Naming Conventions
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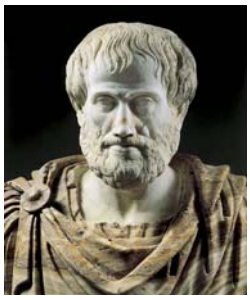
Nomenclature of Microorganisms

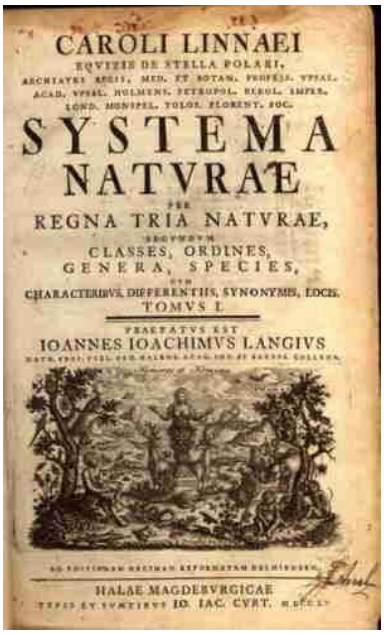
The Origin of Names



The Greek philosopher Aristotle attempted to classify all living things as either Plant or Animal. He grouped animals into Land Dwellers, Water Dwellers, and Air Dwellers. Although this system made sense to Aristotle, we would have a difficult time in grouping elephants and earthworms, whales and water striders, flies and falcons together.

Subsequent scientists later tried to classify living creatures by means of locomotion, grouping butterflies and bats (flying), barnacles and barley (both rooted in place). This system of classification was obviously flawed as well.

The efforts to classify living things saw great progress in the work of **Carl Linnaeus**, a Swedish botanist. He developed his naming system in the middle 1700's, which essentially the same one we use today. He attempted to name all known plants, animals, and minerals using Latin and Greek names. One of his books, ***Systema Naturae,*** meaning "The Natural Classification", was published in 1735 and was based on his religious belief that one could understand God by studying his creation.


CAROLI LINNAEI
SYSTEMA
NATVRAE
REGNA TRIA NATVRAE,
CLASSES, ORDINES,
GENERA, SPECIES,
CHARACTERIBVS, DIFFERENTIIS, SYNONYMIS, LOCIS.
TOMVS I.
IOANNES IOACHIMVS LANGIVS
HALAE MAGDEBVRGICAE

Today, microorganism names originate from four different sources:

1. Descriptive – For example *Staphylococcus aureus* (grape-like cluster of spheres, golden in color), *Streptococcus viridans* (chains of spheres, green in colony color), *Proteus vulgaris* (first and common), *Helicobacter pylori* (spiral shaped rod at the entrance to the duodenum)

2. Scientist's names – e.g., *Escherichia coli* (Theodor Esherich), *Erlichia* (Paul Erlich), *Nessieria* (Albert Neisser), *Listeria* (Joseph Lister), *Pasturella* (Louis Pasteur), *Yersinia* (AlexandreYersin), *Bartonella* (Alberto Barton), *Morganella* (H. de R. Morgan), *Edwardsiella* (P. R. Edwards)

3. Geographic places – e.g., *Legionella longbeachiae* (Long Beach, California), *Pasturella tularensis* (Tulare County, California), *Pseudomonas fairmontensis* (Fairmount Park, Pennsylvania), *Mycobacterium genavense* (Geneva, Switzerland), *Blastomyces brasiliensis* (Brazil), *Providencia* spp. (Brown University, Providence, RI)

4. Organizations – e.g., *Legionella* (American Legion), *Afipia felis* (Air Force Institute of Pathology), *Cedecea* spp. (Centers for Disease Control), *Bilophila wadsworthia* (VA Wadsworth Medical Center in Los Angeles)

Taxonomy

Kingdom (American system has six: Animalia, Plantae, Fungi, Protista, Archaea, Bacteria)
Phylum (there are 23+ bacterial phyla)
Class
Order
Family
Genus (aka, generic name)
Species (aka, specific name, specific epithet)
Subspecies

For example, the bacteria used in yogurt production would be classified as follows…

Kingdom: Bacteria
Phylum: Firmicutes
Class: Bacilli
Order: Lactobacillales
Family: Lactobacillaceae
Genus: Lactobacillus
Species: *L. delbrueckii*
Subspecies: *L. d. bulgaricus*

Known as the "Father of Modern Taxonomy" Carl Linnaeus was the first to consistanly name plants and animals using the binomial system of Latin names for genus and species.

Rules of Nomenclature

1. **Use Binary Names** - Binary names (invented by Linnaeus), consisting of a generic name and a species epithet (e.g., *Escherichia coli*), must be used for all microorganisms. Names of categories at or above the genus level may be used alone, but species and subspecies names (species names) may not. In other words…never use a species name alone.

2. **When to Capitalize** – The genus name (and above) is always capitalized, the species name is never capitalized, e.g. *Bacillus anthracis*

3. **When to Italicize** - Names of all taxa (kingdoms, phyla, classes, orders, families, genera, species, and subspecies) are printed in italics and should be underlined if handwritten; strain designations and numbers are not. If all the surrounding text is italic, then the binary name would be non-italic (Roman typeface) or underlined (e.g. *A common cause of diarrhea is* E. coli 0157*, a gram negative bacillus).*

4. **When to use Initials** - A specific epithet must be preceded by a generic name, written out in **full** the first time it is used in a paper. Thereafter, the generic name should be abbreviated to the initial capital letter (e.g., *E. coli*), provided there can be no confusion with other genera used in the paper. Be careful with the "S" words; Salmonella, Shigella, Serratia, Staphylococcus, Streptococcus, etc.

5. **Common Names** - Vernacular (common) names should be in lowercase roman type, non-italic (e.g., streptococcus, brucella). However when referring to the actual genus name (or above) always capitalize and italicize.

6. **Subspecies and Serovars** - For *Salmonella,* genus, species, and subspecies names should be rendered in standard form: *Salmonella enterica* at first use, *S. enterica* thereafter; *Salmonella enterica* subsp. *arizonae* at first use, *S. enterica* subsp. *arizonae* thereafter. Names of serovars should be in roman type with the first letter capitalized: *Salmonella enterica* serovar Typhimurium. After the first use, the serovar may also be given without a species name: *Salmonella* serovar Typhimurium.

7. **Abbreviations for Species** – use "sp." for a particular species, "spp." for several species ("spp" stands for "species plural"). These abbreviations are not italicized; e.g. *Clostridium* sp. or *Clostridium* spp.

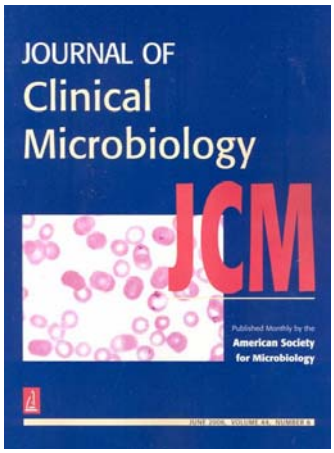
Other Abbreviations:

e.g. meaning 'for example' (it comes from the Latin, exempli gratia)
i.e. meaning 'that is' (from the Latin id est). Note that 'i.e.' specifies particular things, whereas 'e.g.' gives examples.
etc. meaning 'and so forth' (from the Latin et cetera) [Some people, wrongly, write ect.]
et al. meaning 'and others' (from the Latin et alia). You would use this only when citing references.

8. Plural Forms

Plural of genus is genera
Plural of species (sp.) is species (spp.)

Plural of medium is media (never say "this culture media")
Plural of fungus is fungi
Plural of streptococcus is streptococci (staphylococcus - staphylococci; enterococcus - enterococci, etc)
Plural of bacillus is bacilli
Plural of bacterium is bacteria
Plural of alga is algae
Plural of protozoan is protozoa



9. Listing References

Always use the "Journal of Clinical Microbiology" as a guideline. List the authors (in bold), publication date, name of article, name of journal, volume (in bold), then pages. For example:

1. **Agouridas, C., A. Bonnefoy, and J. F. Chantot.** 1997. Antibacterial activity of RU 64004 (HMR 3004), a novel ketolide derivative active against respiratory pathogens. Antimicrob. Agents Chemother. **41:**2149-2158.

2. **Angot, P., M. Vergnaud, M. Auzou, R. Leclercq, and Observatoire de Normandie du Pneumocoque.** 2000. Macrolide resistance phenotypes and genotypes in French clinical isolates of *Streptococcus pneumoniae*. Eur. J. Clin. Microbiol. Infect. Dis. **19:**755-758.

Additional rules:

- List your sources in an alphabetical order according to the author's last name.
- If no author is listed, begin with the main word of the article or book title (ignoring *A*, *An*, or *The*).
- Underline or italicize the title of books or magazines.

10. **O vs. 0** – Mind your "O's" and zeros. It is *E. coli* O157, not *E. coli* 0157

Question for the Ages:

When referring to filamentous fungi….Is it MOLD or MOULD? Hint: it depends on which side of the Atlantic you are on.

Common Latin and Greek roots used in Microbiology

a-, an- not, without
ab-, a-, abs- away
acr-, acro- height, summit, tip
aer-, aero- air, atmosphere
albus- white
ambi- both, on both sides
ampulla- bottle, flask
ana- again, against, back
angeion - vessel
ant-, anti- against, opposed to, preventive
ante-, anti- before, in front of, prior to
anth-, antho- flower
aqu- water
archaeo-, archeo- ancient
arthr- , arthro- joint
astr-, astro- star, star-shaped
aur- relating to gold, or gold-colored
aureus - golden, gold coin
avi- bird
bac- rod-shaped
baro- weight, pressure
basi- at the bottom
bi- two
bio- life
blast- germ, embryo, bud, cell with nucleus
bon(i)- good
bor- north
brach- short
brachi-, brachio- arm
brachys, brachy - short
brev(i)- brief, short (time)
brevis - short
bronch- windpipe
bucc- cheek, mouth, cavity
burs- pouch, purse
camp- field
cand- glowing,iridescent
canis - dog, coyote
cap-, -cip-, capt-, -cept- hold, take
capit-, -cipit- head
cav- hollow
cen(o)- new
cephale- head
cephalo- head
cervic- relating to the neck, relating to the cervix
chrom- color
chryso- gold
clad- branch
coccus- seed, sphere
cochl- shell
coel- hollow
crypt- hidden
cune- wedge
curv- bent
cyan- blue
deca - ten
derma - skin
dino- terrible
diplo- double
dorsum - back
echinos, echino- hedgehog, sea-urchin, spiny
equ- horse
erythros, erythro- red

eu- well
exo- outside
falc- sickle
fasc- bundle
felis- cat
ferr- iron
flav- yellow
flavus- Golden yellow, light yellow
fort- strong
fruct-, frug- fruit
fulvus- Deep yellow, tawny
fung-, funct- do
fusc- dark
galact- milk
gastr- stomach
ge(o)- earth
glabra- smooth, hairless
haem(o)- blood
haema-, hema - blood
hali-, halio - of the sea, salt
heli-, helio- sun
helico- spiral
hom(o)- same
homeo- like
hydro- water
hyper- above, over
inter- among, between
intra- within
kil(o)- thousand
lact- milk
lat(i)- broad, wide
leuc(o)-, leuk(o)- white
lig- bind
lip(o)- fat
lith(o)- stone
luc- bright, light
lutea- yellow, saffron-colored
macr- long
macro- long, large
mamm- breast
medi-, -midi- middle
meg- great, large
melan- black, dark
mening- membrane
mes- middle
micr(o)- small
mill- thousand
min- less, smaller
mir- wonder, amazement
mono- single
morph- form, shape
morpho- shape
mort- death
mur- wall
mut- change
myx- slime
nanos- dwarf
ne(o)- new
necr(o)- dead
nephr- kidney
neur- nerve
nigr- black
nov- new
ocul- eye
odont- tooth
olig- few
oma- cancer
oo- egg
operculum- little cover
orth- straight
oxy- sharp, pointed
pach- thick
paed- child
palae-, pale- ancient, old
pan- panto - all
pan-, pam- all
ped- child
ped- foot
pedi - foot
pen- almost
penia- deficiency
pept- peptic, stomach

peri- around
petr- rock
phaeo- dark
phag- eat
philia- love, friendship
phyl- tribe
phyll- leaf
phyt- plant
pil- hair
pir- pear
plas- mould
plen- full
plesi- near
pleth- full
pleur- side
pneu- air, lung
poly- many
porphyr- purple
post- after, behind
pre- before
prim- first
prot(o)- first
pseud(o)- false
psil(o)- bare
psychr(o)- cold
pulmon- lung
purpur- purple
pyl- gate
pyo- pus
pyro- heat, fire
quadr- four
radi- beam, spoke
ram- branch
retro- backward, behind
rhabd- rod
rhin- nose, snout
rhiza- root
ruber, rubra, rubrum- red
sacchar- sugar
sal- salt
sanguin- blood
sapiens- wise
sarc(o)- flesh
schis- split
scler- hard
scop-, scopy, scept- look at, examine, view, observe
scut- shield
serr- saw, saw-toothed
sinus- hollow, bay
soma- body
spher- spheroid
spir- breathe
spor- seed
squam- scale
staphylo- grapelike
stom(a)- mouth, opening
strept- twisted, in chains
sucr- sugar
supra- above, over
syn-, sy-, syl-, sym- with
tach- swift
taenia- ribbon
terr- dry land
terti- third
tetra- four
theca- case
toxo- arrow, dart
trich- hair
troph- feed, grow
und- wave
vac- empty
ver- true
verm- worm
verrucosus- rough skinned
viridis- green
vitr- glass
viv- live
vulg- common, crowd
vulgaris- common
vulner- wound
xanth- yellow

xen- foreign
xer- dry
zyg- yoke
zygos- joined