Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
HISTORICAL PERSPECTIVE

Microbial Nomenclature: A List of Names and Origins

Stephen A. Berger and Stephen C. Edberg

Microbial nomenclature underwent a large number of changes in the 1970s. Many species of pathogens were added and many others experienced name changes. These modifications primarily were due to two unrelated factors: the use of new DNA hybridization techniques and the advent of computerized literature searches to establish historical precedence. In 1980 an approved list of microbial names was published. This list fixed and legitimized bacterial nomenclature. All future additions or alterations to it had to pass international scientific committees. This list has now been accepted by the scientific community. The derivation of these names are presented in this review.

In the 1970s many species names of microbial pathogens were added and many others experienced nomenclature changes (Brenner, 1983; Stafleu et al., 1972). In part, the impetus for these changes came from new molecular DNA hybridization techniques. Other changes were the result of literature searches that uncovered earlier mention of bacterial pathogens. Historical precedence required reversion to the original name. The large number of such changes caused considerable consternation for both clinicians and medical microbiologists. To establish order, an approved list of bacterial names was published in 1980 (Skerman et al.). This code legitimized the names of bacteria and established a strict scientific mechanism to institute any changes. One could no longer alter a name based on historical precedence alone. The approved list has now been accepted by the scientific community. The purpose of this review is to present the legitimate names of human pathogens and to briefly recount the procedure that resulted in the approved list and the derivation of such names.

More than 200 years ago, Linnaeus (1758) suggested a system of binomial nomenclature for animal and plants. He established the concept of taxonomy based on genus and species. The genus name denoted a cluster having major characteristics in common; a species denoted a group able to reproduce within itself, but not with other groups.

The nomenclature of pathogenic microorganisms began with the acceptance of the Germ Theory in the 1860s, and the ability in the 1880s to grow microbes in vitro and in pure culture. Unlike organisms previously classified according to Linnean concepts, pathogenic bacteria did not have a true nucleus and reproduced asexually. Separation and establishment of species status commonly was based on macroscopic...
### TABLE 1. Bacterial Taxa Derived from Surnames

| Genera       | Named after (ref. no.) | Species      | Named after (ref. no.) |
|--------------|------------------------|--------------|------------------------|
| Bartonella   | AL Barton (73)         | beijerinckii | MW Beijerinck (18)     |
| Bordetella   | J Bordet (54)          | boydii       | Sir John Boyd (23)     |
| Borrelia     | AE Borrel (74)         | bozemanii    | FM Bozeman (6)         |
| Brachymella  | SE Bracham (13)        | burnettii    | FM Burnett (62)        |
| Brucella     | Sir David Bruce (51)   | conorii      | A Conor (8)            |
| Coxiella     | HR Cox (62)            | ducreyi      | A Ducrey (57)          |
| Edwardsiella | PR Edwards (22)        | duttonii     | JE Dutton (60)         |
| Escherichia  | T Escherich (12)       | flexneri     | S Flexner (11)         |
| Francisella  | E Francis (19)         | freundii     | A Freund (4)           |
| Gardnerella  | HL Gardner (24)        | harveyi      | AEG Harvey (25)        |
| Klebsiella   | E Klebs (52)           | israelii     | J Israel (44)          |
| Listeria     | Lord Lister (64)       | jensenii     | S Orla-Jensen (82)     |
| Moraxella    | V Morax (49)           | lignieresii  | J Lignieres (7)        |
| Neisseria    | A Neisser (52)         | lwoffi       | A Lwoff (1)            |
| Nocardia     | E. Nocard (78)         | mazzottii    | L Mazzotti (17)        |
| Pasteurella  | L Pasteur (79)         | midadai      | JE McDade (40)         |
| Rickettsia   | HT Ricketts (86)       | morganii     | H de R. Morgan (85)    |
| Rochalimaeae | H da Rocha-Lima (43)   | naeslundii   | C Naeslund (75)        |
| Rothia       | GC Roth (27)           | novyi        | FG Novy (52)           |
| Salmonella   | DE Salmon (52)         | parkeri      | R Parker (72)          |
| Serratia     | S Serrati (3)          | prausnitizii | C Prausnitiz (65)      |
| Shigella     | K Shiga (11)           | prowazeki    | S von Prowazek (16)    |
| Veillonella  | A Veillon (66)         | retgeri      | LF Retger (69)         |
| Yersinia     | AJE Yersin (81)        | rickettsiae  | HT Ricketts (63)       |
|              |                        | russii       | VR Russ (53)           |
|              |                        | sonnei       | C Sonne (45)           |
|              |                        | sordellii    | A Sordelli (36)        |
|              |                        | stutzeri     | A Stutzer (16)         |
|              |                        | vincenti     | H Vincent (74)         |

### TABLE 2. Other Sources of Bacterial Names

| Genus or Species       | Literal translation or derivation |
|------------------------|----------------------------------|
| **FOODS**              |                                  |
| botulinum cepacia      | A small sausage-like onion       |
| Lactobacillus          | Milk rodlet                      |
| maltophilia            | Friend of malt                   |
| Staphylococcus         | Grape coccus                     |
| **GEOGRAPHY**          |                                  |
| africanum              | African                           |
| arizonae               | Arizona                           |
| australis              | "Southern"                       |
| brasiliensis           | Brazil                            |
| canada                 | Canada                            |
### TABLE 2. (Continued)

| Genus or Species | Literal translation or derivation |
|------------------|----------------------------------|
| **caucasica**    | Caucasas                         |
| **Hafnia**       | Old name for Copenhagen          |
| **hispanica**    | Spain                            |
| **kanssi**       | Kansas                           |
| **melitensis**   | Pertaining to Malta              |
| **osloensis**    | Oslo                             |
| **persica**      | Persian                          |
| **siberica**     | Siberia                          |
| **tularensis**   | Tulare County, California        |
| **venezuelensis**| Venezuela                        |
| **agalactiae**   | Produces bovine mastitis         |
| **akari**        | A mite                           |
| **bovis**        | Of the ox                        |
| **canis**        | Dog                              |
| **chelonei**     | Of a tortoise                    |
| **hermsii**      | O. hermsi (tick vector)          |
| **hominis**      | Of man                           |
| **multocida**    | Many killing (pathogenic for many species) |
| **rhusiopathiae**| Of red disease (swine erysipelas) |
| **suis**         | Pig                              |
| **tsutsugamushi**| “A small and dangerous animal” (mite vector) |
| **turcatae**     | O. turcata (tick vector)         |
| **xenopei**      | A genus of toad (Xenopus)        |

### ORGANS, TISSUES OR EXCRETIONS

| Genus or Species | Description |
|------------------|-------------|
| **Cardiobacterium** | Bacterium of the heart |
| **coli** | Colon |
| **denticola** | Tooth dweller |
| **Enterobacter** | Intestinal small rod |
| **enterocolitica** | Pertaining to the intestine and colon |
| **epidermidis** | Epidermidis |
| **faecium** | Of feces |
| **faecalis** | Pertaining to feces |
| **fetus** | Fetus |
| **macrodentium** | Of large teeth |
| **orale** | Oral cavity |
| **oralis** | Oral cavity |
| **rectale** | Rectum |
| **ruminocola** | Rumen |
| **sanguis** | Blood |
| **sputorum** | Lungs, bronchial tree |
| **vaginalis** | Vagina |

### MISCELLANEOUS

| Genus or Species | Description |
|------------------|-------------|
| **Eubacterium** | True bacterium |
| **fortuitum** | Casual, accidental |
| **hydrophila** | Water loving |
| **Legionella** | The American Legion |
| **marcescens** | “Fading away” |
| **marinum** | Marine |
| **vulgaris** | Common |
parameters. The names of most microbial pathogens were published between 1870 and 1900, and are based on gross descriptive characteristics (Winslow et al., 1920; Winslow et al., 1917; Winslow et al. 1919).

Modern nomenclature was derived predominantly from directly visualized phenomena or from the names of individuals. Personal surnames have been applied in latinized form in order to memorialize the person who either discovered or described the organism first (Table 1). Often, a pathogen was named to honor an important researcher in a related field. The process of adapting names to the Linnean form occasionally has obscured the original spelling of the honored individual (e.g., McDade as micdadei and daRocha-Lima as Rochalimaea) (Vallery-Radat Pasteur, 1922). In at least one instance, the name of a person unrelated to biology was chosen. Serratia was named to honor Serafino Serrati because it was felt this early inventor of the steamboat concept had not received sufficient recognition (Bizio, 1823).

Geographic names (Table 2) reflect the area in which the organism was either described or found in endemic or epidemic form. Nomenclature also has been based on vector, host, and resemblance to foods or inanimate objects (Tables 2 and 3). The most clinically relevant terms were derived from a disease process or histopathologic finding (Table 4). In some instances, taxonomy is confusing because the original association of a microbial isolate with a disease subsequently has been proven incorrect. For example, Haemophilus influenzae initially was assumed to be the cause of influenza (Pfeiffer, 1892). Potentially confusing prefixes also have been applied to microbial names. Thus, the name “Eubacterium” implied a “true bacterium” and “Mycobacterium” denoted a “fungus-like bacterium.”

Names that reflect laboratory phenomena and morphology frequently have been utilized (Table 5). Gross and microscopic morphology of the fungi (Table 6) and the parasites (Table 7) are based predominantly on the shape, texture, etc. of these organisms. Fungi and parasites generally are still identified on the basis of such criteria.

In the 1960s a concerted effort was made to conform viral nomenclature to the genus and species principle. The majority of viral names reflect disease entities (e.g., poliovirus, mumps virus) or original place of isolation (e.g., Marburg virus, Coxsackie virus). Since the widespread utilization of cell cultures, cytopathologic names have been utilized (e.g., cytomegalovirus, respiratory syncytial virus). With the exception of the Epstein–Barr virus (Epstein et al., 1964), viral taxonomy rarely has been assigned personal surnames (Table 8).

The naming of microbial pathogens has paralleled the increasing sophistication of laboratory analysis. In the late 1800s characteristics such as size, shape, color, and disease entity were utilized. Morphology remains the first step in the identification process. For example, the definition of the name Staphylococcus aureus, (a “golden colored cluster of grapes”) is the primary step in the algorithm to identify this pathogen.

Because many species share gross similar features, the use of enzymatic biochemical tests became preeminent in the 1920s and 1930s. These tests detect a particular enzyme after growth in a defined milieu. The presence or absence of an enzyme system allowed laboratories to perform large numbers of tests on a single isolate. They could also compare results and exchange tests. Such phenotypic tests helped to overcome the inherent problem of species definition in asexual organisms by grouping pathogens based on stable, measureable characteristics. A large number of microbial isolates tested with multiple substrates could now be separated into groups. Nomenclature became a process of answering a series of “yes or no” questions, which microbiologists termed “positive” and “negative.” Algorithms were developed to generate uniform identification schema. When some characteristics were found to be more important than others, various mathematical and statistical analyses were added to such decision trees (Jones and Sackin, 1980).
| Genus or Species           | Literal translation or derivation                     |
|---------------------------|-------------------------------------------------------|
| **Actinobacillus**        | Ray rod                                               |
| **Arachnia**              | A cob web                                             |
| **Bacillus**              | A small rod                                           |
| **Calymmatobacterium**    | The sheathed rodlet                                   |
| **Campylobacter**         | A curved rod                                          |
| **Clostridium**           | A small spindle                                       |
| **Corynebacterium**       | Club bacterium                                        |
| **Erysipelothrix**        | Thread of erysipelas                                  |
| **Leptospira**            | A fine coil                                           |
| **Pseudomonas**           | False unit                                            |
| **Spirillum**             | A small spiral                                        |
| **Streptobacillus**       | A pliant small rod                                    |
| **Treponema**             | A turning thread                                      |
| **alvei**                 | Of a beehive                                          |
| **bacilliformis**         | Rodlet shaped                                         |
| **cloacae**               | Of a sewer                                            |
| **clostridiiformis**      | In the form of a small spindle                        |
| **interrogans**           | Shaped like a question mark                           |
| **moniliformis**          | Necklace shaped                                       |
| **Actinomyces**           | Ray fungus                                            |
| **Bifidobacterium**       | Cleft small rod                                       |
| **Chromobacterium**       | A colored small rod                                   |
| **Flavobacterium**        | A yellow small rod                                    |
| **Fusobacterium**         | Spindle shaped small rod                              |
| **Mycobactrium**          | Fungus small rod                                      |
| **Proteus**               | A God able to transform to many shapes                |
| **Streptococcus**         | Pliant fungus                                         |
| **aeruginosa**            | Having the color verdigris                            |
|                           | (green-blue poison)                                   |
| **aureus**                | Golden                                                |
| **biacutus**              | Two pointed                                           |
| **bullosum**              | Knobbed                                               |
| **cereus**                | Wax colored                                           |
| **contortum**             | Twisted                                               |
| **diminuta**              | Minute                                                |
| **flavescens**            | Becoming yellow                                       |
| **furcosus**              | Forked                                                |
| **lanceolatus**           | Lancet shaped                                         |
| **minor**                 | Smaller                                               |
| **mucosa**                | Slimy                                                 |
| **naviforme**             | In the shape of a ship                                 |
| **nucleatum**             | Nucleated                                             |
| **pallidum**              | Pale                                                  |
| **parvula**               | Very small                                            |
| **perfoetens**            | Very stinking                                         |
| **perteneue**             | Slender                                               |
| **pneumosintes**          | Breath destroying                                     |
| **precutus**              | Quite sharp                                           |
| **putida**                | Stinking                                              |
| **ramosum**               | Much branched                                         |
| **salivarius**            | Slimy                                                 |
| **sphenoides**            | Wedge shaped                                          |
| **subflava**              | Yellowish                                             |
| **tortuosum**             | Full of windings                                      |
| **ventriosum**            | Pot bellied                                           |
| **violaceum**             | Violet colored                                        |
| Species             | Translation or derivation                                      |
|---------------------|----------------------------------------------------------------|
| abortus             | Abortion                                                       |
| acnes               | Acne, eruption                                                 |
| anginosus           | Pertaining to angina (pharyngitis)                             |
| anthracis           | Charcoal carbuncle                                             |
| bronchiseptica      | Infected bronchus                                              |
| carateum            | Bean (pinta)                                                   |
| catarrhalis         | Flowing                                                        |
| choleae             | Bilious disease                                                |
| dencocariosa        | Decayed teeth                                                  |
| diphertheriae       | Piece of leather                                               |
| dysenteriae         | Intestinal                                                    |
| gonorrhoeae         | Effusive, effluent                                             |
| granulomatis        | Granuloma, granular                                            |
| histolyticum        | Tissue dissolving                                              |
| influenzae          | Influence of the stars                                         |
| innocum             | Harmless                                                       |
| intracellulare      | Intracellular                                                  |
| mallei              | Of glands                                                      |
| meningitidis        | Inflammation of the meninges                                   |
| meningosepticum     | Associated with sepsis and meningitis                          |
| mitis               | Mild                                                           |
| monocytogenes       | Monocytosis-producing (in rabbits)                             |
| mortiferum          | Death-bearing                                                  |
| necrophorum         | Necrosis-bearing                                               |
| odontolyticus       | Tooth-dissolving                                               |
| ozaenae             | Smelling, odoriferous                                          |
| perfringens         | Breaking through                                               |
| pestis              | Pestilence                                                     |
| pertussis           | Thoroughly                                                     |
| pneumoniae          | Breathing                                                      |
| pneumophila         | Lung loving                                                    |
| pneumotropica       | Having affinity for the lungs                                  |
| pseudomallei        | False glands                                                   |
| pseudotuberculosis  | False swelling                                                  |
| putredinin          | Putrid                                                         |
| quintana            | Fifth (5-day fever, another name for Q fever)                   |
| recurrentis         | Recurring                                                      |
| rhinoscleromatis    | Nose destroying                                                |
| scrofulaceum        | Swellings                                                      |
| septicum            | Separate                                                       |
| tetani              | Stretched, rigid                                               |
| tuberculosis        | Tumor, swelling                                                |
| typhi               | Blind                                                          |
| ulcerans            | Ulcer                                                          |
| xerosis             | Dry                                                            |
### TABLE 5. Bacterial Name Reflecting In Vitro Behavior or Colonial Morphology

| Genus or Species            | Literal translation                                           |
|-----------------------------|---------------------------------------------------------------|
| Acidiminococcus             | Amino acid coccus                                            |
| Acinetobacter               | Nonmotile rod                                                |
| Aeromonas                   | Gas producing unit                                           |
| Alcaligenes                 | Alkalai producing                                            |
| Citrobacter                 | Citrate using rod                                            |
| Haemophilus                 | Blood loving                                                 |
| Peptococcus                 | Digesting coccus                                             |
| Peptostreptococcus          | Digesting streptococcus                                      |
| Plesiomonas                 | Neighbor unit (to be differentiated from Aeromonas)           |
| Proprionobacterium          | Prorprionic acid bacterium                                   |
| Vibrio                      | That which vibrates                                          |
| acidovorans                 | Acid devouring                                               |
| activus                     | Active                                                       |
| aerofaciens                 | Gas producing                                               |
| aerogenes                   | Gas producing                                               |
| alactolyticum               | Nonmilk digesting                                             |
| alcalescens                 | Alkalai making                                               |
| anaerobius                  | Anaerobic                                                    |
| aphrophilus                 | Foam loving                                                  |
| asaccharolyticus            | Not digesting sugar                                          |
| asteroides                  | Star-like                                                    |
| avidum                      | Voracious                                                    |
| calcoaceticus               | Calcium acetate (used in enrichment)                         |
| capillosus                  | Very hairy                                                   |
| coagulans                   | Curdling                                                     |
| constellatus                | Studded with stars                                           |
| corrodenes                  | Gnawing                                                      |
| difficile                   | Difficult                                                    |
| equisimilis                 | Ressembling Streptococcus equi                               |
| fermentans                  | Fermenting                                                   |
| fragilis                    | Fragile                                                      |
| glutinosum                  | Glutinous                                                    |
| granulosum                  | Granular                                                     |
| haemolyticus                | Hemolytic                                                    |
| indolis                     | Pertaining to indole                                         |
| lacunata                    | Pitted                                                       |
| lentum                      | Slow                                                         |
| limosum                     | Slimy                                                        |
| melaninogenicus             | Melanin producing                                            |
| nitrogenes                  | Nitrite producing                                            |
| nonliquifaciens             | Not liquifying                                               |
| phenylpyruvica              | Deaminates phenylalanine                                     |
| pseudoalcaligines           | False alkalai producing                                      |
| pseudotetanicum             | False tetani (resembles Clostridium tetani)                  |
| saprophyticus               | Saprophytic                                                  |
| serpens                     | Creeping                                                     |
| shigelloides                | Shigella-like (some strains share a common O antigen with Shigella sonnei) |
| sicca                       | Dry                                                          |
| Sporogenes                  | Spore producing                                             |
| tarda                        | Slow (inactive)                                              |
### TABLE 6. Derivation of Fungal Genus Names (15)

| Genera          | Translation or derivation                          |
|-----------------|----------------------------------------------------|
| Aspergillus     | A sprinkler                                        |
| Blastomyces     | Germ fungus                                        |
| Candida         | Dazzling white                                     |
| Cladosporium    | Branch seed                                        |
| Coccioides      | Resembling a little berry                          |
| Cryptococcus    | Hidden coccus                                      |
| Epidermophyton  | Outer skin plant                                   |
| Fonsecaea       | O Fonseca Filho                                   |
| Fusarium        | Spindle                                            |
| Geotrichium     | Earth hair                                         |
| Histoplasma     | Web formed                                         |
| Malassezia      | LC Malassez                                        |
| Microsporum     | Small seed                                         |
| Monilia         | Necklace                                           |
| Mucor           | Mold                                               |
| Penicillium     | Paint brush                                        |
| Phialophora     | Bowl carrier                                       |
| Pityrosporium   | Bran seed                                          |
| Rhinosporidium  | Little nose seed                                   |
| Sporothrix      | Seed hair                                          |
| Torulopsis      | Little knot form                                   |
| Trichophyton    | Hair plant                                         |

### TABLE 7. Derivation of Parasite Taxa \(^a\) (59)

| Genera              | Species     | Translation or Derivation       |
|---------------------|-------------|---------------------------------|
| Acanthocheilonema   |             | Spine lip thread                |
| Ancylostoma         |             | Hook mouth                      |
| Angiostrongylus     |             | Round vessel                    |
| Ascaris             | lumbricoides| Helminth                        |
| Babesia             | microti     | Worm-like                       |
| Babesia             | Field vole  | V Babes                         |
| Babesia             | (microtus)  |                                 |
| Balantidium         |             | A small bag                     |
| Brugia              |             | SL Brug                         |
| Capillaria          |             | Hair                            |
| Chilomastix         | mesnili     | Whip lip                        |
| Clonorchis          |             | Branched testis                 |
| Dicrocoelium        |             | Double cavity                   |
| Dicrocoelium        |             | Tubercle swelling               |
| Diplostophyuma      |             | Twice-leaved groove             |
| Diphyllbothrium     | latum       | Broad                           |
| Dipylidium          |             | Two gate                        |
| Dirofilaria         |             | Dreaded thread                  |
| Drancunculus        |             | Dragon                          |
| Echinococcus        | granulosis  | Spine berry                     |
| Echinostoma         |             | Mass of granules                |
| Eimeria             |             | Spine mouth                     |
| Endolimax           | nana        | T Eimer                         |
| Entamoeba           | histolytica | Change (of shape) within        |
| Enterobius \(^b\)   |             | Tissue dissolving               |
|                     |             | Intestinal life                 |

350
| Genera          | Species     | Translation or Derivation       |
|----------------|-------------|---------------------------------|
| Fasciola       | vermicularis| Little worm                     |
| Fasciolopsis   |             | A fillet                        |
| Giardia        |             | Fasciola-resembling             |
| Gnathostoma    | lamblia     | A Giard                         |
| Gongylonema    |             | F Lambli                        |
| Heterophyes    |             | Round thread                    |
| Hymenolepis    |             | Different shape                 |
|                | nana        | Membrane shell                  |
| Iodameba       |             | Iodine amoeba                   |
| Isospora       | butchli     | Equal shape                     |
| Leishmania     | belli       | Sir William Leishman            |
| Loa            | donovani    | C Donovan                       |
| Metagonimus    | yokogawi    | Posterior genitalia             |
| Mansonella     |             | M Yokogawa                      |
| Multiceps      |             | Sir Patrick Manson             |
| Necator        |             | Many headed                     |
| Onchocerca     | volvulus    | Killer                          |
|                |             | Hook tail                       |
| opisthorchis   |             | Rolled                          |
| Oxyuris        |             | Posterior testis                |
| Paragonimus    |             | Sharp tail                      |
| Plasmodium     | falciparum  | Side-by-side testis             |
|                | vivax       | Formed material                 |
|                | ovale       | Shape of a sickle               |
|                | malariae    | Long-lived                      |
| Pneumocystis   | carinii     | From excrement                  |
| Sarcocystis    |             | Bad air (from disease malaria)  |
| Schistosoma    | mansonii    | Marriage together               |
| Strongyloides  | stercorealis| Marriage together               |
| Syngamus       |             | Tape                            |
| Taenia         |             | To suck                         |
| Thelazia       |             | Bow head                        |
| Trichinella    |             | A north African rodent (Ctenodactylus gundi) |
| Trichomonas    |             | Small hair                      |
| Trichostrongylus|            | Hair unit                       |
| Trichuris      |             | Round hair                      |
| Trypanosoma    |             | Hair tail                       |
|                |             | Auger body                      |
| Wuchereria     | gondii      | A north African rodent (C. gundi) |
|                |             | O Cruz                          |
|                |             | O Wucherer                      |

*Easily defined or self-evident terms (i.e., coil, americanus, have not been included in this list.
*The Genus designations Oxyuris and Enterobius were both used by Linneaus (48).
*The term Schistosoma has priority over Bilharzia, having been published earlier.
TABLE 8. Chlamydia, Mycoplasma, and Viruses

| Organism          | Species     | Characteristics               |
|-------------------|-------------|-------------------------------|
| Chlamydia (58)    | *trachomatis* | Mantle                        |
|                   | *psittaci*   | Rough, harsh                  |
|                   |             | Parrot                        |
| Mycoplasma (14)   |             | Fungus (mushroom) form        |
|                   | *pneumoniae* | Of pneumonia                  |
|                   | *hominis*    | Man, human                    |
| Ureaplasma (14)   |             | Urea releasing                |
| Adenovirus (28)   |             | Adenoids                      |
| Cytomegalovirus (29)|         | Large cell                    |
| Herpesvirus (29)  |             | Creeping                      |
| Papovavirus (20)  |             | Hill, swelling                |
| Parvovirus (28)   |             | Small                         |
| Poxvirus (30)     |             | Pitted (of pox diseases)      |
| Arbovirus (31)    |             | Arthropod borne               |
| Arenavirus (31)   |             | Sandy                         |
| Bunyavirus (31)   |             | Shade                         |
| Coronavirus (32)  |             | Crowned                       |
| Coxsackievirus (33)|         | Coxsackie, New York           |
| Echovirus (33)    |             | Enteric cytopathic            |
|                  |             | human orphan                  |
| Enterovirus (33)  |             | Enteric                       |
| Orthomyxovirus (34)|           | Derived from slime            |
|                  |             | (mucus)                       |
| Paramyxovirus (35)|             | Associated with slime         |
|                  |             | (mucus)                       |
| Picornavirus (33) |             | Small RNA                     |
| Reovirus (36)     |             | Respiratory enteric orphan    |
| Retrovirus (36)   |             | Backward                      |
| Rhabdovirus (37)  |             | Rod, mad                      |
| Rotavirus (36)    |             | Rotary, wheel-shaped          |
| Togavirus (31)    |             | Covered                       |

The measurement of phenotypic enzymatic expressions allowed the separation of major microbial pathogens into an acceptable genus and species framework, but could not be relied on to be a true standard. For example, it was found that some phenotypic expressions considered stable were not chromosomal but plasmid-mediated (e.g., the production of urease by some members of the genus *Proteus*).

In the 1970s the Centers for Disease Control applied DNA hybridization techniques to the comparison of genetic relatedness. At the end of the 1970s most of the medically important pathogens had been reanalyzed by DNA hybridization techniques. The microbiology community embarked on a program to codify the names of bacteria in order to avoid trivial, unscientific, and historical additions (Skerman et al., 1980). It had been common practice to accept the original description of a microorganism for assignment of a legitimate name. Some individuals took advantage of this regulation to search the literature in an attempt to establish historical precedence and change commonly accepted species names. Often, the original description was fragmentary and incomplete. This problem became particularly acute in the late 1970s, and threat-
ened to severely disrupt the ability of microbiologists to search the literature. In 1980 a code of bacterial nomenclature was presented (Skerman et al., 1980). This code contained all accepted names. If an organism was not in the code it could not be used for scientific purposes. The code further stipulated that, as of 1980, names would not be changed for strictly historical reasons. Any new microbial name would have to be presented to an international committee and be accepted. From 1980 to 1983 additions and changes were proposed for over 40 genera and 200 species of bacteria (Brenner, 1983). The following references are secondary references for the original authors and establish primacy: Beale, 1872; Brumpt, 1932; Bulloch, 1930; Burri and Stutzer, 1895; Chanock and Tully, 1980; Conant et al., 1971; Dulbecco, 1980; Gastinel, 1949; Ginsberg, 1980a, 1980b, 1980c, 1980d, 1980e, 1980f, 1980g, 1980h, 1980i, 1980j; Ligmeres and Spitz, 1902; Lignieres, 1900; Mazzotti, 1949; Morgan, 1906; Naeslund, 1925; Nichols and Manire, 1980; Faust and Russell, 1964; Prausnitz, 1922; Rettger, 1909; Russ, 1905; Trevisan, 1885a, 1885b.

REFERENCES

1. Audureau A (1940) Etude du genre Moraxella. Ann Inst Pasteur (Paris) 64:126–166.
2. Beale L (1872) Disease Germs, Their Real Nature, 2nd ed. London: pp. 176, 472.
3. Bizio B (1823) Lettera di Bartolomeo Bizio al chiarissimo canonic Angelo Bellani sopra il fenomeno della polenta poirporina. Bibl Ital G Lett, Scu Arti (Anno. VIII) 30:275–295.
4. Braask HR (1982) Onderzoekingen over Vergisting van Glycerine. Thesis, W.D. Meinema-Ultger, Delft.
5. Brenner DJ (1983) Impact of modern taxonomy on clinical microbiology. ASM News 49:58–63.
6. Brenner DJ, Steigerwalt AG, Gorman GW, Weaver RE, Feeley JC, Cordes LG, Wilkinson HW, Patton C, Thomason BM, Lewallen Sasseville KR (1980) Legionella bozemanii sp. nov. and Legionella dumoffii sp. nov.: Classification of two additional species of Legionella associated with human pneumonia. Curr Microbiol 4:111–116.
7. Brumpt E (1910) Precis de Parasitologie, 1st ed. Paris: Masson and Co.
8. Brumpt E (1932) Longevite de virus de la fiebre boutonneuse (Rickettsia conori, n.sp.) chez la Tique, Rhipicephalus sanguineus. C R Seances Soc Biol Filiales 110:1199–1202.
9. Bulloch W (1930) History of Bacteriology, A System of Bacteriology in Relation to Medicine. London: Medical Research Council, His Majesty's Stationery Office, pp. 1–44.
10. Burri R, Stutzer A (1895) Ueber Nitrat Zerstorende Bakterien und den durch dieselben bedington stickstoffverlust. Zentnbl Bakteriol Parasitenk Infektionskr Hyg Abt II 1:257–265.
11. Castellani A, Chalmers AJ (1910) Manual of Tropical Medicine, 1st ed. London: Bailliere, Tindal and Cox.
12. Castellani A, Chalmers AJ (1919) Manual of Tropical Medicine, 3rd ed. New York: Williams and Wood Co.
13. Catlin BW (1967) Genetic studies of sulfadiazine-resistant and methionine-requiring Neisseria isolated from clinical material. J Bacteriol 94:719–733.
14. Chanock RM, Tully JG (1980) Mycoplasmas. In Microbiology, 3rd Ed. Eds., BD Davis, R Dulbecco, GN Eisen, HS Ginsberg. New York: Harper & Row, pp. 785–796.
15. Conant NF, Smith DT, Baker RD, Callaway JL, Eds. (1971) Manual of Clinical Mycology, 3rd ed. Philadelphia: WB Saunders Co.
16. da Rocha-Lima H (1916) Zur Aetiologie des Fleckfiebers. Berlin Klin Wochenschr 53:567–569.
17. Davis GE (1956) A relapsing fever spirochete, Borrelia mazzottii (sp. nov.) from Ornithodorus talaje from Mexico. Am J Hyg 63:13–17.
18. Derx HG (1950) Further researches on Beijerinckia. Bogoriensis 1:1–11.
19. Dorofeev KA (1949) Classification of the causative agent of tularemia. Symp Res Works Inst Epidemiol Mikrob:ol Chito 1:170–180.
20. Dulbecco R (1980) Oncogenic viruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1231–1282.
21. Epstein MA, Achong BA, Barr YM (1964) Virus particles in cultured lymphoblasts from Burkitt’s lymphoma. Lancet i:702–703.
22. Ewing WH, McWhorter AC (1965) Genus Edwardsiella and E. tarda. In Ewing, McWhorter, Escobar and Lubin. Edwardsiella, a new genus of Enterobacteriaceae base on a new specis, E. tarda. Intl Bull Bacterial Nomencl Taxon 15:33–38.
23. Ewing WH (1949) Shigella nomenclature. J Bacteriol 57:633–638.
24. Gardner HL, Dukes CD (1955) Haemophilus vaginalis: A newly defined specific infection, previously classified as “nonspecific” vaginitis. Am J Obstet Gynecol 69:962–976.
25. Garnham PCC (1949) A new blood spirochete in the grivet monkey, Cercopithecus aethiops. East Afr Med J 24:47–51.
26. Gastinel D (1949) Precis de Bacteriologie Medicale. Paris: Librairies de L’academie de Medicine, pp. 3–40.
27. Georg LK, Brown JM (1967) Rotheia, gen. nov., an aerobic genus of the family Actinomycetaceae. Intl J Syst Bacteriol 17:79–88.
28. Ginsberg HS (1980a) Adenoviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1047–1060.
29. Ginsberg HS (1980b) Herpesviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1061–1076.
30. Ginsberg HS (1980c) Poxviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1077–1094.
31. Ginsberg HS (1980d) Togaviruses, Bunyaviruses, and Arenaviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1177–1196.
32. Ginsberg HS (1980e) Coronaviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1161–1166.
33. Ginsberg HS (1980f) Picornaviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1095–1118.
34. Ginsberg HS (1980g) Orthomyxoviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1119–1138.
35. Ginsberg HS (1980h) Paramyxoviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1139–1160.
36. Ginsberg HS (1980i) Reoviruses and epidemic acute gastroenteritis virus. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1205–1216.
37. Ginsberg HS (1980j) Rhabdoviruses. In Microbiology, 3rd ed. Eds., BD Davis, R Dulbecco, HN Eisen, HS Ginsberg. New York: Harper & Row, pp. 1167–1176.
38. Hall IC, Scott JP (1927) Bacillus sordellii, a cause of malignant edema in man. J Infect Dis 41:329–335.
39. Hauduroy P, Ehringer G, Guillot G, Margrou J, Prevot AR, Urbain (1953) Dictionnaire des Bacteries Pathogenes, 2nd ed. Paris: Masson and Co.
40. Hebert GA, Steigerwalt AG, Brenner DJ (1980) Legionella micdadei species nova: Classification of a third species of Legionella associated with human pneumonia. Curr Microbiol 3:255–258.
41. Hirsch A (1883–1886) Handbook d-hist-geography, Pathologie, Erlangen, 1881-3. London: English Trans.
42. Jones D, Sackin MJ (1980) Numerical methods in the classification and identification of bacteria with special reference to the Enterobacteriaceae. In Numerical Methods in Classification, pp. 73–106.
43. Krieg A (1961) Grundlagen der Insektenpathologie. Dr. Dietrich Stinkopff. Darmstadt: Verlag.
44. Kruse W (1896) Systematik der Streptothricheen and Bakterien. In Die Mikroorganismen, 3rd ed. vol. 2. Ed., C. Flugge, Leipzig: Vogel, pp. 48–96, 185–526.
45. Levine M (1920) Dysentery and allied bacilli. J Infect Dis 27:31–39.
46. Lignieres J, Spitz G (1902) L’actinobacillosis. Bull Soc Centr Med Vet 20:487–535, 546–565.
47. Lignieres J (1900) Maladies du porc. Bull Soc Centr Med Vet n s 18:389–431.
48. Linnaeus C (1758) Systema Naturae per Regna Tria Naturae, 10th ed. Holmiæ.
49. Lwoff A (1939) Revision et demembrement des Hemophilae, le genre Moraxella nov. gen. Ann Inst Pasteur (Paris) 62:168–176.
50. Mazzotti L (1949) Sobre una nueva espiroqueta de la fiebre rurrectente, encontrada en Mexico. Rev Inst Salubr Inst Enferm Trop Mex 10:277–281.
51. Meyer KF, Shaw EB (1920) A comparison of the morphologic, cultural and biochemical characteristics of B. abortus and B. melitensis. Studies on the genus Brucella nov. gen. J Infect Dis 27:173–184.
52. Migula W (1900) System der Bakterien, vol. 2. Jena: Gustav Fischer.
53. Moore WEC, Holdeman LV (1970) Fusobacterium. In Anaerobe Laboratory Manual. Eds., Holdeman, Moore. Blacksburg, VA: Virginia Polytechnic Institute Anaerobe Laboratory.
54. Moreno-Lopez M (1953) El genero Bordetella. Microbiol Espan 5:117–181.
55. Morgan H de R (1906) Upon the bacteriology of the summer diarrhea of infants. Br Med J 1:908–912.
56. Naeslund C (1925) Studies of Actinomyces from the oral cavity. Acta Pathol Microbiol Scand 2:110–140.
57. Neveu-Lemaire M (1921) Precis de la Parasitologie Humaine, 5th ed. Paris: J. Lemaire.
58. Nichols RL, Manire GP (1980) Chlamydiae. In Microbiology, 3rd ed. Eds., BD Davis, RDN Dulbecco, RN Eisen, HS Ginsberg. New York: Harper & Row, pp. 775–784.
59. Faust EC, Russell PF, Eds. (1964) Nomenclatural aspects of animal species responsible for human disease. In Craig and Faust's Clinical Parasitology, 7th ed. Philadelphia: Lea & Febiger, p. 40.
60. Novy FG, Knapp RE (1906) Studies on Spirillum obermeiri and related organisms. J Infect Dis 3:291–393.
61. Pfeiffer R (1892) Vorläufige Mitteilnungen über den Erreger Der Influenza. Deut Med Wochenschr 18:28.
62. Philip CB (1908) On the name of the Q-fever organism. Pub Health Rep 63:58.
63. Pinkerton H (1936) Criteria for the accurate classification of the rickettsial disease (Rickettsioses) and their etiological agents. Parasitology 28:172–189.
64. Pirie JHH (1940) The genus Listerella pirie. Science (Washington) 81:383.
65. Prausnitz C (1922) Der Bacillus mucosus anaerobius. Zentrabl Bakteriol Parasitenk Infektionskr Hyg Abt I Orig 89:126–132.
66. Prevot A (1933) Etudes de systematique bacterienne. I. Lois generales. II. Cocci anaerobius. Ann Sci Natur Zool Biol Anim 15:23–260.
67. Rettiger LF (1909) Further studies on fatal septicemia in young chickens, or “white diarrhea.” J Med Res 21:115–123.
68. Russ VR (1905) Ueber ein Influenzabacillenahnliches anaerobes. Stobchen Zentrabl Bakteriol Parasitenk Infektionskr Hyg Abt I Orig 39:357–359.
69. Rustigian R, Stuart CA (1943) Taxonomic relationships in the genus Proteus. Proc Soc Exp Biol Med 53:241–243.
70. Skerman VDB, McGowan V, Sneath PHA, Eds. (1980) Approved lists of bacterial names. Int J Syst Bacteriol 30:225–420.
71. Staflou FA, Bonner CEB, McVaug MB, Meikle RD, Rollins RC, Ross R, Schopf JM, Schultz GE. Voss EG (1972) International Code of Botannical Nomenclature. Utrecht: International Bureau for Plant Taxonomy and Nomenclature.
72. Steinhaus EA (1946) Insect Microbiology. Ithaca, NY: Comstock Pub Co.
73. Strong RP, Tyzzer EE, Brues CT, Sellards AW, Gabriaburú JC (1913) Verruga peruviana, Oroya fever and uta. J Am Med Assoc 61:1713–1716.
74. Swellengrebel NH (1907) Sur la cytologie comparee des spirochetes et des spirilles. Ann Inst Pasteur (Paris) 21:448–466, 562–586.
75. Thompson L, Lovestedt SA (1951) An actinomyces-like organism obtained from the human mouth. Proc Staff Meetings Mayo Clinic 26:169–175.
76. Trevisan V (1865a) Il fungo del cholera asiatico. Questioni risolte. Atti Accad Fis-Med-Stat Milano (ser 4) 3:78–91.
77. Trevisan V (1885b) Caratteri di alcuni nuovi generi di Batteriaceee. *Att Accad Fis-Med-Stat Milano* (ser 4) 3:92–107.

78. Trevisan V (1889) I Generi e le Specie delle Battieriaceee. Milano: Zanaboni and Gabuzzi.

79. Trevisan V (1887) Sul Micrococco della rabbia e sulla possibilita di riconoscere durante il periodo d’incubazione, dall’esame dell’angue della persona moricata, se ha contratta l’infezione rabbica. *Rend Ist Lombardo* (ser 2) 20:88–105.

80. Vallery-Radat Pasteur (1922) *Oevres de Pasteur*, 6 Volumes. Paris: Libraries de L’Academie Medicine.

81. Van Loghem JJ (1944) The classification of plague-bacillus. *Antonie van Leeuwenhoek J Microbiol Serol* 10:15–16.

82. Van Niel CB (1928) The proprionic acid bacteria. Haarlem, Holland: Uitgeverszaak and Boissenvain and Co.

83. Winslow CE, Broadhurst A, Buchanan RJ (1920) The families and genera of bacteria. *J Bacteriol* 5:191–229.

84. Winslow CE, Broadhurst A, Buchanan RJ (1917) The families and genera of the bacteria. *J Bacteriol* 2:505–566.

85. Winslow CEA, Kligler IJ, Rothberg W (1919) Studies on the classification of the colontyphoid group of bacteria with special reference to their fermentative reactions. *J Bacteriol* 4:429–503.

86. Wolbach SB, Todd JL (1920) Note sur l’etiologie et l’anatomie pathologique du typhus exanthematique au Mexique. *Ann Inst Pasteur* (Paris) 34:153–158.