Review

The etymology of microbial nomenclature and the diseases these cause in a historical perspective

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A B S T R A C T

When the hunter-gatherers finally started settling down as farmers, infectious diseases started scourging them. The earlier humans could differentiate sporadic diseases like tooth decay, tumors, etc., from the infectious diseases that used to cause outbreaks and epidemics. The earliest comprehension of infectious diseases was primarily based on religious background and myths, but as human knowledge grew, the causes of these diseases were being probed. Similarly, the taxonomy of infectious diseases gradually changed from superstitious prospects, like influenza, signifying disease infliction due to the “influence of stars” to more scientific ones like tuberculosis derived from the word “tuberculum” meaning small swellings seen in postmortem human tissue specimens. From a historical perspective, we identified five categories for the basis of the microbial nomenclature, namely phenotypic characteristics of microbe, disease name, eponym, body site of isolation, and toponym. This review article explores the etymology of common infectious diseases and microorganisms’ nomenclature in a historical context.

1. Background

Hot, dry winds forever blowing,
Dead men to the grave-yards going:
    Constant hearses,
    Funeral verses;
Oh! What plagues—there is no knowing! .
    (Philip Freneau, Philadelphia, 1793)

There was a time in the history of humankind when infectious diseases used to strike with such ferocities that villages and cities used to be wiped out of human residents. In Middle Ages and Early Modern Era, the emergence of any infectious disease outbreak was accompanied by extensive horror among the masses resulting in abandoning their living abode and running away- favoring the transformation of a local phenomenon into a pandemic. People were utterly oblivious to the underlying cause of those dreadful diseases and even ignorant of their treatment and prevention. The misery is reflected in the above verses of a poem titled “Pestilence,” written in the backdrop of an outbreak of Yellow Fever in Philadelphia in 1793.

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E t y m o l o g y is the study of the origin of the word from its roots and its development through times till its present form. The birth of microbiology has its roots in Europe; therefore, the microbes' nomenclatures are primarily derived from old Greek and Latin languages, and therefore, many science students are oblivious to the true meanings of those names. Thus, this research will not only explain the meanings of the names of infectious diseases and microbes but will also bridge the gap between their nomenclature and pathogenesis, highlighting the untiring work of the scientists who unfolded the mysteries of horrible infectious diseases of the past. In this article, we will endeavor to trace the etymology of the current names of the major infectious diseases and the nomenclature of some medically important microbes from historical perspectives.

2. The etymology of some common infectious diseases’ names

A gradual shift from hunter-gatherers to more settled agriculture living among humans started around 10,000 BCE (Hart-Davis 2012). Living in the settled agriculture communities had definite advantages of livestock domestication, better community protection, more food, etc. Yet, it was also accompanied by hazards of acquisition and spread of infectious diseases. The problem was compounded when the world population started to increase, with the surfacing of glitches like wars, famine, mass migrations, human exploration for new lands, etc., thus, the ground for the spread of infectious diseases was laid down. For example, when sea routes
were utilized for trading captive laborers from Africa to New World, there was an exchange of some lethal infectious diseases between those continents and subsequently bartering diseases to Europe with drastic consequences. Diseases like malaria, yellow fever, cholera, plague, and influenza had killed more human beings than the combined casualties of the World Wars and other major battles fought in the history of humankind.

The word disease (dis-ease) is an antonym meaning lack of ease. One disease that has scoured mankind since antiquity is malaria. The name originates from the medieval Italian words mal for bad and aria for air. The Romans had noticed that this disease was more prevalent around the marshlands, believing it to be due to inhalation of the dirty fumes from those swamps (Rawal 2020). However, they were not aware of the role of mosquitoes in the transmission of malaria at that time. Another dreadful disease with very high mortality rates was the plague that had rampaged the world, especially in Europe. It was initially called the Black Death because of the appearance of dark blots on the victims’ skin signifying subcutaneous hemorrhages (Duncan and Scott 2005). In the Middle Ages, the word plague was used for any fast-spreading illness. The word originates from the Latin word Plaga which means Stroke or Wound (Ketchell May 14, 2020). The disease was named perhaps due to the rapidity with which plague used to afflict the human population akin to killing and wounding a large number of soldiers on battlefields in a shorter time.

Influenza has an astrological connection, and the name might have been derived from an Italian phrase influenzae coeli meaning the influence of heaven or stars (Struss June 23, 2014). Another viewpoint states the word Influenza being the precursor of the Latin word influentia, which means “To Flow into.” It was believed in Medieval times that an invisible fluid from stars caused disease in the human population (Wickramasinghe 2020). Ancient civilization noted the appearance of comets or other celestial phenomena preceding dreadful diseases like plague or Influenza. Many researchers still debate today that the contagions, suspended in the outer earth atmosphere, are showered on earth in the cosmic dust from the movement of comets/ asteroids/ meteorites, etc. (Wickramasinghe 2010). The modern English word “influence” is also derived from it.

The disease cholera has also caused multiple pandemics with significant morbidity and mortality. Till the nineteenth century, the word cholera was used for any diarrheal disease of humans. This word has its roots in Ancient Greek kholéra from cholē, which means bile, or the phrase cholēdrá meaning gut (Kousoulis 2012). Both words cue profuse diarrhea and bilious vomiting accompanying the illness. The word dysentery is of ancient Greek origin devised by Hippocrates in which accompanying the illness. The word dysentery is of ancient Greek meaning bad/ abnormal/ difficult and entera for intestines/ bowel. Poliomyelitis is a disease of antiquity, and it derives its name from the Greek word polio, which means grey, myelo for the spinal cord, and its as a suffix for inflammation. Histopathological changes noted exclusively in the grey matter of the spinal cord was the reason behind this term.

In history, Tuberculosis is associated with the tragic death of famous personalities. On Feb 3rd, 1830, after seeing blood spots during a bout of cough, John Keats said, “That drop of blood is my death warrant. I must die” (Smith 2004); he died of tuberculosis a year later. Known as Romantic disease in the past, tuberculosis was once called phthisis from the Greek word phthisoe, which means shriveling of organic matter after exposure to intense heat. This is the clinical presentation of untreated tuberculosis we know today as cachexia. It was also called consumption for the same reason. The word tuberculosis originates from the Latin botanical term tuber, which describes a solid, underground rounded outgrowth from a stem, such as a potato. The word tubercle is from the tuberculum, which is diminutive of the tuber, signifying small swelling, while osis is a suffix describing a disease process (Markel 2012). This reflects the small swellings seen in postmortem specimens of tuberculosis-affected tissues, mainly the lungs of the deceased.

There is perhaps no period in human history devoid of any sexually transmitted infection. Gonorrhea is one of the oldest diseases known to humankind. It was also called Claps due to clapping sensation experienced by the victim of disease during micturition (Jose et al., 2020), or due to the treatment protocol in the pre-antibiotic era when the penis of the patient was used to be clapped between two hands of the physician or slapped against the board to force out the pathological discharge (Wooldridge 2022). Alternate views claim it to be a derivative of the French word clapier, which means brothel. Galen first coined the word gonorrhea, denoting the Greek word gonos for seeds and rhea indicating flow. The urethral discharge in gonorrhea was mistakenly believed to be semen-thought to contain seeds for the future creation of human beings. The word gonad is also derived from gonos which means the organs producing seeds (testes and ovaries).

The records of Dengue fever date back to the Chinese Chin Dynasty around 240–420 CE, when this disease was called “Water Poison,” indicating its relation to flying insects dwelling on water. The word Dengue might have been derived from a Spanish Swahili phrase, “xi denga pepo,” which translates as “Sudden, cramp-like seizure of evil spirit,” (Guzman et al., 2008). Another viewpoint suggests that Dengue fever is a restructured local dialect of the term “Dandy Fever” from Barbados Caribbean islands since the 1800’s (Bardi and Jason 2022), which meant “stiffness and dread of motions” (an important clinical feature of the disease). Table 1 depicts some important infectious disease names with the etymological association.

3. Microbial nomenclature and etymological background

The microbial nomenclature follows a binomial system with established laid down rules (Low et al., 2015). The binomial system allows the microbes to be assigned genus names followed by species names and sub-species if there exists one. Viruses are not considered living beings, and they do not follow the binomial system of nomenclature. In our research, we identified five broad categories for the basis of microbial nomenclature. These include Phenotypic characteristics of microbe, disease process/symptoms produced, Eponym (name of scientist/researcher/patients), site of isolation, and finally, Toponym (Name of place where the organism was first isolated or identified).

3.1. Phenotypic characteristics of the microbe

3.1.1. Nomenclature based on wet mount appearance of microbes

The development and improvement of the first compound microscope in late 1600 by Antony van Leeuwenhoek opened a new insight into the unseen world of microbes. The enthusiastic scientists started observing everything under the microscope. The initial microscopic observations were primarily focused on the wet mount preparation of various specimens, e.g., drops of ponds, lakes, rainwater, etc. The first fascinating characteristic of tiny living creatures that caught the eyes of the observers was their motility. Early scientists devised a now obsolete term “infusoria” for any minute motile aquatic creatures, and one of its types was a single-celled organism called “monas”. Many microbial names were later coined based on these monads, and some still exist in medicine, e.g., Pseudomonas (False Monas) (Palleroni 2010), Aeromonas (Gas producing Monas), Trichomonas (hairy Monas or scientifically flagellated monas), Stenotrophomonas (Greek steno means narrow, trophos meaning feed and monas; depicting limited feeding range of the organism).
Similarly, Vibrio is derived from the Latin word “vibrare,” which means to vibrate or move rapidly (Dorland 2012). This name is reflective of the rapid shooting star-like motility seen in this genus. The Greek word “ukineto,” which means non-motile, was Latinized to “acinetos” with a change in Greek “k” to Latin “c” sound in the nomenclature of Acinetobacter (Triuper 1999). Entamoeba is a unicellular organism belonging to phylum protozoa. The name is derived from the Greek word entos, meaning ‘within’ and amoeba, which translates as “change, alteration.” This is the classical description of the parasite, which keeps on changing its shape. The term Entamoeba was coined to differentiate the free-living freshwater amoeba feeding upon algae and plankton from Entamoeba that primarily live inside the living host tissues mainly the intestine (Lakina 2017). Yet another parasite called Acanthamoeba has a different etymological background. The Greek word akantha means spike/thorn which depicts the characteristic thorny appearance of the parasite due to its tapering sub-pseudopodia (Walker et al., 2011).

Two microorganisms belonging to the phylum spirochetes are best visualized by darkfield microscopy. Treponema pallidum, the causative agent of syphilis, is named from the Greek trekto, signifying to rotate/ to turn and nema, which means thread. This is based upon the thin structure and peculiar rotatory motility of the microbe (Pogliani and Ollhoff 2021). The species name pallidum is from the Latin word pallidus, meaning pale yellow-green. The other spirochete Leptospira interrogans has an interesting reason for its name. Leptos in ancient Greek means fine or thin, whereas spira in Latin translates as the coil. The tight coil of this spirochete is reflected in its name. The species nomenclature interrogans was proposed by Surgeon A. M. Stimson in 1907 due to this organism’s resemblance to the English question mark sign (Stimson 1907).

3.1.2. Nomenclature based on stained smear of pathogen/isolate

Hematoxylin, carmin, aniline dyes were used to stain the prokaryote before Danish physician Dr. Hans Christian Jochim Gram in 1884 invented Gram Staining (Madani 2003). In 1880, Scottish Surgeon Sir Alexander Ogston observed pus from a patient with a knee abscess under the microscope and identified a microorganism he called Staphylococcus. The Greek word staphyle means a bunch of grapes, and kokkos stands for berry (Licitra 2013) because the staphylococci appear in clusters on stained smears. This conformed to an earlier term, Streptococcus, coined by Austrian surgeon Theodor Billroth in 1877, who observed Streptococci in chains. The Greek word streptos means twisted or chain, and kokkos for berry (Cavaillon and Legout 2022).

Fungi had long been identified by their mycelial structure, and any microbe that showed branching filaments were considered fungus in the past. One example is Mycoplasma, which Louis Pasteur discovered while studying Pleuropneumonia in felines in 1843, calling the causative organism a Pleuropneumonia-like organism. Mycoplasma stands for the Greek word mykes, meaning fungus and plasma (formed or shaped), and was first used by A. B. Frank in 1889 while studying the legume root-nodule organisms. However, Julien Nowak in 1929 used this term for the causative organism of bovine Pleuropneumonia due to its mycelial configuration (Kras and Gardner 1973). Other microbes with similar falcacies include the agents like Mycobacterium (Fungus bacterium), Actinomyces (Ray-fungus), Streptomyces (Chain fungus), etc. The true fungus penicillium borrowed its name from Latin penicillus, which means paintbrush, exactly how it looks under a microscope as shown in Fig. 1.

An Italian priest and biologist, Pier Antonio Micheli, named fungus Aspergillus on its resemblance to the aspergillum—a holy water sprinkler (Yu 2010) as shown in Fig. 2.

The introduction of Romanowsky and other stains paved the way to the revelation of microorganisms not visible by ordinary Gram staining or wet mount preparation. In 1885, two Italian physicians, Ettore Marchiafava and Angelo Celli, working on malaria, proposed the genus name plasmodium for the causative agent of the disease, the word derived from Late Latin plasma that means mold or formation. The word plasmodium is a botanical term earlier used for the vegetative stage of slime mold of Class Myxomycetes, which appears as a single multi-nucleated cell (Bruce-Chwatt 1987, Britannica February 3, 2010). This resemblance was so striking to the schizont stage of malarial parasites containing multiple merozoites that the term plasmidoma was incorrectly adopted and accepted. Similar terminology used for other microbes includes anaplasma from Greek ana for no and plasma for shape, meaning no shape, Toxoplasma from Greek toxon for arc/ bow, and plasmo for shape/ form, also pointing towards the bow-shaped tachyzoites. The species falciparum has interesting etymology where Latin falk or falci translates as sickle and parum for like or equal to another (Tiwari and Sinha 2021). This beautifully transcribes the banana-shaped or sickle-shaped gametocytes of

| S. No | Disease Name | Word of origin with English meanings | Etymological comments |
|-------|--------------|--------------------------------------|----------------------|
| 1     | Anthrax      | The Greek word “anthrax” means Charcoal (Palasik and Kolodnytska 2020) | Reflects of the rapid shooting star-like motility seen in this genus. |
| 2     | Botulism     | Medieval Latin “botulus” for Sausage | Food from which the organism was the first isolated (Erbguth and Nauman 2000). |
| 3     | Tetanus      | From Romanized Ancient Greek, “tetanos” that means taut | Clinical feature of muscle spasm |
| 4     | Varicella    | Latin word “varicella” is diminutive of variola (smallpox) | Smaller skin lesions compared to smallpox |
| 5     | Zoster       | Greek “zoster” for belt/girdle | A belt-like skin lesion |
| 6     | Diphtheria   | Greek “diphthera” means prepared hide or leather | The leather-like tough membrane formed in the throat |
| 7     | Leprosy      | Greek “lepr” stands for scaly skin lesions | Clinical features of the disease |
| 8     | Measles      | Middle English “mazel” for the little spot | Skin lesions |
| 9     | Mumps        | English “Mump” meaning to mutter, or Iceland “mumpa” meaning to fill mouth too much” | Characteristics articulation sound of the patient likened to talking with a mouth full of potato. |
| 10    | Pertussis    | Latin “per” for intensive & “russis” for cough | Clinical features of the disease |
| 11    | Q fever      | English “queri fever.” | To replace original epithets like Abatour Fever to discourage defaming the cattle industry |
| 12    | Rabies       | Latin “ruber” (to rage) or Sanskrit “rabhis” (to do violence) (Beman 2017) | Clinical features seen in canines and human cases |
| 13    | Rubella      | New Latin “rubes” for red | Color of skin rash |
| 14    | Syphilis     | Greek word “syphilis” was first used in 1530 by Italian physician and poet Hieronymus Fracastorius in a poem (Spitzer 1955) | A Greek mythological character of shepherd believed to be the first sufferer of the disease |
| 15    | Trachoma     | Greek “tricuma” that stands for roughness | Pathological changes in eyes mucosa |
| 16    | Typhus       | Greek “typhos” means stupor, smoke, blind | Clinical features of the disease |
| 17    | Typhoid      | Greek “typhoid” means typhus like | Initially thought to be typhus but later differentiated as a separate entity |

Table 1 Major Infectious Diseases’ origin of the name and historical correlation.
Plasmodium falciparum seen on Romanowsky stains. The other species vivax derives its name from the Latin word vivō meaning to live/to be alive, while -āx (inclined to) is an adjective expression of the verb vivō. The literal meaning is long-lasting, which hints the longevity of vivax species infection in the host due to its hypnozoites stage causing relapses.

3.1.3. Nomenclature based upon the colonial appearance of the microorganism

Many colonial characteristics were attributed in naming the genus or species of prokaryotes that can grow on artificial culture media. For example, in Staphylococcus aureus, the species name aureus points towards the golden colonies seen on culture medium, and in the Latin language, aurum means gold. Similarly, the species name cereus in Bacillus cereus depicts the waxy colonial appearance of the colonies as cereus in Latin means wax or candle. We are familiar with the word cerumen which is another word for earwax. The colonies of Bacteriodes fragilis demonstrate fragility under certain conditions that led to its species name fragilis.

The scientists studying Proteus were mesmerized by its ability to change shape from small rod to elongated multi-nucleated form teeming with flagella, a characteristic observable on enriched media as swarming strains. The terminology is based upon a Greek mythology character named Proteus who could assume any shape he desired to escape the captor (Armbruster and Mobley 2012). Another interesting phenomenon displayed by prokaryotes is pigment production on the solid enriched culture media. The nomenclature of many bacterial species reflects this trend. For example, the rapid pigment decay in culture medium seen among genus Serratia led to its name marcescens-Latin word meaning decay (Nazzaro 2019). Pseudomonas aeruginosa produces a plethora of pigments on the nutrient agar, but it is most commonly associated with greenish pigment production. The word aeruginosa is derived from the Latin word aerūgō for copper rust and -ōsus added to
make adjective of the noun meaning an abundance of copper rust (Talon 2012).

Some microorganisms are named for the biochemical properties of their colonies grown on solid or liquid media. For example, Citrobacter means citrate utilizing rod, species name maltophilia in Stenotrophomonas maltophilia means maltose loving for its maltose fermentation property, another species Hydrophila which means water-loving is named due to its propensity to grow in freshwater. The genus Hemophilus in Greek means blood-loving. This name was designated because this bacterium failed to grow on ordinary nutrient agar but grew substantively on medium enriched with blood. The history of the naming of Candida albicans is a fascinating one. The word Candida is borrowed from the Latin albus meaning white and it refers to white toga worn by the Roman senators while albicans means to whiten (Vila et al., 2020). Both words essentially denote the white color of the colony of this yeast.

3.1.4. Nomenclature based on electron microscopic appearance of microorganisms

The invention of the first electron microscope in 1931 in Germany paved the way for examining ultra-structures of cells and, more importantly, the study of viruses that were not possible with ordinary compound microscopes. Quite a few viruses were named based on their electron microscopic morphology, e.g., Rotavirus (rota means wheel in modern Latin), Coronavirus in Latin means crown virus for the virus spike proteins resembled the diverging narrow bands seen in the radiant crowns. Similarly, Rhadoviridae, seen as bullet-shaped in electron microscopy, borrowed its name from the Ancient Greek word rhabeiōs which means rod. On the other hand, Arenavirus derived its name from Latin arenosus, meaning "sandy," which reflects the grainy appearance of the ribosomes derived from the host cells. Table 2 depicts some microorganisms' nomenclature with their microscopic appearances.

| S. No. | Name of microorganism | Word of origin with English meanings | Etymological comments |
|-------|-----------------------|--------------------------------------|----------------------|
| 1     | Bacillus              | Diminutive of Latin baculus meaning Little Rod/wand | The square edges of bacillus look like a wand |
| 2     | Clostridium           | Greek klōstris for spinner or spinner | Central or subterminal spore gives pathogen a spinle stick appearance |
| 3     | Corynebacterium       | Ancient Greek korōnē for club or mace | The resemblance of bacteria to baseball club |
| 4     | Campylobacter         | Greek kampulos means bent            | Bacilli curved at ends |
| 5     | Helicobacter          | Ancient Greek hēlix means spiral shape | The spiral appearance of the bacterium |
| 6     | Chlamydia             | Greek khλamys for short mantle       | The incorrect assumption that this bacteria cloaks the nucleus of infected cells (Byrne 2003) |
| 7     | Sporothrix            | Ancient Greek spōrō for seed and thrix for hair | The arrangement of spores along the hyphae likened to seeds along a hair |
| 8     | Cryptococcus          | Greek krypto (hidden), kokkios (berry) | The large capsule surrounding the yeast cell |
| 9     | Pneumocystis          | Ancient Greek pneumōn for lungs and kūstis for bladder or pouch | The predilection of organisms' cysts for lung tissues |
| 10    | Cryptosporidium       | Greek krypto for hidden and sporidium for small spores | Very small oocysts of parasites usually not visible except Ziehl Neelsen Staining |

3.1.5. Nomenclature based on the gross appearance of the parasites

Most parasites belonging to the phylum Platyhelminthes and Nemathelminthes are visible to the naked eye. The initial naming of these parasites was based upon their gross morphological appearance. For example, Ascaris derived its name from the Greek word askaris, which means intestinal worm, whereas the species name lumbricoides means resembling an earthworm. This was based upon the observation that Ascaris lumbricoides had a striking resemblance to a common soil-dwelling earthworm. One of the hookworms, Ancylostoma, is composed of two words from the ancient Greek language; ankulos, which means curved/ crooked, and stoma for the mouth. The morphology of this parasite showed a characteristic curved appearance of the mouth part. Trichinella spiralis is another nematode whose name reflects its gross appearance. Trichinella is from the Greek word trichinos, which means made of hair, while -ella is a diminutive suffix. The worm is so tiny that it appears as a very small thread with a naked eye. The species name spiralis is reflective of the curled-up shape of the larval form of this parasite in the muscle tissue of the host.

There are two species of Taenia that have interesting reasoning for their nomenclature. Taenia is from the Greek word tainia, which means tape or ribbon (gross appearance of the parasite) (Viljoen 1937), while the origin of the species name solium might have originated from the French "Solitaire," which means solitary. When the scientists studied this worm, they observed that on most occasions, an individual is infected with only one specimen of the adult worm at one time (Andrade-Filho, 2011). This led to the naming of this parasite as a solitary tapeworm. When scientists encountered another look-alike species of Taenia, they found it plump, fatter, and larger than the T. solium; hence they named it saginata, which in Latin language means well-fed (Henry 2017). This reflected the naming of the second species of Taenia compared to the earlier discovered T. solium on gross appearance. However, the literature shows that solitary worm infection of humans is not limited to T. solium but can also be seen in T. saginata infestation (Haind Fadel 2022).

The fluke Schistosoma is second only to malaria if we consider the number of individuals it infects and disables worldwide. The adult male, 15–20 mm long, has a gynecophoral canal where the slender female resides. The groove of the gynecophoral canal of the male fluke gives it a mistaken appearance of a split body. This morphological appearance of the adult male is reflected in its name Schistosoma, a name proposed by David Friedrich Weinland in 1858, which comprises two Greek phrases; schistos means split and soma means the body (Di Bella et al., 2018).

3.2. Disease process or symptoms produced

If we closely look at the nomenclature of the microorganism following the binomial system, we will find that many microbes' species names are the disease names or the symptoms they produce in humans or lower animals. For example, in the case of Corynebacterium diptheriae, Vibrio cholerae, Mycoplasma pneumoniae, Bacillus anthracis, Shigella dysenteriae, Bordetella pertussis, Mycobacterium tuberculosis, Chlamydia trachomatis, the species name denotes the major diseases the particular microorganism produces (e.g., in above cases, diptheria, cholera, pneumonia, anthrax, dysentery, pertussis, tuberculosis, trachoma). Few names, however, deserve elucidation and will be discussed in detail.

Streptococcus agalactiae is an important cause of meningitis and pneumonia in the neonatal period and is associated with significant morbidity and mortality. During the golden era of microbiology, when every disease was suspected of being caused by unseen microbes, scientists tried to find the etiology of a disease in cattle associated with low milk production. That disease used to involve 15–40 % of the herd with significant losses to the dairy industry in...
America. A streptococcus was isolated in the lab from the infected cows’ udders, which was named agalactiae; a is a prefix meaning no, and galactos mean milk (Chen 2019). This signifies the organism responsible for the absence of milk production in the cattle.

The pre-antibiotic era witnessed many horrific infectious diseases associated with the penetrating wounds inflicted in wars or accidents. One such condition was called gas gangrene, when the infected tissue used to develop gangrene and gas production evident by wound crepitus. When the causative agent was discovered, it was named Clostridium perfringens. The species name perfringens is a Latin epithet that comprises two words: per means through, and frango means to shatter or break in pieces. This was reflective of the histopathological appearance of the gangrenous tissue that displayed coagulative and liquefactive necrosis of the myocytes. Another pathogen that causes rapid fulminant septicemia following wound infection is Vibrio vulnificus. The species name vulnificus is a Latin compound word consisting of two phrases: vulnus, which means a wound, and facere, which translates as to make. Any healthy individual who sustains trauma in seawater develops serious wound infection on exposure to this organism which is the basis of its name.

Entamoeba histolytica is associated with the destruction of the tissue with resultant ulceration or pus formation. The species name histolytica is derived from two Greek words, histos, which translates as tissue, and luein, which means to dissolve. This name is attributed to the lytic properties of this parasite on tissues. Similarly, the species name of Brucella abortus is due to the causation of abortion primarily in cattle. Haemophilus influenzae was named so because it was once thought that this bacterium is the cause of the disease influenza—the species name influenzae in the Greek language means one that causes influenza. The Greek phrase para has many meanings, but in the context of the microbial names, it interprets in the English language as ‘resembling’ or ‘like’ and is used in many microbes’ species names, e.g., parainfluenza (resembling Influenza), parapertussis (resembling pertussis), paratyphoid (typhoid like), paratuberculosis (tuberculosis like), etc. The Greek work para has another connotation in the genus name of the trematode Paragonimus westermani, which signify as ‘nearby’ close to, while gonimus is from the Greek word gonos which means seeds, and, in this context, the phrase gonimus means fertility organs-testes and ovaries. As testes and ovaries are very close to each other in this parasite, so was the reason for its name.

Herpesviruses are a significant cause of morbidity and mortality in human beings, and herpes simplex virus is considered the single most common infectious agent that inflicts humankind today. The word herpes was initially coined for any spreading skin lesion and included conditions like skin cancers, fungal skin infections, bacterial infections like erysipelas, etc. The word herpes is derived from Greek Erpein, which means to creep (Scott 1986). The species name simplex was first used by Daniel Sennert, who classified three types of herpes infections; Herpes simplex, Herpes miliaris, and Herpes exedens, with mild differences in their description (Beswick 1962). He used the term Herpes simplex for skin lesions that ulcerate. The term Herpes simplex survived till today, albeit did not work on this bacterium, his services in microbiology were great. Edwin Klebs's main work was related to Corynebacterium diphtheriae which he, along with Friedrich August Johannes Löffler, discovered as the cause of diphtheria. The Corynebacterium diphtheriae was initially called KLB (Klebs Löffler Bacillus). Dysentery was once a disease of high mortality and considered a disease of war and famine. Genus Shigella is the most important cause of bacillary dysentery. Its discovery is credited to a Japanese physician Kiyoshi Shiga who isolated it from dysentery patients in an epidemic in Japan in the late nineteenth century. Kiyoshi Shiga used the serum of the patient to show that it agglutinated the bacillus isolated from the stool specimen of the same patient but failed to agglutinate with the serum collected from healthy people (Lampel et al., 2018). The organism was later named Shigella dysentery type 1. Simon Flexner, in 1898 isolated a bacillus from dysentery patients in two US Army soldiers, which was similar to the Shiga bacillus, but it failed to agglutinate the serum of Shigella dysentery patients, so this organism was named called variola virus, which in the Latin language means pustule and is probably derived from the word Varus which means pimple (Männikkö, 2011b).

The Chickenpox virus was once considered a milder presentation of smallpox. One hypothesis about its terminology suggests that the disease's milder intensity was probably coward to express itself as smallpox and hence chickenpox. The alternate theory suggests that the old English word for itch was “Giccan,” while in the middle English word, it was called “Icchen” (Sirni 2014). So, the phrase chickenpox might have been derived from these older English words as Giccanpox or Icchenpox. Another assumption is that chickenpox lesions resemble chickenpeas and hence derive its name. A similar sonant virus name Chikungunya is usually associated with non-eruptive illness. The word Chikungunya is from Makonde, northern Mozambique, and southeast Tanzania, which translates as “that which bends up.” This reflects the stooped posture resulting from painful arthritis seen in this disease (Schwartz et al., 2014).

3.3. Eponyms

During the golden era of microbiology, there was a practice of specifying the microbes’ nomenclature to the scientist's name who discovered it or worked on it. There was a race among the scientists to lead the discovery of a causative organism of a particular infectious disease and publish the results in the scientific journal. During a deadly outbreak of plague in June 1894 in Hong Kong, two teams from rival institutes arrived to investigate the cause of the plague. The first to arrive was the Japanese team from Robert Koch Institute headed by Shibasaburo Kitasato, while the second was the French team from Pasteur Institute led by Alexender Yersin. Despite the government’s full support to the Japanese team, Shibasaburo Kitasato’s work lacked focus. Wrong specimens were drawn for isolation of causative organism, conclusions were drawn in haste, while the description of the causative organism of plague was inaccurate and confusing.

On the other hand, Alexender Yersin focused his work on isolating the organism from the buboes of the deceased patients. His description was correct, comprehensive, and backed by the Pasteur Institute (Butler 2014). However, the isolated organism was initially named Bacterium pestis, changing to Bacillus pestis, then Pasteurella pestis. Finally, the services of Alexender Yersin were acknowledged posthumously, and the bacillus was named Yersinia pestis.

Klebsiella was first described by Carl Friedländer in 1882 in a patient who died of pneumonia, and for a few years, it was called Friedländer’s bacillus. In 1885, Trevisan devised the genus name Klebsiella in honor of German physician Edwin Klebs, who, although did not work on this bacterium, his services in microbiology were great. Edwin Kleb's main work was related to Corynebacterium diphtheriae which he, along with Friedrich August Johannes Löffler, discovered as the cause of diphtheria. The Corynebacterium diphtheriae was initially called KLB (Klebs Löffler Bacillus).
Flexner's bacilli and later *Shigella flexneri*. Subsequently, Carl Sonne in 1915 in Denmark and Major J.S.K. Boyd of the British Royal Army Medical Corps in 1929 in India isolated new species of Shigella that were later named *Shigella sonnei* and *Shigella boydii*, respectively.

A German-Austrian pediatrician named Theodor Escherich worked on the infants' fecal samples and isolated many bacteria. He proposed the name *Bacterium coli commune* for a motile, Gram-negative gas-producing bacillus. This was later named *Escherichia coli* (Minodier 2011). He did isolate a bacterium from infants’ stool samples suffering from dysentery but discarded it as a contaminant because those organisms did not produce gas in carbohydrate media. It is speculated that the organism he isolated was most likely Shigella, and had he probed further, one wonders that the name of Shigella might have been Escherichia today.

David Bruce was an Australian-borne British doctor who joined Royal Army Medical Corps in 1884 as a pathologist. When he was stationed at Valletta, Malta, there was an outbreak of fever among British soldiers called Malta fever. He was appointed as the head of the commission to investigate the cause of Malta fever. The commission isolated an organism from the British soldiers that was called *Micrococcus melitensis* and later *Brucella melitensis*. The commission also established the link of this bacterium with unpasteurized goat milk. In 1993, he investigated sleeping sickness in Africa and identified *Trypanosoma* as the cause of illness and tsetse fly as a disease vector. The protozoan was named *Trypanosoma brucei* after his name.

The first successful launch of a commercial steamboat is credited to Robert Fulton, an American engineer, who in 1807 traveled on his steamboat carrying passengers on Hudson River (Hartenberg 2022). An Italian Monk, Serafino Serrati, in 1795 ran the world’s first steamboat on Arno River, but his scientific discovery was largely ignored in his lifetime. Serrata bacteria was discovered in Italy in 1819. An Italian pharmacist working on the pigment of this bacterium named it Serratia to highlight the world of his countryman’s scientific work on steamboat (Nazzaro 2019).

Table 3 shows the list of eponyms for common microbes.

### Table 3: Eponyms and etymological comments for some common microorganisms

| S. No. | Microbial nomenclature | Name of Scientist/Person | Comment |
|--------|------------------------|--------------------------|---------|
| 1      | C. freundii           | A. Freund                 | The species name was credited to microbiologist A. Freund who first discovered the fermentation product trimethylene glycol. |
| 2      | Salmonella             | Daniel Elmer Salmon       | Salmonella was named after USA veterinary doctor Daniel Elmer Salmon for his services in veterinary microbiology. His research assistant Theobald Smith in 1885, first isolated Salmonella choleraesuis. |
| 3      | Burkholderia           | Walter Burkholder         | Walter Burkholder, a USA plant pathologist, isolated an organism from onion bulb rot disease in 1906, which he named *Pseudomonas cepacia*, that later was named *Burkholderia cepacia*. |
| 4      | Acinetobacter baumanii | Prof. Paul and Linda Baumann | Prof. Paul and his wife Linda Baumann first isolated the bacterium in 1968, now called *Acinetobacter baumanii*. |
| 5      | Bordetella             | Jules Bordet              | A Belgium immunologist Jules Bordet and his brother-in-law Octave Gengou successfully isolated the bacterium in 1906 from the sputum specimen of his son suffering from whooping cough. |
| 6      | Neisseria              | Albert Ludwig Sigsmund Neisser | A German physician working as a dermatologist discovered the causative agent of gonorrhea in 1879. Also, he co-discovered the agent of Leprosy with Gerhard Armauer Hansen. |
| 7      | Gardnerella            | Hermann L. Gardner        | An American bacteriologist isolated this bacterium in 1955 from vaginal samples of women suffering from vaginitis. He named it *Haemophilus vaginalis* which was later changed to *Gardnerella vaginalis* in his honor in 1984. |
| 8      | Borrelia burgdorferi   | Amédée Borrel & Willy Burgdorfer | Dr. Willy Burgdorfer, an American zoologist/microbiologist, identified spirochetes in *Ixodes* ticks and established the cause of Lyme disease in 1982. Amédée Borrel was a French cytopathologist who studied spirochetes and wrote papers on their classification based on morphology. A Dutch bacteriologist named the borrelia genus in 1907 for Amédée Borrel's work on the classification of spirochetes. |
| 9      | Rickettsia prowazekii  | Howard Taylor Ricketts, Stanislaus von Prowazek | A Brazilian microbiologist da Rocha-Lima in his publication in 1916, used the term Rickettsia prowazekii to honor the work of American pathologist Howard Taylor Ricketts who died of typhus in 1910 while doing his research, and his colleague Stanislaus von Prowazek who also died of epidemic typhus in 1915 while studying typhus outbreak in Germany prison hospital. |
| 10     | Coxiella burnetii      | H.R. Cox, Frank MacFarlane Burnet | Australian virologist Frank MacFarlane Burnet worked on this organism and contracted the illness. He isolated this organism from a patient in 1937, while H.R. Cox, an American bacteriologist, isolated this organism from ticks in 1938. |
| 11     | Epstein-Barr virus     | Michael A. Epstein & Y. M. Barr | Michael Anthony Epstein—a British pathologist isolated and grew a virus on cell lines and identified it as the cause of Epstein-Barr virus in 1964. His colleague Yvonne Barr in 1963 from a sample of a patient with Burkitt lymphoma from Uganda isolated the virus. |
| 12     | BK virus               | A Sudanese patient        | The initial of a 28-year-old patient from which the virus was first isolated in 1971. |
| 13     | JC virus               | John Cunningham           | The virus was isolated from John Cunningham, suffering from progressive multifocal leuкоencephalopathy in 1972. |
| 14     | Sporothrix schenckii   | Benjamin Schenck          | An American medical student at John Hopkins hospital isolated fungus from a patient's hand in 1896. |
| 15     | Pneumocystis jirovecii | Prof. Otto Jirovec        | A Czechoslovak scientist who, in 1953, first discovered this organism as a cause of pulmonary disease. |
| 16     | Giardia lamblia        | Prof. A. Giard & Dr. F. Lamb | Prof. A. Giard was a French biologist who, in 1882, described flagellated protozoa as the cause of common diarrheal illness. Vilém Dušan Lambi was a Czech physician who, in 1859, first published the microscopic drawing of this parasite from the stool sample of a child. |
| 17     | Leishmania donovani    | Sir W.B. Leishman & Charles Donovan | A British Royal Army Pathologist, Sir W.B. Leishman, in 1903, while examining spleen specimens of kala-azar patients in India, found oval bodies of protozoa. Similar protozoal structures were also described independently by Charles Donovan in kala-azar patients in India. |
| 18     | Naegleria fowleri      | F.P.O. Nagler & Malcolm Fowler | Austrian bacteriologist F.P.O. Nagler first described the life cycle of *Naegleria fowleri* in 1914. In 1970, first isolated the microbe from the brain tissue of a patient with encephalitis. |
| 19     | Schistosoma mansoni    | Sir Patrick Manson        | A Scottish physician is credited with describing many infectious parasitic diseases, namely Mansonella perstans, Mansonia ozzardi, Schistosoma mansoni, and many more. |
humans to differentiate from *Cryptosporidium parvum* that is a zoonosis (Giles et al., 2009). This is in contrast to *Toxoplasma gondii*, which was first isolated from a rodent Ctenodactylus gundi. However, species names of many microbes were designated on the human body anatomical organs from where these are regularly found or cause disease. Examples include *Escherichia coli* (colon), *Ancylostoma duodenale* (duodenum), *Campylobacter jejuni* (jejunum), *Helicobacter pylori* (pylorus of the stomach), *Gardnerella vaginalis*, and *Trichomonas vaginalis* (vagina). In the case of *Entero- coccus faecalis* and *Enterococcus faecium*, the species name faecalis and faecium both signify feces—the specimen which harbors it most. *Strongyloides stercoralis* was first isolated from the stool samples of soldiers with diarrhea returning from Vietnam. The Latin word stercus means excrement/ dung, and the name was designated because it was observed in the feces of those infected with this worm.

*Staphylococcus epidermitidis* is predominantly found on skin epidermis, hence the species’ name. In contrast, the other species saprophyticus is named so as it was found to be growing on dead and decaying matter. The isolation of *Streptococcus pyogenes* from the pus specimen resulted in naming this organism. First isolated from onions inflicted by onion rot plant disease, *Burkholderia cepacia* (onion) was named so (Burkholder 1950), although this organism is an important cause of lung infection in cystic fibrosis patients. One species of *Brucella* was commonly contracted from pigs, and the organism was named *Brucella suis* due to this association. A similar association is speculated for calling the organism *Toxoplasma gondii,* where the word soillium in the old Latin language also means pig-related. The other etymological association of this parasite is discussed elsewhere in this article.

One organism deserves narration from a historical perspective. *Legionella pneumophila* was first isolated among patients attending the American Legion convention in Philadelphia in 1976 (Winn, 1988). The pneumonia outbreak occurred in older soldiers who participated in the convention, and the disease was called a mystery illness at that time. However, the investigations pointed out colonization of cooling towers of the air conditioning system of Bellevue Stratford Hotel by *Legionella pneumophila* that started the outbreak.

### 3.5. Toponym

Genus or species of some microbes are named so in relation to the place from where these were first discovered or geographic location where these microbes were once/ are still endemic. The *Vibrio cholerae* biotype ElTor was first isolated from the pilgrims returning from Makkah near Al Tur Sinai Egypt in 1905 (Chastel 2007). The new strain was named *Vibrio cholerae* ElTor because it was a different biotype from the earlier prevalent classic one. Similarly, in 1883, Robert Koch, working in the German Cholera Commission in Egypt, identified a bacterium responsible for Egyptian eye disease (Acute hemorrhagic conjunctivitis), later named *Haemophilus aegyptius*. The Latin word aegyptius means “pertaining to Egypt.”

Certain viruses that cause outbreaks are named after the location where these were first isolated. For example, the Zaire Ebola virus disease was first noticed in an outbreak in Yambuku, Democratic Republic of Congo, in 1976 near a village along the Ebola River. Similarly, in 1947, while researching sylvatic yellow fever disease in Ziao forests in Uganda, a virus was accidentally discovered in a febrile rhesus monkey (Gubler et al., 2017). Later, this virus was linked to the outbreak of microencephaly and anencephaly in babies born to pregnant ladies infected with this virus. The virus was named Zia virus after its place of discovery.

### Table 4

| S. No. | Microbial nomenclature | Geographic location | Brief description of the topographic relationship |
|-------|------------------------|---------------------|-----------------------------------------------|
| 1     | Marburg virus          | Marburg, Germany    | In 1967, an outbreak of viral hemorrhagic fever in Marburg affected 30 individuals, including a veterinarian who had contact with the tissues of a sick monkey (Slenczka and Klenk 2007). |
| 2     | St. Louis Enterobacteriaceae virus | St. Louis, Missouri | In 1933, a massive outbreak of encephalitis with high mortality occurred in St. Louis, Missouri, and surrounding counties (Luby 1979). |
| 3     | Coxsackievirus         | Coxsackie, New York | While investigating suspected poliomyelitis outbreak, the virus was discovered in 1947 at a small town called Coxsackie on the Hudson River, Greene County, NY. |
| 4     | Brucella melitensis    | Latin word melitensis means “From Malta” | The species name denotes the place from where the organism was first found, i.e., the island of Malta (Melita). |
| 5     | Francisella tularensis | Tulare, California  | In 1911, two researchers discovered the bacterium at Tulare County, California Männikkö, 2011a |
| 6     | Schistosoma japonicum | Japan               | This parasite was once endemic in Katayama district, Hiroshima, Japan. Katayama fever was another name for this disease. |
| 7     | Schistosoma mekongi    | Mekong river basin  | The first case of schistosomiasis was discovered along the Mekong River lower basin stretching from Lao to Cambodia. |
| 8     | Mycobacterium africanum | Africa            | A predominant species that causes almost 40% of pulmonary tuberculosis cases in West African countries |
| 9     | Mycobacterium kansasii | Kansas             | In 1952, the pathogen was first isolated from two patients with chronic tuberculosis-like disease at Kansas City General Hospital, Kansas, Missouri. |
| 10    | Leishmania braziliensis | Brazil            | Isolation of Leishmania parasite from patients in the state of São Paulo, Brazil, in 1909. |
| 11    | Trypanosoma brucei Rhodesian | Rhodesia (Zambia) | The specie was isolated in 1909 from the blood of an Englishman in Zambia (“Rhodesia”) (Baker 1995). |
| 12    | Trypanosoma brucei Gambians | Gambia          | The specie was isolated from the blood sample of an Englishman in 1901 in the Gambia. |
| 13    | Necator americanus     | United States      | Predominant hookworm disease in the United States |
| 14    | Clonorchis sinensis    | Sinensis in Latin means “From China.” | Predominant liver fluke found in China |
| 15    | Brugia malayi          | Malay Archipelago  | First isolated from the Malay Archipelago, which consists of the world’s largest islands between the Indian ocean and Pacific Ocean (Islands of Indonesia, Philippines, Sumatra, New Guinea, etc.) |
| 16    | Dracunculus medinensis | Related to Madina, KSA | The disease was once endemic in the Holy city of Madina, KSA. |
The bacteria belonging to the genus Providencia are Gram-negative urease-positive pathogens that are an important cause of urinary tract and healthcare-associated infections. This bacterium was named to delineate Brown University in Providence, Rhode Island, United States, where Stuart et al. in 1951 did research on this and related microbes (Charbæk 2019). Table 4 enlist toponyms of some common microorganisms with brief etymological descriptions.

4. Conclusions

The nomenclature of infectious diseases and their causative microorganisms reflects a continuum of understanding of human-kind, from once a mysterious unseen wrath of the demons to the current scientific illumination is not of short span but stretches around many millennia or probably the history of humanity itself. The microbes’ names reflect the failure and success stories of the scientists and the efforts they put in to bring forth the hidden world of microbes and save humankind from the horrors of the infectious diseases of the past.

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