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Chapter 12. Style and Usage for Life Science

12.1 Manuscript Preparation

The rules for writing in life science are consistent with those in earth and environmental sciences and medical science (see Chapters 11 and 13, respectively, as well as Chapter 2 for basic information on manuscript preparation). As with all scientific writing, it is important to research the specific needs and preferences of the journal to which the manuscript is being sent. This will not only ease the writing process, but will also increase the chances of publication.

12.1.1 Writing for Life Science

In scientific writing, especially in the United States, articles dealing with life science issues are appearing much less frequently than those in other scientific disciplines. Because of this, it is important that writing in this field should be as concise and readable as possible. Articles written in this way, will not only have a higher chance of publication, but will also be more accessible and understandable to readers based in other scientific fields of study.

Life science journal articles will usually contain a summary (in addition to an abstract) or a basic introduction to the piece, separate from the actual text, Summaries, along with the actual title of the article, are scanned for keywords for the purposing of indexing. Many articles (even in professional journals) are made available to the general public. Therefore, titles and summaries should be free of any abbreviations, acronyms, and measures with which those not within the field would be unfamiliar.

A section describing research methods is usually included in a separate section at the end of the manuscript; in life science, however, if this section is brief, it may be omitted and described within the actual text. Descriptions of methods that have already been published may also be omitted and, a reference may be cited in its place.
12.1.2 Taxonomy and Nomenclature

In life science writing, it is important to use the correct taxonomic terms and nomenclature within a document. This is especially true, when these terms are used within the title and the abstract of the manuscript. As previously stated, keywords in the title and abstract are weighed more heavily than those in the rest of the text. These keywords are then used to index the article for its journal. If incorrect terms or unfamiliar or improper abbreviations are used in the title or abstract the article may not be properly indexed, or it may not be indexed at all. This will cause serious obstacles in your audience obtaining, reading, and learning from your document.

If papers contain taxonomy and nomenclature of newly discovered species, authors should be aware that it is possible for third parties to exploit the prior publication of nomenclature at any time between an online posting and the print publication date within a journal. Journals will not take responsibility for assertions of priorities in the cases of manuscripts it publishes, if they have previously appeared in the public domain as online posts or preprints. It is therefore particularly important in this field that the first publication of original research is in a peer-reviewed journal.

When creating any new nomenclatures or taxonomic ranks, one must adhere to the rules and principles established by the governing code in their specific field. For example, when naming plant life and fungi, authors should follow the International Code of Botanical Nomenclature (ICBN); for animals, authors should follow the International Commission on Zoological Nomenclature (ICZN); for bacteria, follow the International Code of Nomenclature of Bacteria (ICNB); and for viruses, the International Committee on Taxonomy for Viruses (ICTV).

These codes are set forth in order to promote uniformity, accuracy, and stability in the nomenclature of new species. Since codes are updated every few years, authors should be aware of any new or revised guidelines before publishing new nomenclature. In order for new nomenclature or taxonomic ranks to be valid, they must be approved and published with their specific code.
12.2 Usage

12.2.1 Biochemical Nomenclature and Abbreviations

12.2.1.1 Nucleic Acids

i. Abbreviations for bases and nucleosides.

Table 12.1 Abbreviations for Bases and Nucleosides

| Nitrogenous Base | Nucleoside       | Abbreviation | Deoxynucleoside | Abbreviation |
|------------------|------------------|--------------|-----------------|--------------|
| Adenine          | adenosine        | A            | deoxyadenosine  | dA           |
| Guanine          | guanosine        | G            | deoxyguanosine  | dG           |
| Cytosine         | cytidine         | C            | deoxycytidine   | dC           |
| Uracil           | uridine          | U            | deoxyuridine    | dU           |
| Thymine          | thymidine        | T            | deoxythymidine  | dT           |
| Unknown purine   | unknown purine   | R            |                  |              |
| Unknown pyrimidine | unknown pyrimidine nucleoside | Y |                  |              |

ii. Conventions for naming bases and nucleosides. The names of bases and nucleosides are treated in written text as common nouns in lowercase.

Concentration of uridine in plasma was elevated.

iii. Designating nucleotide sequences. Nitrogenous bases and nucleosides can be designated by one-letter abbreviations when indicating the sequences of bases.

The telomere DNA sequence in humans is GGGTTA.

By convention, nucleotide sequences start (on the left) at the 5’ end and finish (on the right) at the 3’ end.

5’-ATGGCTATGGCTTTACCCAGTGC-3’
ATGGCTATGGCTTTACCCAGTGC

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Codon triplets can be indicated by placing a space every 3 base pairs.

GCA TTA ACC GGT AGA TAC GCA

iv. Designations for nucleotide length. DNA sequence length is designated in base pairs, which can be abbreviated as *bp* when used as a unit in written text. Abbreviate kilobases as *kb* and megabases as *Mb*.

The enzyme recognizes a 6 bp sequence.
The plasmid is 3.4 *kb* in length.
*C. elegans* has a genome of 97 *Mb*.

Nucleotide length can be indicated by using the suffix *-mer*.

The primer consisting of 22 nucleotides is a 22mer.

v. Designating nucleotide mutations.

| Type of Mutation | Symbol   | Meaning                                      |
|------------------|----------|----------------------------------------------|
| substitution     | T152C    | substitution of T to C at nucleotide 152     |
| deletion         | 29delCG  | deletion of C and G at position 29           |
|                  | 164del20 | deletion of 20 bp at nucleotide 164          |
| insertion        | 774insA | insertion of A at nucleotide 774             |
|                  | 58ins12 | insertion of 12 bp at nucleotide 58          |

Examples:

- Substitution:  **TAG**  →  **TAA**
- Deletion:        **TTGACT**  →  **TGACT**
- Insertion:       **ACG**   →  **ATCG**
vi. Nucleic acid abbreviations.

Table 12.3  Nucleic Acid Abbreviation

| **Deoxyribonucleic Acids** | **Ribonucleic Acids** |
|---------------------------|-----------------------|
| deoxyribonucleic acid     | ribonucleic acid       |
| complementary DNA         | complementary RNA      |
| single-stranded DNA       | single-stranded RNA    |
| Double-stranded DNA       | double-stranded RNA    |
| Nuclear DNA               | nuclear RNA            |
| ribosomal DNA             | ribosomal RNA          |
| heterogeneous nuclear cDNA| heterogeneous nuclear RNA |
| mitochondrial DNA          | messenger RNA          |
|                           | microRNA               |
|                           | RNA interference       |
|                           | small interfering RNA   |
|                           | small nuclear RNA       |
|                           | transfer RNA           |
|                           | mRNA                   |
|                           | miRNA                  |
|                           | RNAi                   |
|                           | siRNA                  |
|                           | snRNA                  |
|                           | snoRNA                 |
|                           | tRNA                   |

12.2.1.2 Amino Acids and Proteins

i. Designating amino acids. The names of amino acids are treated as common nouns in written text.

   alanine
   glycine
   tryptophan

ii. Amino acid abbreviations. Amino acids have three-letter and one-letter abbreviations. Abbreviations for amino acids are not used in written text.
Table 12.4 Amino Acid Abbreviations

| Amino Acid  | Three-Letter Abbreviation | One-Letter Abbrev. | Systematic Name                                                   |
|-------------|---------------------------|--------------------|-----------------------------------------------------------------|
| alanine     | Ala                       | A                  | 2-aminopropanoic acid                                           |
| arginine    | Arg                       | R                  | 2-amino-5-guanidinopentanoic acid                                |
| asparagine  | Asn                       | N                  | 2-amino-3-carbamoylpropanoic acid                                |
| aspartic acid| Asp                       | D                  | 2-aminobutanedioic acid                                         |
| cysteine    | Cys                       | C                  | 2-amino-3-mercaptopropanoic acid                                 |
| glutamic acid| Glu                       | E                  | 2-aminopentanedioic acid                                        |
| glutamine   | Gln                       | Q                  | 2-amino-4-carbamoylbutanoic acid                                |
| glycine     | Gly                       | G                  | aminoothanoic acid                                               |
| histidine   | His                       | H                  | 2-amino-3-(1H-imidazol-4-yl)propanoic acid                      |
| isoleucine  | Ile                       | I                  | 2-amino-3-methylpentanoic acid                                  |
| leucine     | Leu                       | L                  | 2-amino-4-methylpentanoic acid                                  |
| lysine      | Lys                       | K                  | 2,6-diaminohexanoic acid                                        |
| methionine  | Met                       | M                  | 2-amino-4-(methylthio)butanoic acid                             |
| phenylalanine| Phe                      | F                  | 2-amino-3-phenylpropanoic acid                                  |
| proline     | Pro                       | P                  | Pyrrolidine-2-carboxylic acid                                   |
| serine      | Ser                       | S                  | 2-amino-3-hydroxypropanoic acid                                 |
| threonine   | Thr                       | T                  | 2-amino-3-hydroxybutanoic acid                                 |
| tryptophan  | Trp                       | W                  | 2-amino-3-(1H-indol-3-yl)propanoic acid                         |
| tyrosine    | Tyr                       | Y                  | 2-amino-3-(4-hydroxyphenyl)propanoic acid                       |
| valine      | Val                       | V                  | 2-amino-3-methylbutanoic acid                                   |
iii. Designating protein sequences. When presenting protein sequences, use either the three-letter or the one-letter abbreviations for amino acids.

When three-letter symbols are used to represent polypeptides, a hyphen between amino acids indicates a peptide bond. When one-letter symbols are used, a hyphen between amino acids is not necessary.

Met-Glu-Ala-Thr-Arg-Arg-Arg-Gln-His-Leu-Gly-Ala-Thr
MEATRRRQHLGAT

iv. Naming proteins. The word protein, as well as names of proteins, should be written as common nouns in lowercase.

motor protein
hemoglobin
actin

Abbreviations for proteins must be defined when used.

multidrug resistance protein (MDR)
Krüppel-like factor 6 (KLF6)

v. Amino acid mutations. Amino acid sequence mutations may be represented in shorthand form in either 3-letter or 1-letter notation.

A histidine to glutamine amino acid mutation would be designated as follows:

His527Gln
H527Q

vi. Transfer RNAs. The type of transfer RNA (tRNA) may be specified based on its amino acid attachment.

nonacylated tRNA: tRNA$^{Val}$
aminocylated tRNA: Val-tRNA$^{Val}$

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12.2.1.3 Sugars and Carbohydrates

Abbreviations are often used when naming sugars and carbohydrates, especially those that are lengthy with substituted carbons. An example of three-letter abbreviations for parent aldoses is given below.

\[
\begin{align*}
O-\alpha-D-Glc\rightarrow(1\rightarrow4)-D-Glcp & \quad \text{maltose} \\
O-\beta-D-Manp\rightarrow(1\rightarrow4)-D-Manp & \quad \text{mannobiose}
\end{align*}
\]

Table 12.5 Abbreviations for Parent Aldoses

| Number of Carbon Atoms | Parent Name | Three-Letter Abbreviation |
|------------------------|-------------|---------------------------|
| 5                      | ribose      | Rib                       |
|                        | arabinose   | Ara                       |
|                        | xylose      | Xyl                       |
|                        | lyxose      | Lyx                       |
| 6                      | allose      | All                       |
|                        | altrose     | Alt                       |
|                        | glucose     | Glc                       |
|                        | mannose     | Man                       |
|                        | gulose      | Gul                       |
|                        | idose       | Ido                       |
|                        | galactose   | Gal                       |
|                        | talose      | Tal                       |

12.2.1.4 Fatty Acids

Fatty acids can be designated in shorthand by their number of carbons and their number of double bonds, separated by a colon.

18:1 oleic acid

If the number of carbons and double bonds is the same between two or more different fatty acids, the positions of the double bonds is added in parentheses.

20:4(8,11,14,17) eicosatetraenoic acid
20:4(5,8,11,14) arachidonic acid

A fatty acid radical is indicated by adding “acyl” in parentheses.

18:2(acyl) acyl radical of linoleic acid

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12.2.2 Genetics

12.2.2.1 Chromosomes and Chromosomal Components

i. Standard Chromosome Nomenclature

(1) Human chromosomes are autosomal chromosomes numbered 1 through 22, or sex chromosomes designated X or Y.
(2) The chromosome number is followed by the arm designation: p for the short arm of the chromosome, or q for the long arm.
(3) The arm designation is followed by the region number (1 to 4), which specifies a region on the chromosomal arm.
(4) The region number is followed by the band number, a period, the subband number, and, when applicable, the sub-subband number.

Example: 7q32.31

7 = chromosome number
q = long arm
32 = region 3, band 2
31 = subband 3, sub-subband 1

ii. Dimensional units for chromosomes. The unit for distances between genetic loci on a chromosome is the centimorgan (cM).

iii. Designations for anonymous DNA sequences. Anonymous DNA sequences are designated by D-number nomenclature and are named according to their chromosomal location, the sequence type, and the site.

Examples:

| D4S7E     | DXF12S1    |
|-----------|------------|
| D = anonymous DNA sequence | D = anonymous DNA sequence |
| 4 = chromosome 4           | X = X chromosome      |
| S = unique sequence*       | F = family sequence*  |
| 7 = sequence number         | 12 = sequence number  |
| E = expressed sequence*     | S1 = site number      |
Table 12.6 Conventions for Sequence Type Abbreviation

| Abbreviation | *Sequence Type         | Conventions                                      |
|--------------|------------------------|--------------------------------------------------|
| S            | unique DNA sequence    | S is followed by a sequence number               |
| Z            | repetitive DNA sequence| Z is followed by a sequence number               |
| F            | family DNA sequence    | F is followed by a sequence number and then S for site number |
| E            | expressed DNA sequence | E is added at the end of the symbol              |

iv. Designating karyotypes. The karyotype designation begins with the autosomal chromosome number separated by a comma from the sex chromosomes.

47,XY,+13 (male with trisomy 13)

When describing chromosomal abnormalities, abnormal sex chromosomes are designated first, followed by abnormal autosomal chromosomes listed in numerical order.

Karyotype designations may also indicate structural alterations in chromosomes. A single chromosomal rearrangement is indicated in the karyotype using a symbol that identifies the type of chromosomal alteration, followed by the chromosome number in parenthesis. If there has been a rearrangement of more than one chromosome, a semicolon separates the designations. For abbreviations used to indicate chromosomal rearrangements, see Section 12.2.2.5.

Examples:

46,XX,dup(3)(q32q33) indicates duplication of the region between bands 3q32 and 3q33.

46,XY,del(19)(q23q25) indicates deletion in chromosome 19 with rejoining of 19q23 and 19q25.
12.2.2 Human Gene Nomenclature

i. Conventions: symbols for genes and phenotypes. Among the nomenclature committees involved in establishing a system for standardizing human gene nomenclature, are the International Committee on Gene Symbols and Nomenclature, and the HUGO Gene Nomenclature Committee.

Gene names most commonly describe the mutant phenotype or the protein encoded. Gene symbols are usually derived by shortening the original name or by using the initials of a multiword name. They are almost always italicized. Gene symbols followed by an additional letter or Arabic numeral indicate genes with different loci but similar phenotypes.

\[ \text{BRCA1, BRCA2 (breast cancer genes)} \]
\[ \text{PFN1, PFN2 (profilin genes)} \]

ii. Alleles. Alleles are alternative forms of genes. They are often designated by the gene symbol followed by an asterisk, followed by the italicized allele designation.

\[ \text{CFTR*N, CFTR*R} \]

12.2.2.3 Common Genes and Phenotypes

i. HLA nomenclature. Nomenclature guidelines for the human major histocompatibility complex are established by the World Health Organization Committee for Factors of the HLA System. Human major histocompatibility complex gene names begin with HLA-, followed by a locus symbol and designations for subregions or chains.

\[ \text{HLA-DQA1, HLA-DRB4} \]

ii. Symbols representing human retroviral genes. Human retroviral genes are italicized and have a variety of alphanumeric designations.

HIV genes: \textit{gag, pol, env}
HTLV genes: \textit{p19, p24, gp68}
iii. Symbols for oncogenes. Human oncogene sequences are three letters long, written in lowercase, and italicized. For example:

\[ \text{src} \]
\[ \text{myc} \]
\[ \text{ras} \]
\[ \text{erb} \]

To further specify the location or source of the gene, non-italicized prefixes may be used.

\[ \text{c-myc} \quad \text{c- for cellular} \]
\[ \text{v-abl} \quad \text{v- for virus} \]
\[ \text{H-ras} \quad \text{H- for Harvey rat sarcoma} \]
\[ \text{B-lym} \quad \text{B- for B-cell lymphoma} \]

iv. Transspecies gene families: the P450 supergene family. Cytochrome P450 genes are italicized and abbreviated \[ \text{CYP} \], followed by an arabic numeral designating the gene family, a capital letter indicating the subfamily, and another numeral for the individual gene.

\[ \text{CYP2A6} \]
\[ \text{CYP3A43} \]
\[ \text{CYP8A1} \]

v. Conventions for representing bacteriophage genes. Bacteriophage genes are designated by a prefix for the phage, either spaced or unspaced from the name of the gene.

\[ \text{T4 soc} \]
\[ \lambda \text{ int} \]
\[ \phi \text{X174} \]

12.2.2.4 Genes: Related Functional Elements

i. Abbreviated Prefixes for Initiation and Elongation Factors.

Initiation factors are abbreviated IF, followed by a hyphen and alphanumeric designations. Bacterial initiation factors have no prefix, while eukaryotic initiation factors are designated by the lowercase prefix e.

\[ \text{IF-1, IF-2} \quad \text{eIF-4B, eIF-4G} \]
Bacterial elongation factors are designated EF-Tu and EF-G. Eukaryotic elongation factors are designated EF-1 and EF-2.

ii. Designations for Probes

Table 12.7 Abbreviations for Plasmids

| Vector type        | Abbreviation |
|--------------------|--------------|
| plasmid            | p            |
| cosmid             | c            |
| lambda phage       | l            |
| yeast              | y            |

iii. Plasmids notation. Plasmids are designated by a lowercase p for plasmid, followed by a variety of alphanumeric designations. Deletions are conventionally identified using a Greek delta sign. Insertions, transpositions, and translocations are designated using a Greek omega sign.

pMG101
pL258Δ7
pLF273Ω7

iv. Enzymes. Specify the type of enzyme being used, as different enzymes may come from the same organism and have similar names.

Taq DNA ligase
Taq DNA polymerase
Dam DNA ligase
Dam methylase

v. Abbreviations for restriction endonucleases. Restriction endonucleases have a standard three-letter italicized abbreviation (for the source organism) with the first letter capitalized. This is followed by a non-italicized strain designation including arabic or roman numerals.

A BamH1 and SmaI double digest was performed.
The vector includes four EcoRI restriction sites.
vi. Abbreviations for transposons. Transposons in bacteria are designated by Tn followed by italicized alphanumeric designations.

\[ \text{TnA} \quad \text{Tn10} \]

Transposons in eukaryotes are usually not italicized.

\[ \text{P element (Drosophila melanogaster)} \]

12.2.2.5 Field-Specific Abbreviations

Table 12.8 Field-Specific Abbreviations

| Abbreviation | Term                          |
|--------------|-------------------------------|
| ace          | acentric fragment            |
| add          | additional material of unknown origin |
| b            | break                         |
| c            | constitutional anomaly        |
| cen          | centromere                    |
| chr          | chromosome                    |
| cht          | chromatid                     |
| del          | deletion                      |
| dic          | dicentric                     |
| dup          | duplication                   |
| e            | exchange                      |
| fra          | fragile site                  |
| g            | gap                           |
| h            | heterochromatin               |
| i            | isochromosome                 |
| ins          | insertion                     |
| inv          | inversion                     |
| mar          | marker chromosome             |
| mos          | mosaic                        |
| rea          | rearrangement                 |
| rec          | recombinant chromosome        |
| s            | satellite                     |
| t            | translocation                 |
| tan          | tandem                        |
| tel          | telomere                      |
| tri          | tricentric chromosome         |
| v            | variable region               |
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12.2.2.6 Standard Symbols

Table 12.9 Symbols for Terms in Genetics

| Symbol                  | Term                      |
|-------------------------|---------------------------|
| superscript plus sign (⁺) | wild-type allele          |
| superscript minus sign (⁻) | mutant allele             |
| Δ                       | deletion                  |
| IN                      | inversion                 |
| double colon (::)       | insertion                 |
| Φ                       | fused genes               |
| p                       | promoter site             |
| t                       | terminator site           |
| o                       | operator site             |
| a                       | attenuator site           |
| p                       | short arm of chromosome   |
| q                       | long arm of chromosome    |

12.2.2.7 Sources for Specialized Terminologies

• Home Page of the Human Cytochrome P450 (CYP) Allele Nomenclature Committee. Available from: http://www.cypalleles.ki.se/

• HUGO Gene Nomenclature Committee. London (UK): HUGO Nomenclature Committee. Available from: http://www.gene.ucl.ac.uk/nomenclature

• IMGT/HLA Sequence Database. Cambridge (UK): European Bioinformatics Institute; 2005. Available from: http://www.ebi.ac.uk/imgt/hla/

• International Committee on Genetic Symbols and Nomenclature. Report of the International Committee on Genetic Symbols and Nomenclature. Union Int Sci Biol, Ser B. 1957; (30):1-6.

• ISCN 1995. An International System for Human Cytogenetic Nomenclature. Mitelman F, editor. Basel (Switzerland): Karger, 1995.
12.2.3 Other Abbreviations and Nomenclature Conventions

12.2.3.1 Format for the Description of Cell Lines

Cell lines are commonly referred to by acronyms and should be defined at first mention.

HUVEC (human umbilical vein endothelial cells)
CHO (Chinese hamster ovary cells)

12.2.3.2 Isotopes

Abbreviations for radioactive isotopes should be defined when used for the first time. To indicate that the nonradioactive isotope is normally part of the compound, use brackets around the isotope symbol.

The phospholipid was labeled with radioactive phosphate $\left[^{32}\text{P}\right]$

$\left[^{32}\text{P}\right]\text{phospholipid}$

When the isotope is not normally part of the compound, do not use brackets. Instead, separate the element from the compound with a hyphen.

$^{131}\text{I}$-human growth hormone
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For uniformly labeled compounds, write the abbreviation \textit{ul} in parenthesis following the compound name.

\[ ^{14}\text{C}]\text{glucose (ul)} \]

12.2.4 Taxonomy and Nomenclature

See Appendix G.000, for a complete list of taxonomy ranks and endings.

12.2.4.1 General Rules

i. **Standard format for naming taxa.** There are seven basic taxa: kingdom, phylum (or division), class, order, family, genus, and species. Any of these taxa can be prefixed by either \textit{sub-} or \textit{super-} to further extend the taxonomic categories.

   The names of taxa at the rank of family and above are written in plain roman type; names of taxa for genus and below are italicized. Names of taxa at the level of genus and above have an initial capital letter.

   When the taxonomic term precedes the name, the taxonomic term is written in lowercase, as in “kingdom Bacteria.”

   Names of taxa at the rank of family and above are treated as plural, while names of taxa for genus and below are treated as singular.

   The family Micrococcaceae are…

   The genus \textit{Python} is…

ii. **Standard format for scientific names.** Only the names of taxa at the rank of genus and above may stand alone as monomials. Names of taxa at the level of species and below cannot stand alone and must be preceded by the genus name. The first letter of the genus name is capitalized, the species name is written in all lowercase letters, and the entire name is italicized.

   The genus \textit{Homo}…

   The species \textit{Homo sapiens}…

A species name may be abbreviated if the full name is used at first mention. Thus, \textit{Staphylococcus aureus} becomes \textit{S. aureus}.
12.2.4.2 Bacteria

i. Format for descriptions of taxa. Bacterial nomenclature is defined by the International Committee on Systematic Bacteriology in the *International Code of Nomenclature of Bacteria*. Typical taxonomic endings are shown for examples of bacterial species. See Section 12.2.4.1, above.

Table 12.10 Bacterial Nomenclature

| Taxon     | Name             |
|-----------|------------------|
| Kingdom   | Archaea          |
|           | Bacteria         |
|           | Eubacteria       |
| Phylum    | Euryarchaeota    |
|           | Proteobacteria   |
|           | Firmicutes       |
| Class     | Halobacteria     |
|           | Gamma Proteobacteria |
|           | Bacilli          |
| Order     | Halobacterales   |
|           | Enterobacterales |
|           | Lactobacillales  |
| Family    | Halobacteriaceae |
|           | Enterobacteriaceae |
|           | Streptococcaceae |
| Genus     | *Halobacterium*  |
|           | *Escherichia*    |
|           | *Streptococcus*  |
| Species   | *Halobacterium*  |
|           | salinarum       |
|           | *Escherichia*    |
|           | *coli*           |
|           | *Streptococcus*  |
|           | *pneumoniae*     |

ii. Standards for scientific names. Using the name of a genus on its own suggests the genus as a whole.

*Streptococcus* is comprised of gram-positive bacteria.

Using the term species after the genus name implies that the genus is certain but the species is not.

*Streptococcus* species are part of the normal flora of the mouth.

iii. Designations for infrasubspecific taxa and strains. Infrasubspecific subdivisions, or subdivisions below the subspecies level, are not included in the Bacteriological Code but are useful for practical purposes. These designations include:

- biovar or biotype (bv.)
- serovar or serotype (sv.)
- pathovar or pathotype (pv.)
Infrasubspecific subdivisions, biovars, and biotypes are designated with letters or numbers.

_Agrobacterium vitis_ biovar III  
_Fusobacterium necrophorum_ biovar A

Infrasubspecific subdivisions serotype, serovar, and type are useful for designating strains. For instance, _Escherichia coli_ strains are designated by the O:K:H serotype profile.

_Escherichia coli_ O1:K1:H7  
_Escherichia coli_ O126:H27

_Haemophilus influenzae_ strains are designated by types a through f.

_Haemophilus influenzae_ type a

_Salmonella_ strains are designated by the infrasubspecific divisions serotype/serovar.

_Salmonella_ serotype Enteritidis, serovar Enteritidis  
_Salmonella_ serotype Muenchen, serovar Muenchen

Furthermore, _Salmonella_ serotypes are expressed as O, Vi, and H antigen types. The letters O, Vi, and H are not included in the serotype, which is composed of alphanumeric designations separated by colons.

_Salmonella_ serovar Typhi 9:d:k

iv. Vernacular names and adjectival forms. Vernacular names for bacteria are written in lowercase roman letters.

rhizobia  cholera  typhoid

Adjectival forms derived from scientific names usually end in _-al_, but the noun form may also serve as the adjective. A genus name in lowercase roman letters may be used as a vernacular adjective.

staphylococcal infection  
staphylococcus infection
Traditional plural designations can be used for vernacular plurals. If the
generic plural is unknown, add the word “organisms” to the genus name.

staphylococci
Escherichia organisms

v. Field-specific abbreviations. Bacteria that are well characterized but
cannot be maintained or isolated in culture are given Candidatus status.
These terms should be written in quotation marks, with the word Candidatus italicized and the taxon name in roman: “Candidatus Phytoplasma allocasuarinae.” Candidatus can subsequently be abbreviated Ca. Names of bacteria used in laboratory media are written in lowercase roman letters, as in “salmonella agar.”

vi. Standard Symbols

Table 12.11 Standard Symbols for Taxonomy and Nomenclature for Bacteria

| Symbol | Term            |
|--------|-----------------|
| p      | promoter site   |
| t      | terminator site |
| o      | operator site   |
| a      | attenuator site |
| superscript s, as in Kan\(^s\) | drug sensitive |
| superscript r, as in Amp\(^r\) | drug resistant |

vii. Sources for Specialized Terminologies

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12.2.4.3 Viruses

i. Format for descriptions of taxa. A system for classifying viruses was established by the International Committee on Taxonomy of Viruses (ICTV). In viral classification, there are no ranks above the level of order. Specialist groups (not the ICTV) deal with taxa below the level of species. Names of orders are not italicized, while names of families, genera, and species are italicized. See Section 12.2.4.1.1.

Table 12.12 Suffixes for Virus Taxonomy

| Taxon      | Suffix     |
|------------|------------|
| Order      | -virales   |
| Family     | -viridae   |
| Subfamily  | -virinae   |
| Genus      | -virus     |
| Species    | -virus     |

ii. Standards for scientific names. Although virus species do not have Latin names, the name of the virus is formally written in italics, with the first word of the species name capitalized. Other words in the virus name are capitalized only if they are proper nouns.

Ebola virus
Epstein-Barr virus
iii. **Acronyms for viruses.** Acronyms can be used to designate viruses when the full virus name is used at first mention. Abbreviations for some common virus species are listed below.

*human papillomavirus* (HPV)

*rabies virus* (RABV)

**Table 12.13 Abbreviations for Common Virus Species**

| Virus Species                      | Abbreviation |
|-----------------------------------|--------------|
| California encephalitis virus     | CEV          |
| Ebola virus                       | EBOV         |
| hepatitis A virus                 | HAV          |
| hepatitis B virus                 | HBV          |
| hepatitis C virus                 | HCV          |
| human adenoviruses 1 to 47        | HAdV-1 to 47 |
| human coronavirus                 | HCV          |
| human herpesvirus 1 to 6          | HHV-1 to 6   |
| human papillomavirus              | HPV          |
| human parainfluenza virus         | HPIV         |
| human rhinovirus                  | HRV          |
| human T-lymphotropic virus        | HTLV         |
| measles virus                     | MeV          |
| rabies virus                      | RABV         |
| rotavirus                         | ROTAV        |
| rubella virus                     | RUBV         |
| variola (smallpox) virus          | VARV         |

iv. **Strain designations.** Strain designations are regulated by international specialist groups, not the ICTV. Information about the virus strain may be included in the virus name. The strain designation may be separated from the virus name by a dash.

HaCPV-B (*Heliothis armigera cypovirus*, strain B)

v. **Designations for vernacular names of viruses.** Family, genus, and species classifications can all be given in the vernacular. Vernacular terms can be ambiguous because the same name can be used for more than one taxonomic level. Therefore, vernacular names should be used with the specific taxonomic rank term.

topovirus genus           topovirus species
vi. Sources for Specialized Terminologies

• The Universal Virus Database of the International Committee on Taxonomy of Viruses. Available from: http://www.ncbi.nlm.nih.gov/ICTVdb/index.htm

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12.2.4.4 Plants, Fungi, Lichens, and Algae

i. Plants

a. Rules for Stylistic Treatment of Nomenclature

1. Format for descriptions of taxa. The ultimate authority on the International Code of Botanical Nomenclature is the International Botanical Congress. Typical endings for the taxonomic ranks are shown below. See Appendix G, Table H.000 for a full table on ranks in plants taxonomy.

| Taxon      | Suffix |
|------------|--------|
| Division   | –phyta |
| Subdivision| –phytina|
| Class      | –opsida|
| Subclass   | –idae  |
| Order      | –ales  |
| Family     | –aceae |
| Subfamily  | –oidene|
| Tribe      | –eae   |
| Subtribe   | –inae  |
| Genus      | –us    |
2. Standards for scientific names. Scientific names for plants are written using the standard Latin binomial system of nomenclature. The first name represents the genus and is capitalized, the second name identifies the species and is written in lowercase, and the entire name is italicized. See Section 12.2.4.1: General Rules.

3. Format for the publication of names. Requirements for publishing plant names of any taxonomic rank are specified in the International Code of Botanical Nomenclature. A person who publishes a scientific name is considered the author of that name, though citation of the author’s name is optional. The author’s name is not italicized, and follows the italicized scientific name. For names published by Linnaeus that are still valid, the author is designated as “L.”

4. Vernacular names for plants. Vernacular names may be genus or family names and should be written in all lowercase letters. Vernacular names are not capitalized unless they are proper nouns.

   pine
   Canary Island pine

   When the vernacular name does not reflect the correct taxonomic position of the plant, join the terms with a hyphen. However, it should be noted that this rule is practiced inconsistently.

   poison-oak (belongs to a different genus from true oak)
   white oak (a true oak)

5. Synonyms and homonyms. Valid scientific names should not be synonyms or homonyms. However, synonyms and homonyms do exist for scientific and vernacular names. Multiple names used for the same species (synonyms) or names that sound the same but represent different species (homonyms) pose problems in consistency and in retrieval of data and should be avoided if possible.
b. Cultivar notation. Cultivar notation is defined by the *International Code of Nomenclature for Cultivated Plants* (ICNCP). Cultivar names are written in roman type with an initial capital letter and are placed within single quotation marks when they come after the scientific name. Single quotation marks are not needed when the cultivar name is used alone.

 Miscanthus sinesis ‘Adagio’
 Adagio

c. Designating hybrids. Hybrids are designated by a formula in which the names of the parents are separated by a multiplication symbol. If no other convention is specified, list the names in alphabetical order.

 Magnolia × soulangeana
 Fragaria × ananassa

d. Orchid nomenclature. Orchid nomenclature is governed both by the *International Code of Botanical Nomenclature* and the *International Code of Nomenclature for Cultivated Plants*. All described orchid species are named using the standard Latin binomial system.

e. Construction of common names for plant diseases. Plant disease names are usually based on the major disease symptom or on the pathogen responsible for the disease. A recommended list of common names for plant diseases has been published by the American Phytopathological Society. When the Latin name of the pathogen is part of the disease name, the Latin word should be italicized and its first letter should be capitalized.

 Aphanomyces root-rot

 The same disease name may be used even when the disease is caused by different pathogens in different host species. In order to avoid confusion, include the host name as part of the disease name.

 southern corn leaf blight (caused by a fungus)
 leaf blight of rice (caused by a bacterium)
Plant diseases caused by nematodes are described using the common name of the nematode pathogen.

root-gall nematode disease
root-knot nematode disease

ii. Fungi

a. Format for descriptions of taxa. Fungal nomenclature is defined by the *International Code of Botanical Nomenclature*. Typical endings for the taxonomic ranks are shown below.

| Taxon       | Suffix        |
|-------------|--------------|
| Division    | -mycota      |
| Subdivision | -mycotina    |
| Class       | -mycetes     |
| Subclass    | -mycetidae   |

b. Standards for scientific names. The scientific name of a fungus is written with the first letter of the genus name capitalized, the species name written in all lowercase letters, and the entire name italicized. See Section 4.1: General Rules.

*Glugea heraldi*
*Vairimorpha plodiae*

Fungal genera are not written in plural form. To refer to a group of species in a genus, write the abbreviation for *species* after the genus name. The abbreviation for species is either sp. (for a group composed of one species) or spp. (for a group consisting of two or more different species).

*Pleistosporidium* sp.
*Bacillidium* spp.
c. Designations for infrasubspecific taxa and strains. Infrageneric or infraspecific rank names are preceded by an abbreviation indicating the taxonomic rank. This abbreviation is not capitalized or italicized.

*Banksia* subg. *Isostylis*

*Erigonum longifolium* subsp. *Diffusum*

Below the rank of species, the scientific name may be written in shortened form.

*E. longifolium* var. *plantagineum*

d. Yeasts and slime molds. Rules for naming both yeast and slime molds follow the guidelines set for fungi in the Botanical Code. *Yeast* is not a taxonomic term, but is usually applied to fungi in the order Saccharomycetales. In a scientific paper, the word *yeast* can be used if the scientific name is used at first mention. Yeast used for cooking or brewing are not usually identified by genus or species names.

Table 12.16  Yeast Gene Conventions

| Feature                        | Convention                              | Examples |
|--------------------------------|-----------------------------------------|----------|
| Gene symbol                    | Three italic letters                    | ARG arg  |
| Gene locus                     | Italicized number following the symbol  | ARG2     |
| Dominant allele                | Capitalized italic letter               | ARG2     |
| Recessive allele               | Lowercase italic letters               | Arg      |
| Allele designation             | Italicized number following the locus number and a hyphen | Arg2-14 |
| Gene cluster                   | Italicize capital letter following the locus number | His4A his4B |
| Wild-type gene                 | Added plus symbol (sign)                | ARG2+    |
| Gene conferring resistance or susceptibility | Superscript R or S, not italicized | CUP^R1    |
| phenotype                      | same characters as gene symbol, but not italicized; superscript + and − | arg− arg+ |
iii. Lichens. A lichen is a made up of a fungus and an alga. Nomenclature for lichens reflects their fungal components. Lichens are commonly referred to by their vernacular names.

*Flavoparmelia caperata* belongs to the fungal genus *Flavoparmelia*. 
*Cladonia rangiferina* is also known as Reindeer lichen. 
*Cetraria islandica* is also known as Iceland moss.

iv. Algae. The word *algae* is not a taxonomic term. The same nomenclature style and format rules set forth for plants in the Botanical Code are also applied to algae. Typical taxonomic endings are shown below.

**Table 12.17 Taxonomic Nomenclature for Algae**

| Taxon   | Name          |
|---------|---------------|
| Kingdom | Protista      |
| Phylum  | Heterokontophyta | Rhodophyta | Chlorophyta |
| Class   | Phaeophyceae  |
| Order   | Fucales       |
| Family  | Fucaceae      |
| Genus   | Fucus         |
| Species | *Fucus serratus* | *Chondrus crispus* | *Ulva lactuca* |

v. Sources for Specialized Terminologies

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12.2.4.5 Human and Animal Life

i. Format for designating taxonomic categories. Nomenclature rules for taxonomic designation of animals are given by the *International Code of Zoological Nomenclature*. The International Commission on Zoological Nomenclature produces official lists of approved scientific names. See above, Section 12.2.4.1: General Rules.

ii. Format for author names. Inclusion of the author’s name as part of the genus or species name is optional. When the author’s name is included, it should also include the year in which it was named and be written in this format:

*Enhydra lutris*, Linnaeus 1758

A document’s list of references should include the publication in which the taxonomic name was published.

iii. Vernacular names. Common names are not capitalized except in the case of proper names. Lists of scientific names with approved common names have been published for species in a number of phyla, including insects, reptiles, fish, birds, and mammals.

iv. Designation systems for laboratory animals. The International Index of Laboratory Animals provides information on inbred animal strains. A system for specifically designating inbred strains of mice has been established by the Committee on Standardized Genetic Nomenclature for Mice (CSGNM).

v. Sources for Specialized Terminologies

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12.2.5 Preferred Units in the Life Sciences

Preferred units have been established by the International System of Units (SI). SI units are recognized by international agreement, but they are not used exclusively in the United States, which may require dual reporting with metric units. For example, the Celsius scale (°C) is acceptable for reporting temperature rather than the SI unit, the kelvin (K). For SI derived units, multiplying prefixes, and conversion factors, see Appendix B1.

Table 12.18 Abbreviations for Common Measurement Units

| Measurement                  | SI Unit       | SI Abbreviation |
|------------------------------|---------------|-----------------|
| Length                       | meter         | m               |
| Mass                         | kilogram      | kg              |
| Volume                       | liter         | L               |
| Quantity of substance        | mole          | mol             |
| Molecular weight of substance| grams per mole| g/mol           |
| Time                         | second        | s               |
| Temperature                  | kelvin        | K               |
| Electric current             | ampere        | A               |
| Luminous intensity           | candela       | cd              |

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12.3 Lists of Life Science Tables and Appended Material

12.3.1 Tables in This Chapter

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- Table 12.2 Meaning of Mutation Symbols
- Table 12.3 Nucleic Acid Abbreviation
- Table 12.4 Amino Acid Abbreviations
- Table 12.5 Abbreviations for Parent Aldoses
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12.3.2 Contents of Appendix G in Part III

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G2 Table of Ranks In Plant Taxonomy
G3 Table of Common Viral Abbreviations
C4 Taxonomic Name Endings
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