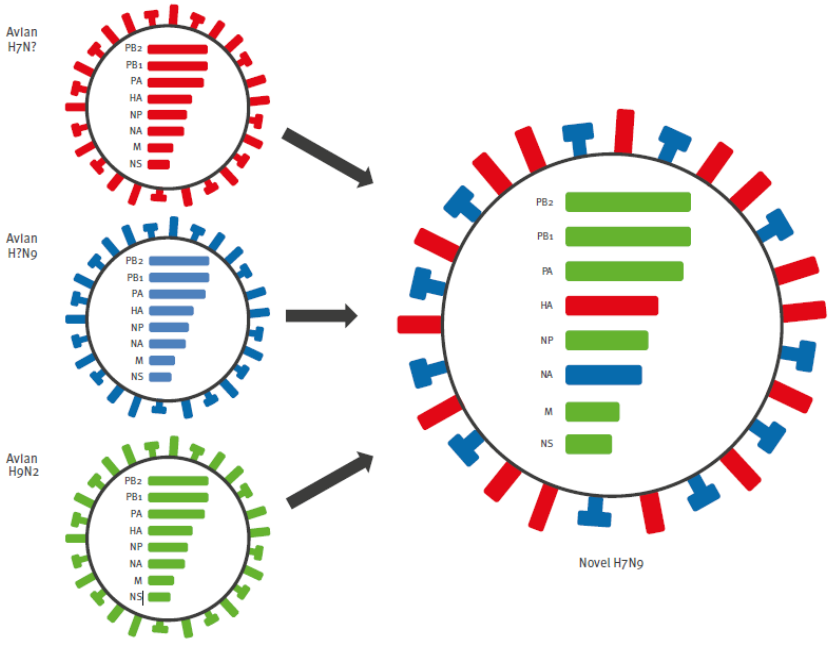

Figure 4. Schematic diagram of novel influenza A(H7N9) virus generation [28]

HA: haemagglutinin; NA: neuraminidase The novel influenza A(H7N9) viruses are likely to have acquired their HA gene from an avian H7 virus of unknown NA subtype, their NA gene from an avian N9 virus of unknown HA subtype, and their remaining six viral segments from avian H9N2 viruses circulating in poultry.

H7N9 is a bird flu strains of the species Influenza virus A (avian influenza virus or bird flu virus). Avian influenza A H7 viruses normally circulate amongst avian populations with some variants known to occasionally infect humans [24]. An H7N9 virus was first reported to have infected humans in March 2013, in China [25].

Influenza A viruses are divided into subtypes based on two proteins on the surface of the virus: hemagglutinin (HA) and neuraminidase (NA) [28,30]. The avian influenza A (H7N9) virus designation of H7N9 identifies it as having HA of the H7 subtype and NA of the N9 subtype [25,27,28]. Symptoms include fever, cough, and shortness of breath, which may progress to severe pneumonia. The virus can also overload the immune system, causing what is known as a cytokine storm. Blood poisoning and organ failure are also possible [26,29]. Laboratory testing shows that influenza antiviral medicines called neuraminidase inhibitors (e.g. oseltamivir, zanamivir) are effective against H7N9 but another class of antiviral, the adamantanes, is not [25,26,29,30].

2.2.1.2. Severe Acute Respiratory Syndrome (SARS)

SARS is a viral respiratory disease of zoonotic origin caused by the SARS coronavirus (SARS-CoV) [31,32]. Severe acute respiratory syndrome (SARS) is a serious form of pneumonia [33]. Initial symptoms are flu-like and may include fever, myalgia, lethargy symptoms, cough, sore throat, and other nonspecific symptoms. The only symptom common to all patients appears to be a fever above 38 °C (100 °F). Shortness of breath may occur later. The patient has symptoms as with a cold in the first stage, but later on they resemble influenza [32,33].

Treatment includes: [31,34]

- Antibiotics to treat bacteria that cause pneumonia
- Antiviral medications (although how well they work for SARS is unknown)
- High doses of steroids to reduce swelling in the lungs
- Oxygen, breathing support (mechanical ventilation), or chest therapy

2.2.1.3. H5N1

Influenza A virus subtype H5N1, also known as A (H5N1) or simply H5N1. It is a subtype of the influenza A virus which can cause illness in humans and many other animal species [35,36]. A bird-adapted strain of H5N1, called HPAI A (H5N1) for highly pathogenic avian influenza virus of type A of subtype H5N1, is the highly pathogenic causative agent of H5N1 flu, commonly known as avian influenza ("bird flu") [36,37]. The avian flu virus (H5N1) lives in the environment for long periods of time. Infection may be spread just by touching surfaces that have the virus on them. Birds who were infected with this flu can give off the virus in their feces and saliva for as long as 10 days [38,39]. Symptoms of avian flu infection in humans depend on the strain of virus [36]. The H5N1 virus in humans causes typical flu-like symptoms, such as: Cough, Diarrhea, Trouble breathing, Fever greater than 100.4°F (38°C), Headache, General ill feeling (malaise), Muscle aches, Runny nose, Sore throat [36,37,39].

In general, treatment with the antiviral medication oseltamivir (Tamiflu) or zanamivir (Relenza) may make the disease less severe. You need to start taking the medicine within 48 hours after your symptoms start for it to work [37,38,39].

2.3. Protozoa

Protozoa are single-celled eukaryotes (organisms whose cells have nuclei) that commonly show characteristics usually associated with animals, most notably mobility and heterotrophy [2]. Protozoa are microscopic unicellular eukaryotes that have a relatively complex internal structure and they have structure for propulsion or other types of movements. Shapes of protozoa are mainly Ciliate, amoebae and flagellates [2,3]. Protozoan pathogens, including microsporidia, amoebae, ciliates, flagellates, and apicomplexans, originating in human or animal faeces have been found in surface waters worldwide. Many have been found infrequently or in low numbers or have been identified only by general morphological features that are not precise [23]. Protozoa are a group of microscopic one-celled animals. Protozoa can be parasites or predators. In humans, protozoa usually cause disease [4]. Some protozoa, like plankton, live in water environments and serve as food for marine animals, such as some kinds of whales. Protozoa also can be found on land in decaying matter and in soil, but they must have a moist environment to survive. Termites wouldn't be able to do such a good job of digesting wood without these microorganisms in their guts [4,23]. Malaria is caused by a protozoan parasite. Another protozoan parasite, *Toxoplasma gondii*, causes toxoplasmosis, or toxo, in humans. This is an especially troublesome infection in pregnant women because of its effects on the fetus, and in people with HIV/AIDS or other disorders of the immune system [2,23].

2.3.1. Diseases Caused by Protozoa

2.3.1.1. Babesiosis

Babesiosis is a malaria-like parasitic disease caused by infection with *Babesia*, a genus of protozoal piroplasms. Babesia microti is believed to be the most common piroplasm infecting humans, but scientists have identified over twenty piroplasms carried by ticks. Ticks may carry only Babesia or they may be infected with both Babesia and Lyme spirochetes. People can also get babesiosis from a contaminated blood transfusion [40,41,43].

Symptoms of babesiosis often start with a high fever and chills. As the infection progresses, patients may develop fatigue, headache, drenching sweats, muscle aches, nausea, and vomiting [45,46]. Blood smears may be examined under a microscope to try to identify the parasite inside red blood cells. The PCR (polymerase chain reaction) test can detect babesia DNA in the blood. The FISH (Fluorescent In-Situ Hybridization) assay can detect the ribosomal RNA of Babesia in thin blood smears [42,44,47]. Babesiosis is treated with a combination of two types of anti-parasite drugs, atovaquone (Mepron, Malarone) plus an erythromycin-type drug (azithromycin, clarithromycin, or telithromycin). Long-standing infections may need to be treated for several months, and relapses sometimes occur and must be retreated [40,43,45,46].

2.3.1.2. Trichomoniasis

Trichomoniasis (or "trich") is a very common sexually transmitted disease (STD) that is caused by infection with a protozoan parasite called Trichomonas vaginalis. Trichomoniasis is primarily an infection of the urogenital tract; the most common site of infection is the urethra and the vagina in women [48,49]. Symptoms include inflammation of the cervix (cervicitis), urethra (urethritis), and vagina (vaginitis) which produces an itching or burning sensation. Discomfort may increase during

intercourse and urination. There may also be a yellow-green, itchy, frothy, foul-smelling ("fishy" smell) vaginal discharge [50,51]. Trichomoniasis is diagnosed by visually observing the trichomonads via a microscope. In women, the examiner collects the specimen during a pelvic examination by inserting a speculum into the vagina and then using a cotton-tipped applicator to collect the sample. The sample is then placed onto a microscopic slide and sent to a laboratory to be analyzed [51,52]. Trichomoniasis can be cured with a single dose of prescription antibiotic medication (either metronidazole or tinidazole), pills which can be taken by mouth [49,52].

2.3.1.3. Toxoplasmosis

Toxoplasmosis (toxo) is an infection caused by a single-celled parasite called *Toxoplasma gondii*. The infection is most commonly acquired from contact with cats and their feces or with raw or undercooked meat [23,53,54]. Toxoplasmosis is one of the most common parasitic diseases and has been found in nearly all warm-blooded animals, including pets and humans. Despite the high prevalence of *T. gondii* infection, the parasite rarely causes significant clinical disease in cats-or any species [54,55]. The parasite infects most genera of warm-blooded animals, including humans, but the primary host is the felid (cat) family [56]. The diagnosis of toxoplasmosis is typically made by serologic testing. A test that measures immunoglobulin G (IgG) is used to determine if a person has been infected. If it is necessary to try to estimate the time of infection, which is of particular importance for pregnant women, a test which measures immunoglobulin M (IgM) is also used along with other tests such as an avidity test [56,57,58]. Most healthy people recover from toxoplasmosis without treatment. Persons who are ill can be treated with a combination of drugs such as pyrimethamine and sulfadiazine, plus folinic acid [54,55]. Infection with *T. gondii* ranges from mild to severe, from flu-like illness to specific organ impairment affecting virtually any organ of the body. Toxoplasmosis can be fatal for the fetus and immunocompromised humans and other animals [57,58]. Despite its wide host range and worldwide distribution, *T. gondii* has low genetic diversity. Humans have three clonal lines that correlate with *T. gondii* genotypes. Type I predominates in congenital infections, and Type I or Type I-like strains are associated with ocular toxoplasmosis in immunocompetent adults. Isolates, mostly from human cases, have been highly virulent for outbred laboratory mice. Type II appears to predominate in infections of immunocompromised patients [56,57,58].

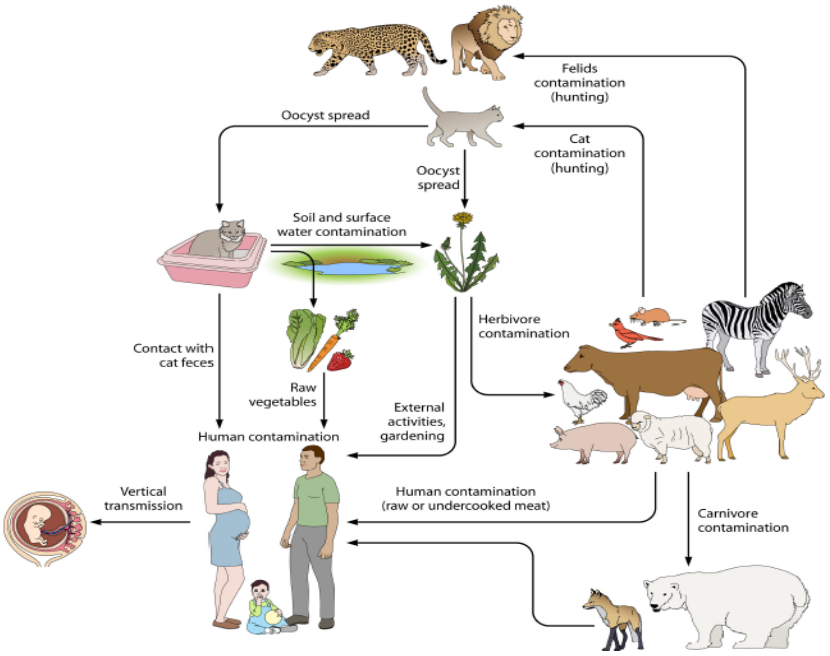

Figure 5. Sources of *T. gondii* infection in humans. The various sources of food-borne and environmental contamination of humans are represented [54]

2.4. Fungi

Some fungi can actually be seen with the naked eye, others are slightly bigger than bacterial cells. Fungi come in many different shapes. Fungi have the most complex structures of all the microbes. They feed off other living things. A fungus is a member of a large group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms [2]. A fungus is actually a primitive plant. Fungi can be found in air, in soil, on plants, and in water. Thousands, perhaps millions, of different types of fungi exist on Earth. The most familiar ones to us are mushrooms, yeast, mold, and mildew. Some live in the human body, usually without causing illness. Fungal diseases are called mycoses. Mycoses can affect your skin, nails, body hair, internal organs such as your lungs, and body systems such as your nervous system. *Aspergillus fumigatus* fungi, for example, can cause aspergillosis, a lung disease [2]. Many types of fungi exist and cause problems in humans, animals and plants. Fungal infections commonly affect the skin and nails in humans. They can cause ringworm, athlete's foot, other localised skin rashes and infections in and around nails. Most fungi are free-living in the environment and few of these are capable of causing infection in an otherwise healthy person. However, they can cause serious infections in patients with weakened immune systems (for example, those who have recently received chemotherapy for cancer) [4].

2.4.1. Diseases Caused by Fungi

2.4.1.1. Onychomycosis

Onychomycosis is a fungal infection of the toenails or fingernails that may involve any component of the nail unit, including the matrix, bed, or plate [61]. Onychomycosis can cause pain, discomfort, and disfigurement and may produce serious physical and occupational limitations, as well as reducing quality of life [62,63]. The most common symptom of a fungal nail infection is the nail becoming thickened and discolored: white, black, yellow or green. As the infection progresses the nail can become brittle, with pieces breaking off or coming away from the toe or finger completely. If left untreated, the skin can become inflamed and painful underneath and around the nail [63,64]. A systemic treatment is always required in proximal subungual onychomycosis and in distal lateral subungual onychomycosis involving the lunula region [61,64]. White superficial onychomycosis and distal lateral subungual onychomycosis limited to the distal nail can be treated with a topical agent. A combination of systemic and topical treatment increases the cure rate. Photodynamic therapy and lasers may represent future treatment options [59,60,62,64].

Figure 6. Proximal Onchomycosis (T.Interdigitale) [61]

Figure 7. Typical Onchomycosis [61]

2.4.1.2. *Pneumocystis* Pneumonia (PCP)

Pneumocystis pneumonia (PCP) or pneumocystosis is a form of pneumonia, caused by the yeast-like fungus (which had previously been erroneously classified as a protozoan) *Pneumocystis jirovecii* [65,66]. *Pneumocystis* is commonly found in the lungs of healthy people, but, being a source of opportunistic infection, it can cause a lung infection in people with a weak immune system [66,67]. Symptoms of PCP include fever, non-productive cough (because sputum is too viscous to become productive), shortness of breath (especially on exertion), weight loss, and night sweats [65]. The diagnosis can be confirmed by the characteristic appearance of the chest x-ray, which shows widespread pulmonary infiltrates, and an arterial oxygen level (PaO_2) that is strikingly lower than would be expected from symptoms. Gallium 67 scans are also useful in the diagnosis [65,67]. In immunocompromised patients, prophylaxis with co-trimoxazole (trimethoprim/sulfamethoxazole), atovaquone, or regular pentamidine inhalations may help prevent PCP [67,68].

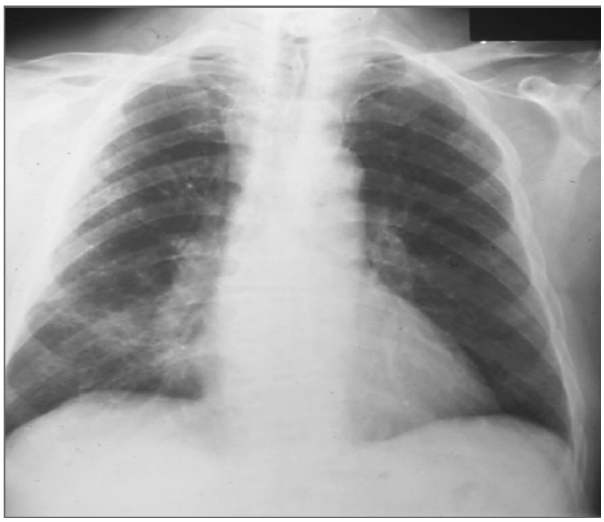

Figure 8. Pneumocystis Pneumonia [68]

2.4.1.3. Cryptococcus Gattii

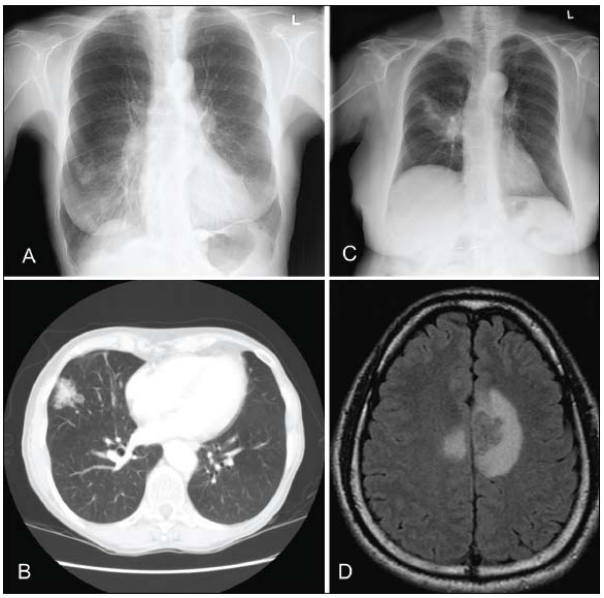

Figure 9. Images from patients with Cryptococcus gattii infection [69] (***A*** *Case 1: chest x-ray showing a 2 cm nodule in the peripheral, lateral segment of the right middle lobe.* ***B*** *Case 1: chest computed tomography scan showing a 3 cm nodule in the right middle lobe with no surrounding consolidation.* ***C*** *Case 2: chest x-ray showing right upper lobe consolidation and air bronchograms.* ***D*** *Case 3: magnetic resonance imaging scan of the head showing the presence of a ring-enhancing lesion)*

Cryptococcosis is a fungal infection caused by fungi that belong to the genus *Cryptococcus*. There are over 30 different species of *Cryptococcus*, but two species – *Cryptococcus neoformans* and *Cryptococcus gattii* – cause nearly all cryptococcal infections in humans and animals [69,70]. Most people who develop cryptococcosis have

weakened immune systems, although healthy people can also become infected, particularly with *C. gattii* [69,71,72]. Cryptococcal infection may cause a pneumonia-like illness, with shortness of breath, coughing and fever. Skin lesions may also occur. Another common form of cryptococcosis is central nervous system infection, such as meningoencephalitis. People with cryptococcal meningoencephalitis are usually immunocompromised. Symptoms may include fever, headache, or change [73,74,75]. Cryptococcosis requires treatment with prescription antifungal medication for at least 6 months, usually longer. Treatment of severe cryptococcal infections, including those with central nervous system involvement, usually begins with amphotericin B, often in combination with flu cytosine [74,75].

2.5. Algae

Algae are a very large and diverse group of simple, typically autotrophic organisms. It ranges from unicellular to multicellular forms, such as the giant kelp, that may grow up to 50 meters in length [76]. Algae include diverse groups of organisms because the reason is that in the early days of development of light microscopes, and before those of electron microscopes, their full diversity could not be detected. The cells of some algae are of bacterial size, for example, about 1 um (1 micrometer= 1 /1000mm) or about 0.00004 ins across. Microscopic algae can be found everywhere from permanent snow and ice to deserts, the oceans, lakes, rivers, puddles, rock and soil [76]. Algae have a wide ranging classification, falling within several groups from plants through to protists (single celled organisms) and even bacteria (blue-green algae). Algae form an important part of many ecosystems and have a vast variety of body shapes, biochemistries and life cycles [77]. Algae have cells called chloroplasts that take light energy from the sun and convert it into chemical energy that the organism can use. These chloroplasts can be anywhere from yellow to brown, blue-green to bright green and red; therefore algae can come in a variety of colours [77].

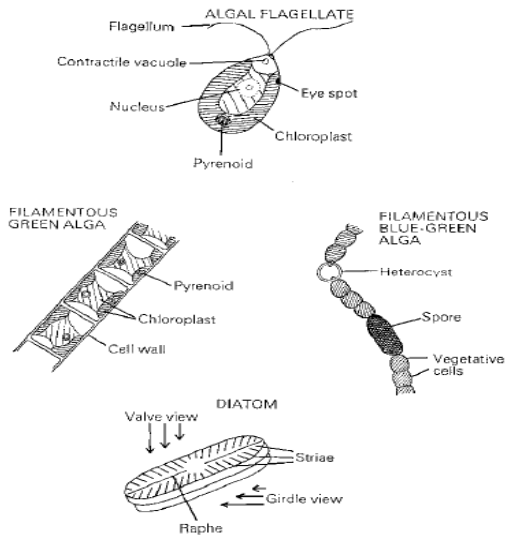

Figure 10. Diagrammatic structure of some algae [76]

2.5.1. Diseases Caused by Algae

2.5.1.1. Diarrhetic Shellfish Poisoning (DSP)

Diarrhetic shellfish poisoning (DSP) is an acute gastrointestinal illness caused by consumption of bivalve mollusks that have accumulated okadaic acid (OA) or related dinophysistoxins through filter feeding. DSP toxins are produced by several species of marine dinoflagellates from the genera Dinophysis and Prorocentrum [78]. Symptoms of DSP include nausea, abdominal pain, vomiting, diarrhea, headache, chills, and fever [79]. A mouse bioassay using an intraperitoneal injection of toxin extracts with a 24 hour waiting period is used in Japan and shellfish with DSP toxin levels greater than 50 MU/kg are banned; similar surveillance systems have been established in the European countries. An HPLC method for detection of DSP toxins is available and used in Sweden for monitoring purposes [78,79]. Treatment is symptomatic and supportive with regards to short-term diarrhea and accompanying fluid and electrolyte losses. In general, hospitalization is not necessary; fluid and electrolytes can usually be replaced orally [80].

2.5.1.2. Prototheco sis

Prototheco sis is a disease found in dogs, cats, cattle, and humans caused by a type of green algae known as *Prototheca* that lacks chlorophyll. It and its close relative Helicosporidium are unusual in that they are actually green algae that have become parasites. The two most common species are *Prototheca wickerhamii* and *Prototheca zopfii*. Both are known to cause disease in dogs, while most human cases are caused by *P. wickerhami*. *Prototheca* is found worldwide in sewage and soil [81]. In prototheco sis, the skin is most commonly involved, resulting from primary inoculation through a wound or abrasion. The infection is usually localized to the site of inoculation; however, in immunocompromised individuals, it can become widespread [82]. Diagnosis is performed by isolation of the microorganism in culture or by histopathology [81,83]. The ideal treatment has not been defined, with amphotericin B and the azoles having been employed [83].

2.5.1.3. Amnesiac Shellfish Poisoning

Amnesic shellfish poisoning (ASP) is a human illness caused by consumption of the marine biotoxin called domoic acid. This toxin is produced naturally by marine diatoms belonging to the genus *Pseudo-nitzschia* and the species *Nitzschia navis-varingica* [84]. When accumulated in high concentrations by shellfish during filter feeding, domoic acid can then be passed on to humans via consumption of the contaminated shellfish [85]. Symptoms are mainly Vomiting, diarrhea and abdominal cramps, Disorientation and memory loss, Seizures, Renal failure, Coma (in a small number of cases, death may follow due to a combination of the above) [85,86]. The mouse assay used for ASP testing is the same as for PSP. The relative potency of ASP toxins appears to be less than PSP. In addition, involuntary scratching of shoulders with hind legs by the mice was noted and is not typical of PSP. HPLC analysis can quantify domoic acid from contaminated shellfish in ASP episodes [84,86]. There is no antidote. The only treatment for severe cases is the use of life support systems until the toxin passes from the victim's system [86].

3. Conclusion

Usually the microbes live in accord with the host through commensal contacts and mutual realtions, but diseases can appear when parasites which exist become pathogenic or when a new pathogen enters a new host. Numerous studies have reported relations between pathogen load and human behavior. Better anti-infective drugs need to found out to suppress the infection and diseased condition. The various current activities to control the microbial infections include projects sequencing the whole or partial genomes of a variety of pathogenic microbes, malaria research programs, learning more about emerging viruses and studies based on the pathogenesis of bacterial and viral sexually transmitted infections and prevention strategies to control these infections.

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