Appendix D

Taxonomy Of Clinically Relevant Microorganisms

Bacterial Pathogens

The following tables list the species, and some higher groups, of pathogenic Eubacteria mentioned in the text. The classification of Bacteria, one of the three domains of life, is in constant flux as relationships become clearer through sampling of genetic sequences. Many groups at all taxonomic levels still have an undetermined relationship with other members of the phylogenetic tree of Bacteria. *Bergey's Manual of Systematics of Archaea and Bacteria* maintains a published list and descriptions of prokaryotic species. The tables here follow the taxonomic organization in the *Bergey's Manual* Taxonomic Outline.[1]

We have divided the species into tables corresponding to different bacterial phyla. The taxonomic rank of kingdom is not used in prokaryote taxonomy, so the phyla are the subgrouping below domain. Note that many bacterial phyla not represented by these tables. The species and genera are listed only under the class within each phylum. The names given to bacteria are regulated by the International Code of Nomenclature of Bacteria as maintained by the International Committee on Systematics or Prokaryotes.

Phylum Actinobacteria

Class	Genus	Species	Related Diseases
Actinobacteria	*Corynebacterium*	*diphtheriae*	Diphtheria
	Gardnerella	*vaginalis*	Bacterial vaginosis
	Micrococcus		Opportunistic infections
	Mycobacterium	*bovis*	Tuberculosis, primarily in cattle
	Mycobacterium	*leprae*	Hansen's disease
	Mycobacterium	*tuberculosis*	Tuberculosis
	Propionibacterium	*acnes*	Acne, blepharitis, endophthalmitis

Table D1

Phylum Bacteroidetes

Class	Genus	Species	Related Diseases
Bacteroidia	*Porphyromonas*		Periodontal disease
	Prevotella	*intermedia*	Periodontal disease

Table D2

1. Bergey's Manual Trust. *Bergey's Manual of Systematics of Archaea and Bacteria*, *Taxonomic Outline*. 2012. http://www.bergeys.org/outlines.html

Phylum Chlamydiae

Class	Genus	Species	Related Diseases
Chlamydiae	*Chlamydia*	*psittaci*	Psittacosis
	Chlamydia	*trachomatis*	Sexually transmitted chlamydia

Table D3

Phylum Firmicutes

Class	Genus	Species	Related Diseases
Bacilli	*Bacillus*	*anthracis*	Anthrax
	Bacillus	*cereus*	Diarrheal and emetic food poisoning
	Listeria	*monocytogenes*	Listeriosis
	Enterococcus	*faecalis*	Endocarditis, septicemia, urinary tract infections, meningitis
	Staphylococcus	*aureus*	Skin infections, sinusitis, food poisoning
	Staphylococcus	*epidermidis*	Nosocomial and opportunistic infections
	Staphylococcus	*hominis*	Opportunistic infections
	Staphylococcus	*saprophyticus*	Urinary tract infections
	Streptococcus	*agalactiae*	Postpartum infection, neonatal sepsis
	Streptococcus	*mutans*	Tooth decay
	Streptococcus	*pneumoniae*	Pneumonia, many other infections
	Streptococcus	*pyogenes*	Pharyngitis, scarlet fever, impetigo, necrotizing fasciittis
Clostridia	*Clostridium*	*botulinum*	Botulinum poisoning
	Clostridium	*difficile*	Colitis
	Clostridium	*perfringens*	Food poisoning, gas gangrene
	Clostridium	*tetani*	Tetanus

Table D4

Phylum Fusobacteria

Class	Genus	Species	Related Diseases
Fusobacteriia	*Fusobacterium*		Periodontal disease, Lemierre syndrome, skin ulcers
	Streptobacillus	*moniliformis*	Rat-bite fever

Table D5

Phylum Proteobacteria

Class	Genus	Species	Related Diseases
Alphaproteobacteria	*Anaplasma*	*phagocytophilum*	Human granulocytic anaplasmosis
	Bartonella	*henselae*	Peliosis hepatitis, bacillary angiomatosis, endocarditis, bacteremia
	Bartonella	*quintana*	Trench fever
	Brucella	*melitensis*	Ovine brucellosis
	Ehrlichia	*chaffeensis*	Human monocytic ehrlichiosis
	Rickettsia	*prowazekii*	Epidemic typhus
	Rickettsia	*rickettsii*	Rocky Mountain spotted fever
	Rickettsia	*typhi*	Murine typhus
Betaproteobacteria	*Bordetella*	*pertussis*	Pertussis
	Eikenella		Bite-injury infections
	Neisseria	*gonorrhoeae*	Gonorrhea
	Neisseria	*meningitidis*	Meningitis
	Spirillum	*minus (alt. minor)*	Sodoku (rat-bite fever)
Epsilonproteobacteria	*Campylobacter*	*jejuni*	Gastroenteritis, Guillain-Barré syndrome
	Helicobacter	*pylori*	Gastric ulcers
Gammaproteobacteria	*Aeromonas*	*hydrophila*	Dysenteric gastroenteritis
	Coxiella	*burnetii*	Q fever
	Enterobacter		Urinary and respiratory infections
	Escherichia	*coli* Strains: shiga toxin-producing (STEC) (e.g., O157:H7) also called enterohemorrhagic *E. coli* (EHEC) or verocytotoxin-producing *E. coli* (VTEC)	Foodborne diarrhea outbreaks, hemorrhagic colitis, hemolytic-uremic syndrome
	Escherichia	*coli* Strain: enterotoxigenic *E. coli* (ETEC)	Traveler’s diarrhea
	Escherichia	*coli* Strain: enteropathogenic *E. coli* (EPEC)	Diarrhea, especially in young children

Table D6

Phylum Proteobacteria

Class	Genus	Species	Related Diseases
	Escherichia	*coli* Strain: enteroaggregative *E. coli* (EAEC)	Diarrheal disease in children and travelers
	Escherichia	*coli* Strain: diffusely adherent *E. coli* (DAEC)	Diarrheal disease of children
	Escherichia	*coli* Strain: enteroinvasive *E. coli* (EPEC)	Bacillary dysentery, cells invade intestinal epithelial cells
	Francisella	*tularensis*	Tularemia
	Haemophilus	*ducreyi*	Chancroid
	Haemophilus	*influenzae*	Bacteremia, pneumonia, meningitis
	Klebsiella	*pneumoniae*	Pneumonia, nosocomial infections
	Legionella	*pneumophila*	Legionnaire's disease
	Moraxella	*catarrhalis*	Otitis media, bronchitis, sinusitis, laryngitis, pneumonia
	Pasteurella		Pasteurellosis
	Plesiomonas	*shigelloides*	Gastroenteritis
	Proteus		Opportunistic urinary tract infections
	Pseudomonas	*aeruginosa*	Opportunistic, nosocomial pneumonia and sepsis
	Salmonella	*bongori*	Salmonellosis
	Salmonella	*enterica*	Salmonellosis
	Serratia		Pneumonia, urinary tract infections
	Shigella	*boydii*	Dysentery
	Shigella	*dysenteriae*	Dysentery
	Shigella	*flexneri*	Dysentery
	Shigella	*sonnei*	Dysentery
	Vibrio	*cholerae*	Cholera
	Vibrio	*parahemolyticus*	Seafood gastroenteritis

Table D6

Phylum Proteobacteria

Class	Genus	Species	Related Diseases
	Vibrio	*vulnificus*	Seafood gastroenteritis, necrotizing wound infections, septicemia
	Yersinia	*enterocolitica*	Yersiniosis
	Yersinia	*pestis*	Plague
	Yersinia	*pseudotuberculosis*	Far East scarlet-like fever

Table D6

Phylum Spirochaetes

Class	Genus	Species	Related Diseases
Spirochaetia	*Borrelia*	*burgdorferi*	Lyme disease
	Borrelia	*hermsii*	Tick-borne relapsing fever
	Borrelia	*recurrentis*	Louse-borne relapsing fever
	Leptospira	*interrogans*	Leptospirosis
	Treponema	*pallidum*	Syphilis, bejel, pinta, yaws

Table D7

Phylum Tenericutes

Class	Genus	Species	Related Diseases
Mollicutes	*Mycoplasma*	*genitalium*	Urethritis, cervicitis
	Mycoplasma	*hominis*	Pelvic inflammatory disease, bacterial vaginosis
	Mycoplasma	*pneumoniae*	*Mycoplasma* pneumonia
	Ureaplasma	*urealyticum*	Urethritis, fetal infections

Table D8

Viral Pathogens

There are several classification systems for viruses. The International Committee on Taxonomy of Viruses (ICTV) is the international scientific body responsible for the rules of viral classification. The ICTV system used here groups viruses based on genetic similarity and presumed monophyly. The viral classification system is separate from the classification system for cellular organisms. The ICTV system groups viruses within seven orders, which contain related families. There is, presently, a large number of unassigned families with unknown affinities to the seven orders. Three of these orders infect only Eubacteria, Archaea, or plants and do not appear in this table. Some families may be divided into subfamilies. There are also many unassigned genera. Like all taxonomies, viral taxonomy is in constant flux. The latest complete species list and classification can be obtained on the ICTV website.[2]

Viral Pathogens					
Order	**Family**	**Sub-family**	**Genus**	**Species**	**Related diseases**
Herpesvirales	*Herpesviridae*	*Betaherpesvirinae*	*Human cytomegalovirus group*	*Human herpesvirus 5*	Cytomegalovirus hepatitis and other infections in immunocompromised people
		Gammaherpesvirinae	*Lymphocryptovirus*	*Human herpesvirus 4* (HHV-4; Epstein-Barr virus)	Infectious mononucleosis
		Alphaherpesvirinae	*Simplexvirus*	*Human herpesvirus 1, human herpesvirus 2*	Herpes simplex virus 1, herpes simplex virus 2
			Varicellovirus	*Human herpesvirus 3*	Chicken pox, shingles
Mononegavirales	*Filoviridae*		*Ebolavirus*	*Zaire ebolavirus* (EBOV)	Ebola
			Marburgvirus	*Marburg marburgvirus* (MARV)	Marburg virus disease
	Rhabdoviridae		*Lyssavirus*	*Rabies virus*	Rabies
	Paramyxoviridae	*Pneumovirinae*	*Pneumovirus*	*Human respiratory syncytial virus*	Lower respiratory tract infection
		Paramyxovirinae	*Morbillivirus*	*Measles virus*	Measles (rubeola)
Nidovirales	*Coronaviridae*	*Coronavirinae*	*Coronavirus*		Common cold, pneumonia, SARS
Picornavirales	*Picornaviridae*		*Hepatovirus*	*Hepatitis A virus*	Hepatitis A
			Enterovirus	*Enterovirus C*	Polio
				Rhinovirus A	Common cold
				Rhinovirus B	Common cold
				Rhinovirus C	Common cold
Unassigned	*Adenovirus*		*Mastadenovirus*		Respiratory and other infections
	Arenaviridae		*Mammarenavirus*	*Lassa mammarenavirus*	Lassa fever
	Astroviridae				Gastroenteritis
	Bunyaviridae		*Hantavirus*	Several species	Hantavirus hemorrhagic fever with renal syndrome (HFRS), hantavirus pulmonary syndrome (HPS)
			Nairovirus	*Crimean-Congo hemorrhagic fever virus* (CCHF)	Crimean-Congo hemorrhagic fever
	Caliciviridae		*Norovirus*	*Norwalk virus*	Gastroenteritis

Figure D1

2. International Committee on Taxonomy of Viruses. “ICTV Master Species List.” http://talk.ictvonline.org/files/ictv_documents/m/msl/default.aspx

Viral Pathogens (continued)					
Order	**Family**	**Sub-family**	**Genus**	**Species**	**Related diseases**
Unassigned	*Flaviviridae*		*Flavivirus*	*Dengue virus*	Dengue fever
				Yellow fever virus	Yellow fever
			Hepacivirus	*Hepatitis C virus*	Hepatitis C
	Hepadnaviridae		*Orthohepadna-virus*	*Hepatitis B virus*	Hepatitis B
	Hepeviridae		*Orthohepevirus*	*Hepatitis E virus*	Hepatitis E
	Orthomyxoviridae		*Influenzavirus A*	*Influenza A virus*	Pandemic flu
			Influenzavirus B	*Influenza B virus*	Flu
			Influenzavirus C	*Influenza C virus*	Flu
	Papillomaviridae		*Alphapapilloma-virus*	*Human papillomavirus*	Skin warts
	Parvoviridae	*Parvovirinae*	*Erythroparvovirus*	*Human parvovirus B19*	Fifth disease (erythema infectosum)
	Poxviridae	*Chordopoxvirinae*	*Orthopoxvirus*	*Variola virus*	Variola major, Variola minor (smallpox)
				Vaccinia virus	Cowpox
	Reoviridae	*Sedoreovirinae*	*Rotavirus*	Eight species	Gastroenteritis
	Retroviridae	*Orthoretrovirinae*	*Lentivirus*	*Human immuno-deficiency virus*	AIDS
	Togaviridae		*Alphavirus*	*Chikungunya virus* (CHIKV)	Chikungunya
			Rubivirus	*Rubella virus*	Rubella (German measles)
	Unassigned		*Deltavirus*	*Hepatitis D virus*	Hepatitis D

Figure D2

Fungal Pathogens

The Fungi are one of the kingdoms of the domain Eukarya. Fungi are most closely related to the animals and a few other small groups and more distantly related to the plants and other groups that formerly were categorized as protist. At present, the Fungi are divided into seven phyla (or divisions, a hold over from when fungi were studied with plants), but there are uncertainties about some relationships.[3] Many groups of fungi, particularly those that were formerly classified in the phylum Zygomycota, which was not monophyletic, have uncertain relationships to the other fungi. The one species listed in this table that falls into this category is *Rhizopus arrhizus*. Fungal names are governed by the International Code of Nomenclature for Algae, Fungi, and Plants,[4] but the International Commission on the Taxonomy of Fungi (ICTF) also promotes taxonomic work on fungi. One activity of the ICTF is publicizing name changes for medically and otherwise important fungal species. Many species that formerly had two names (one for the sexual form and one for the asexual form) are now being brought together under one name.

3. D. S. Hibbett et al. "A Higher-level Phylogenetic Classification of the Fungi." *Mycological Research* 111 no. 5 (2007):509–547.

4. J. McNeill et al. *International Code of Nomenclature for Algae, Fungi, and Plants (Melbourne Code)*. Oberreifenerg, Germany. Koeltz Scientific Books; 2012. http://www.iapt-taxon.org/nomen/main.php?

Fungal Pathogens

Division	Genus	Species	Related Diseases
Ascomycota	*Aspergillus*	*flavus*	Opportunistic aspergillosis
	Aspergillus	*fumigatus*	Opportunistic aspergillosis
	Blastomyces	*dermatitidis*	Blastomycosis
	Candida	*albicans*	Thrush (candidiasis)
	Coccidioides	*immitis*	Valley fever (coccidioidomycosis)
	Epidermophyton		Tinea corporis (ringworm), tinea cruris (jock itch), tinea pedis (althlete's foot), tinea unguium (onychomycosis)
	Histoplasma	*capsulatum*	Histoplasmosis
	Microsporum		Tinea capitis (ringworm), tinea corpus (ringworm), other dermatophytoses
	Pneumocystis	*jirovecii*	Opportunistic pneumonia
	Sporothrix	*schenckii*	Sporotrichosis (rose-handler's disease)
	Trichophyton	*mentagrophytes* var. *interdigitale*	Tinea barbae (barber's itch), dermatophytoses
	Trichophyton	*rubrum*	Tinea corporis (ringworm), tinea cruris (jock itch), tinea pedis (althlete's foot), tinea unguium (onychomycosis)
Basidiomycota	*Cryptococcus*	*neoformans*	Opportunistic cryptococcosis, fungal meningitis, encephalitis
	Malassezia		Dandruff, tinea versicolor
uncertain	*Rhizopus*	*arrhizus*	Mucormycosis

Table D9

Protozoan Pathogens

The relationships among the organisms (and thus their taxonomy) previously grouped under the name Protists are better understood than they were two or three decades ago, but this is still a work in progress. In 2005, the Eukarya were divided into six supergroups.[5] The latest high-level classification combined two of the previous supergroups to produce a system comprising five supergroups.[6] This classification was developed for the Society of Protozoologists, but it is not the only suggested approach. One of the five supergroups includes the animals, fungi, and some smaller protist groups. Another contains green plants and three algal groups. The other three supergroups (listed in the three tables below) contain the other protists, many of them which cause disease. In addition, there is a large number of protist groups whose relationships are not understood. In the three supergroups represented here we have indicated the phyla to which the listed pathogens belong.

5. S.M. Adl et al. "The New Higher Level Classification of Eukaryotes with Emphasis on the Taxonomy of Protists." *Journal of Eukaryotic Microbiology* 52 no. 5 (2005):399–451.
6. S.M. Adl et al. "The Revised Classification of Eukaryotes." *Journal of Eukaryotic Microbiology* 59 no. 5 (2012):429–514.

Supergroup Amoebozoa

Phylum	Genus	Species	Related Diseases
Amoebozoa	*Acanthamoeba*		Granulomatous amoebic encephalitis, acanthamoebic keratitis
	Entamoeba	*histolytica*	Enterobiasis

Table D10

Supergroup SAR (Stramenopiles, Alveolata, Rhizaria)

Phylum	Genus	Species	Related Diseases
Apicomplexa	*Babesia*		Babesiosis
	Cryptosporidium	*hominis*	Cryptosporidiosis
	Cryptosporidium	*parvum*	Cryptosporidiosis
	Cyclospora	*cayetanensis*	Gastroenteritis
	Plasmodium	*falciparum*	Malaria
	Plasmodium	*malariae*	“Benign” or “quartan” (3-day recurrent fever) malaria
	Plasmodium	*ovale*	“Tertian” (2-day recurrent fever) malaria
	Plasmodium	*vivax*	“Benign” “tertian” (2-day recurrent fever) malaria
	Plasmodium	*knowlesi*	Primate malaria capable of zoonosis, quotidian fever
	Toxoplasma	*gondii*	Toxoplasmosis

Table D11

Supergroup Excavata

Phylum	Genus	Species	Related Diseases
Metamonada	*Giardia*	*lamblia*	Giardiasis
	Trichomonas	*vaginalis*	Trichomoniasis
Euglenozoa	*Leishmania*	*braziliensis*	Leishmaniasis
	Leishmania	*donovani*	Leishmaniasis
	Leishmania	*tropica*	Cutaneous leishmaniasis
	Trypanosoma	*brucei*	African sleeping sickness (African trypanosomiasis)
	Trypanosoma	*cruzi*	Chagas disease
Percolozoa	*Naegleria*	*fowleri*	Primary amoebic meningoencephalitis (naegleriasis)

Table D12

Parasitic Helminths

The taxonomy of parasitic worms, all of which belong to the kingdom Animalia still contains many uncertainties. The

pathogenic species are found in two phyla: the Nematoda, or roundworms, and the Platyhelminthes, or flat worms. The Nematoda is tentatively divided into two classes[7], one of which, Chromadorea, probably contains unrelated groups. The parasitic flatworms are contained within three classes of flatworm, of which two are important to humans, the trematodes and the cestodes.

Phylum Nematoda

Class	Genus	Species	Related Diseases
Chromadorea	*Ancylostoma*	*caninum*	Dog hookworm infection
	Ancylostoma	*duodenale*	Old World hookworm infection
	Ascaris	*lumbricoides*	Ascariasis
	Enterobius	*vermicularis*	Enterobiasis (pin worm)
	Loa	*loa*	Loa loa filariasis (eye worm)
	Necator	*americanus*	Necatoriasis (New World hookworm infection)
	Strongyloides	*stercoralis*	Strongyloidiasis
Enoplea	*Trichinella*	*spiralis*	Trichinosis
	Trichuris	*trichiura*	Trichuriasis (whip worm infection)

Table D13

Phylum Platyhelminthes

Class	Genus	Species	Related Diseases
Trematoda	*Clonorchis*	*sinensis*	Chinese liver fluke
	Fasciolopsis	*buski*	Fasciolopsiasis
	Fasciola	*gigantica*	Fascioliasis
	Fasciola	*hepatica*	Fascioliasis
	Opisthorchis	*felineus*	Opisthorchiasis
	Opisthorchis	*viverrini*	Opisthorchiasis
	Schistosoma	*haematobium*	Urinary schistosomiasis
	Schistosoma	*japonicum*	Schistosomiasis
	Schistosoma	*mansoni*	Intestinal schistosomiasis
Cestoda	*Diphyllobothrium*	*latum*	Diphyllobothriosis
	Echinococcus	*granulosus*	Hydatid cysts (cystic echinococcosis)
	Echinococcus	*multilocularis*	Echinococcosis
	Taenia	*asiatica*	Intestinal taeniasis

Table D14

7. National Center for Biotechnology Information. “Taxonomy Browser: Nematoda.” http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=6231

Phylum Platyhelminthes

Class	Genus	Species	Related Diseases
	Taenia	*saginata*	Intestinal taeniasis
	Taenia	*solium*	Intestinal taeniasis, cysticercosis

Table D14